MASTER OF SCIENCE IN CHEMISTRY

(M. Sc. Chemistry)

A TWO YEAR FULL TIME REGULAR COURSE

SYLLABUS CONTENT

2020-2021

A CHOICE BASED CREDIT SYSTEM SYLLABUS

DEPARTMENT OF CHEMISTRY
FAKIR MOHAN UNIVERSITY,
VYASA VIHAR, BALASORE-756089
ODISHA, INDIA

Distribution of Course in Semester pattern under Choice Based Credit System (CBCS) for Master of Science in Chemistry (M. Sc. Chemistry) Programme, effective from the academic year 2020-2021 onwards.

SEMESTER I

Core Paper	*Code*	*Paper Name*	*Credit*	*Full Marks*	TOTAL MARKS
Theory	CH-411	Organic Chemistry-I	4	40 + 10	
Theory	CH-412	Inorganic Chemistry-I	4	40 + 10	
Theory	CH-413	Physical Chemistry-I	4	40 + 10	
Theory	CH-414	Spectroscopy-I	4	40 + 10	**300**
Practical	CH-415	Organic Chemistry	8	100	

SEMESTER II

Core Paper	*Code*	*Paper Name*	*Credit*	*Full Marks*	TOTAL MARKS
Theory	CH-421	Organic Chemistry-II	4	40 + 10	
Theory	CH-422	Inorganic Chemistry-II	4	40 + 10	
Theory	CH-423	Physical Chemistry-II	4	40 + 10	
Theory	CH-424	Spectroscopy-II	4	40 + 10	**300**
	---	*Add on Course from MOOC*	*Non Credit Course*		
Practical	CH-425	Inorganic Chemistry	8	100	

SEMESTER III

Core Paper	*Code*	*Paper Name*	*Credit*	*Full Marks*	TOTAL MARKS
Theory	---	*Fakir Mohan Studies*	*Non Credit Course*		
		MOOC From SWAYAM	*Non Credit Course*		
Theory	CH-531	Organic Chemistry-III	4	40 + 10	
Theory	CH-532	Bioinorganic and Supramolecular Chemistry	4	40 + 10	**300**
Theory	CH-533	Analytical and Environmental Chemistry	4	40 + 10	
Theory	*CH-534# (CBCS)*	*The Chemistry of Life and Surroundings*	*4*	*40 + 10*	
Practical	CH-535	Physical Chemistry	8	100	

SEMESTER IV

Core Paper	*Code*	*Paper Name*	*Credit*	*Full Marks*	TOTAL MARKS
Theory	CH-541	Organic Synthesis	4	40 + 10	
Theory	CH-542	Bio physical and Solid state Chemistry	4	40 + 10	
Viva-voce	CH-543	Grand Viva (covering full syllabus)	4	50	**300**
Practical	CH-544	Analytical Chemistry	4	50	
Dissertation	CH-545	Dissertation work Presentation & Defense	8	100	

This is a Choice based Credit Paper open for all other departments student **except the Dept. of Chemistry students**.

SEMESTER-I

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-411	**ORGANIC CHEMISTRY-I**	4	10	40

Objectives	The basic objective of this course is to introduce students the basic concept of the mechanism for the synthesis of desired product
Pre-Requisites	Knowledge on structure of carbon compounds, electronegativity, chemical bonding.
Teaching Scheme	Regular classroom lectures with use of chalk and black board. Sessions are planned to be interactive with focus on problem solving activities.

Detailed Syllabus

Unit I– Basic Principles of Organic Chemistry

Applications of Inductive effect, Resonance and Hyper conjugation, Aromaticity in benzenoid & non benzenoid compounds, Huckel's Rule, energy level of κ- molecular orbital, n-Anulenes, heteroannulene, fullerenes, C-60, Anti aromaticity, y-aromaticity, homo-aromaticity, PMO approach. Bonds weaker than covalents; Addition compounds, Crown ether complexes and cryptands, inclusion complexes, cyclodextrins, catenanes and rotaxanes. Hard-Soft Acid Base (HSAB) Principle.

Reaction Intermediates: Classification, structure, stability, generation and of carbocation, Carbanion, carbene, and free radicals.

Unit II– Stereochemistry and Reaction Mechanism

Stereochemistry: Conformation of cycloalkanes & decalins, Effect of Conformation on reactivity, Elements of symmetry, chirality, molecules with more than one chiral center, projection formulae (i) Fischer (ii) Sawhorse (iii) Newman(iv) Flying Wedge; threo- and erythro isomers, Conformation of sugars, Optical activity in absence of chiral carbon (biphenyls, allenes and spirans), Chirality due to helical shape, Asymmetric synthesis. Racemic modification, Resolution of racemic modification, optical purity, absolute and relative configuration, R, S nomenclature, optical purity, Enantiotropic and Diastereotropic atoms, groups and faces; Stereospecific and Stereoselective Synthesis; E, Z- notations.

Reaction Mechanism: Types of mechanisms, Type of reactions, Thermodynamic and Kinetic requirements, Kinetic and thermodynamic control, Hammond's postulate, Potential Energy Diagram, Isotope Effect, The Hammett Equation and linear free energy relationship (sigma-rho), Substituent & Reaction constants, Taft Equation.

Unit III– Aliphatic substitution

Aliphatic nucleophilic substitution: SN^2 and SN^1 mechanisms, Ion Pairs in SN^1-mechanisms, mixed SN^1 and SN^2 – mechanism, SET mechanism, SN^i – mechanism, nucleophilic substitution at allylic, vinylic and aliphatic trigonal carbon, neighbouring group participation, non-classical carbocation, effect of structure of the substrate, attacking nucleophiles, solvent, leaving group on reactivity of nucleophilic substitution.

Aliphatic Electrophilic Substitution: S_{E2} and S_{E1}. The S_{E2}, S_{E1} and S_{Ei} mechanisms. Electrophilic Substitution at allylic substrate. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Unit IV– Free Radical and Elimination Reaction

Free Radical Reactions: Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, Neighbouring Group Assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity. Allylic halogenations(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.

Elimination Reactions: The E_2, E_1 and E_1cB mechanisms and their spectrum. Orientation of the double bond. Reactivity-effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination.

Course Outcome	At the end of the course, the students will be able to: i) Various approaches of mechanisms. ii) Able to explain the mechanism of synthesized compounds.

Books Recommended;

Text book:

1. Advanced Organic Chemistry by J. March, John Wiley & Sons, 1992
2. Stereochemistry of Carbon Compounds by E. J. Eliel, McGraw Hill
3. Advanced Organic Chemistry, Part – A by F. A Carey and R. J sundberg, Plenum Press

Reference book:

1. Organic Chemistry by J Clayden, N Greeves, S Warren & P Wothers, Oxford University Press.
2. Structure and Mechanism in Organic Chemistry, C K Ingold, Cornell Univ. press
3. Modern Organic Reactions, H.O. House, Benjamin.
4. Organic Chemistry by S. H. Pine, McGraw Hill, 1987.
5. Stereochemistry of Organic Compounds by D. Nasipuri, Wiley, 1994
6. Organic Chemistry by Janice G. Smith, McGraw Hill, 2008.
7. The Art of Writing Reasonable Organic Reaction Mechanisms, by Robert B. Grossman, Springer
8. Understanding Organic Reaction Mechanisms, by Adam Jacobs, Cambridge University Press.

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-412	**INORGANIC CHEMISTRY-I**	4	10	40

Objectives	The basic objective of this course is to introduce students the symmetry of various materials, the cause of various shape of different compounds and basic concepts of Co-ordination chemistry.
Pre-Requisites	Knowledge on the shape and bonding of various molecules.
Teaching Scheme	Regular classroom lectures with use of chalk and black board. Sessions are planned to be interactive with focus on problem solving activities.

Detailed Syllabus

Unit I– Symmetry and Group theory in Chemistry

Symmetry elements and symmetry operation, definitions of group, subgroup, relation between orders of a finite group and its subgroup. conjugacy relation and classes. Generators, Point symmetry groups.

Matrix representations of group operators (representation for the C_n, C_{nv}, C_{nh}, D_{nh} etc…), Nomenclature and symmetry classification of molecules. The Great Orthogonality theorem (without proof) and its explanation. Irreducible and reducible representation of a point group and relation between them, Bases of Representation, Character of Representation. Brief ideas on Character table and its uses.

Unit II– Structure and bonding in main group compounds and non-transition metal chemistry

VSEPR Theory; Walsh diagrams (tri and penta atomic molecules), dK-pK bonds; Bent Rule and Energetics of Hybridization; some simple reactions of covalent bonded molecules.

Non-transition Metal Chemistry: Synthesis, Properties, Structure and Bonding of: Nitrogen, Phosphorous, Sulfur, Pseudohalogen, Interhalogen and Xenon Compounds

Unit III– Metal- Ligand Equilibrium in solution

Step wise and overall formation constants and their interactions trends in step wise constants; Factors affecting the stability of the metal complexes with reference to the nature of the metal ion and the Ligand chelate effect and its thermodynamic origin. Determination of binary formation constants by pH metry and spectrophotometry.

Unit IV–Reactivity of Transition Metal and Coordination Compound complexes

Energy profile of a reaction, Reactivity of metal complexes; inert and labile complexes. Kinetic application of Valence bond and Crystal field theories; Kinetics of Octahedral substitutions. Acid hydrolysis & factors affecting it; base hydrolysis; conjugate base mechanism; anation reactions, Reaction without metal Ligand bond cleavage, Substitution reactions in square planar complexes. The Trans Effect.

Reactivity of Co-ordination Compounds: Redox reaction of Co-ordination Compounds, Electron transfer versus atom transfer, Complementary and non-complimentary redox reactions, one and two electron transfer reaction, unstable oxidation states. Mechanism of electron transfer reactions: Inner sphere type and outer sphere type reactions, Marcus theory.

Course Outcome	At the end of the course, the students will be able to: i) The stability of the molecule or object. ii) Mechanism of the reactivity of various co-ordination compounds.

Books Recommended;

Text book:

1. Inorganic Chemistry: Principles of Structure and Reactivity by J. E. Huheey, E. A. Keiter and R. L. Keiter, 4th ed. Harper Collins 1993
2. Inorganic Chemistry by Meissler and Tarr, pearson Education India
3. Concepts and Models of Inorganic Chemistry by B. E. Douglas, D. H. McDaniel and J. J. Alexander, John Wiley, 1993, 3rd ed.

Reference book:

1. Advanced Inorganic Chemistry, F. A. Cotton and Wilkinson, John Wiley
2. Mechanism of Inorganic Reactions by Fred Basalo, Ralph G. Pearson.
3. Chemistry of the Elements by N. N. Greenwood and A. Earnshaw, Pergamon, 1985.
4. Physical Inorganic Chemistry: A Coordination Chemistry Approach by S. F. A. Kettle, Spektrum, 1996
5. Inorganic Electronic Spectroscopy by A. B. P. Lever, Elsevier, 1984, 2nd Ed.
6. Inorganic Chemistry by Catherine E. Housecroft, Alan G. Sharp
7. Concise inorganic chemistry by J D Lee

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-413	**PHYSICAL CHEMISTRY-I**	4	10	40

Objectives	The basic objective of this course is to introduce students the phenomenon of explaining not only the microscopic particles but also macroscopic particles.
Pre-Requisites	Knowledge of microscopic and macroscopic particles, mathematical concepts such as integration, derivative, etc..
Teaching Scheme	Regular classroom lectures with use of chalk and black board. Sessions are planned to be interactive with focus on problem solving activities.

Detailed Syllabus

Unit I– Quantum Chemistry I

Quantum Mechanical Results: The Schrodinger equation and the postulates of quantum mechanics. Discussion of the Schrödinger equation to some model systems viz, particle in 1and 3dimensional box. the harmonic oscillator. the rigid rotator. the hydrogen atom.

Angular Momentum: Ordinary angular momentum, generalized angular momentum, Eigen functions for angular momentum, Addition of angular moments, Pauli exclusion principle.

Unit II– Quantum Chemistry II

Electronic Structure of Atoms and Many Electron Systems: Electronic configuration. Russel-Saunders terms and Coupling schemes, spin orbit coupling (L-S and J-J coupling), Zeeman splitting. Qualitative treatment for many electron atom, the variation principle, spectral terms for p^1, p^2 and d^1, d^2 metal ions.

Molecular Orbital Theory: Huckel theory of conjugated system. Application to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene. Calculation of bond order and charge density.

Unit III– Classical Thermodynamics

Brief resume of concept of enthalpy, entropy, free energy, and laws of thermodynamics, partial molar properties, chemical potential, effect of temperature and pressure. Activity, activity coefficient, determination of activity and activity coefficient, Ionic strength, Concept of fugacity and its determination by i) Graphical method, ii) From equation of state, iii) Approximation method. Nernst heat theorem and its application to solid. Third law of thermodynamics, Experimental determination of entropy by third law.

Unit IV– Non Equilibrium Thermodynamics

Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, entropy balance equation for different irreversible process. transformation of the generalized fluxes and forces.

Non equilibrium stationary states, microscopic reversibility and Onsager's reciprocity relations. Electro kinetic phenomena, diffusion, electric conduction, irreversible thermodynamics for biological System, coupled reactions.

Course Outcome	At the end of the course, the students will be able to: i) Know the phenomenon happening in microscopic particles as well as macroscopic particles. ii) Know the thermodynamic properties of materials.

Books Recommended;
Text book:

1. Physical Chemistry by P. W. Atkins
2. Molecular Quantum Mechanics by P. W. Atkins and R. S. Friedman, 3rd Ed.,
3. Elementary Quantum Chemistry by F. L. Pilar, Dover Publications, Inc. NY, 1990. 2nd Ed Oxford Univ. Press, 1997.

Reference book:

1. Thermodynamics: Statistical Thermodynamics and Kinetics by Thomas Engel and Philip Reid, Pearson
2. Quantum Chemistry by Ira N. Levine, Prentice Hall,
3. Introduction to Quantum Chemistry by A. K. Chandra, Tata McGraw Hill.
4. Physical Chemistry: Thomas Engel and Philip Reid
5. Advanced Physical Chemistry, (vol.- I, II, III, IV, V) K. L. Kapoor, Macmillan, 2004

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-414	**SPECTROSCOPY-I**	4	10	40

Objectives	The basic objective of this course is to introduce students the basic concept of different instruments used to characterize the materails.
Pre-Requisites	Knowledge about the symmetry and electronic concept of various materials.
Teaching Scheme	Regular classroom lectures with use of chalk and black board. Sessions are planned to be interactive with focus on problem solving activities.

Detailed Syllabus

Unit I– Microwave and Infra-Red Spectroscopy

Microwave Spectroscopy: Classification of molecules, Rigid rotator Model, Effect of Isotopic substitution on the transition frequencies, Intensities, Non- Rigid Rotator, Stark Effect, Nuclear and Spin Interaction and effect of external field, Applications.

Infrared Spectroscopy: vibrational Energies of diatomic molecules, Zero-point energy, Force constant, bond strengths: anharmonicity, Morse Potential Energy diagram. Vibrational-Rotational Spectroscopy, P, Q, R branches, Breakdown of Oppenhemer approximation, Vibration of polyatomic molecules selection rule, normal modes of vibration, group frequencies, Overtones, hot bands, Factors affecting the band positions and intensities, far IR- region.

Unit II– Raman and Atomic Spectroscopy

Raman Spectroscopy: Classical and Quantum theories of Raman effect, pure rotational, Vibrational and Vibrational-rotational Raman spectra. Selection rule, Mutual Exclusion Principle. Resonance Raman spectroscopy, Coherent antistokes Raman spectra.

Atomic Spectroscopy: Energies of atomic orbital's, Vector representation of Momentum and Vector coupling, Electronic Configuration, Russell- Saunders terms and coupling schemes, magnetic Effects: Spin- orbit coupling and Zeeman Coupling, Spectra of hydrogen atom and alkali metal atoms.

Unit III– Molecular and Spin Resonance Spectroscopy

Molecular Spectroscopy: Energy levels, Molecular orbital's, Vibronic Transition, Vibrational Progressions and geometry of excited states, Frank-Condon Principle, Electronic Spectra of Polyatomic Molecules. Emission Spectra, Radiative and Non-Radiative Decay, Internal Conversion, Spectra of Transition Metal Complexes, Charge Transfer spectra.

Electron Spin Resonance Spectroscopy: Hyperfine coupling, spin polarization for atoms and transition metal ions, spin-orbit coupling and significance of g-tensors, application to transition metal complexes (having one unpaired electron) including biological systems

and to inorganic free radicals such as PH_4, $[F_2]^-$, and $[BH_3]^-$.

Unit IV– Mössbauer and Photoelectron Spectroscopy

Mössbauer: Basic principles, spectral parameters and spectrum display. Application to the studies of (1) bonding and structures of Fe^{2+} and Fe^{3+} compounds including those of intermediate spin, (2) Sn^{2+} and Sn^{4+} compounds nature of M-L bond, coordination number, structure and (3) detection of oxidation state and inequivalent MB atoms.

Photoelectron Spectroscopy: Basic Principles: Photo- Electric Effect, ionization process, Koopman's Theorem, Photo electron spectra of simple molecules, ESCA, chemical information from ESCA. Application of ESCA, Auger electron spectroscopy; basic idea.

Course Outcome	At the end of the course, the students will be able to: i) Know the basic concept to characterize the materials. ii) Know the various principles of different instruments.

Books Recommended;
Text book:

1. Fundamentals of Molecular Spectroscopy by C. N. Banwell and E. M. McCash, Tata McGraw Hill, 1994
2. Chemical Applications of Group Theory by F.A. Cotton, Wiley Interscience, 1990, 3rd Ed
3. Physical methods in Chemistry, R. S. Drago, Sauders College

Reference book:

1. Chemical Applications of Molecular symmetry and Group Theory by B S Garg, MacMillan, 2012
2. Modern Spectroscopy, J. M. Hollas, John Wiley
3. Introduction to Molecular Spectroscopy by G. M. Barrow, McGraw Hill
4. Introduction to Atomic Spectra by H. E. White, McGraw Hill, 1934.
5. Symmetry and Spectroscopy of Molecules, K. V. Reddy, New Age Publication.

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-415	**ORGANIC CHEMISTRY PRACTICAL**	8	-	100

Objectives	The basic objective of this course is to introduce students to identify the unknown organic compounds using not only chemical tests but also using various spectroscopy. They also synthesize various organic compounds including indicators as well as estimation.
Pre-Requisites	Knowledge about functional group and concept of IR spectroscopy.
Teaching Scheme	Regular laboratory using test tube, chemicals and instruments. Sessions are planned to be interactive with focus on problem solving activities.

Detailed Syllabus

1. Qualitative analysis:

Identification of Unknown Organic Compounds, Separation, Purification and Identification of Compounds of Binary Mixtures (both are solids, one liquid and one solid) using TLC and Column Chromatography, Chemical Tests, Identification of Functional Group with the help of IR Spectroscopy.

2. Synthesis of Organic Compounds

a. Preparation of Anthranilic Acid b. Preparation of Methyl Orange c. Preparation of p-Bromo Aniline d. Preparation of Nitroacetanilide

3. Estimation of

a. Anilines b. Phenols c. Keto group

Course Outcome	At the end of the course, the students will be able to: i) Identify the unknown organic compound. ii) Synthesize high purity compounds from mixtures.

Books Recommended;

Text book:

1. A Text Book of Practical Organic Chemistry (Quantitative) by Arthur. I. Vogel.
2. Hand Book of Organic Analysis, Qualitative & Quantitative by H. T. Clarke, Edward Arnold (Publisher).
3. Comprehensive Practical Organic Chemistry Qualitative Analysis by V K Ahluwalia and Sunita Dhingra, Universities Press.
4. The Systematic Identification of Organic Compounds; A Laboratory Mannual by R.

L. Shriner, R. C. Fusion and D. V. Curtin, John Wiley & Sons.

5. Systematic Qualitative Organic Analysis by H. Middleton, Edward Arnold (Publisher)
6. Experiments and techniques in Organic Chemistry by D Pasto, C Johnson and M. Miller, Prantice Hall
7. Vogel's Text Book of Practical Organic Chemistry, by Brian S. Furniss, ELBS Longman, 5th edition, 1996.
8. Techniques and Experiments for Organic Chemistry, by Addison Ault, University Science Book, 6th Edition.

SEMESTER-II

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-421	**ORGANIC CHEMISTRY-II**	4	10	40

Objectives	The basic objective of this course is to introduce students the basic concepts of the mechanism of both synthesized aliphatic and aromatic compounds.
Pre-Requisites	Knowledge of aromatic structure and the electronic concept.
Teaching Scheme	Regular classroom lectures with use of chalk and black board. Sessions are planned to be interactive with focus on problem solving activities.

Detailed Syllabus

Unit I– Aromatic Substitution Reactions

Aromatic Electrophilic Substitution: The Arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other rings systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmer reaction, Gattermann-Koch reaction.

Aromatic Nucleophilic Substitution: The S_NAr, S_N1, Benzyne and $S_{RN}1$mechanisms. Reactivity – effect of substrate structure, leaving group and attacking nucleophile. Von-Richter, Sommelet-hauser, Smiles rearrangements.

Unit II– Rearrangement and Addition Reactions

General mechanistic consideration- nature of migration, migratory aptitude, memory effects. A detailed study of the following rearrangement reactions: Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil- Benzilic acids, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hofman, Curtius, Schmidt, Baeyer-Villiger, Shapiro reaction.

Addition to Carbon- Carbon Multiple Bonds: Mechanistic and stereo chemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, region and chemoselectivity, orientation and reactivity, addition to cyclopropane rings. Hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless Asymmetric Epoxidation (SAE).

Unit III– Addition of Multiple Bonds

Addition to Carbon-Hetero Multiple Bonds: Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters, nitriles. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction. Mechanism of condensation reactions involving enolates-Aldol, Konevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions.

Unit IV– Pericyclic Reactions

Molecular orbital symmetry, Frontier orbitals of ethylene, 1, 3-butadiene, 1, 3, 5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions- con rotatiry and dis rotator motions, 4n, 4n+2 and allyl systems. Cycloaddiyions- antrafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketones, 1,3 dipolar cycloadditions and cheletropic reactions.

Sigmatropic rearrangements- - antrafacial and suprafacial shifts of -H, sigmatropic shifts involving carbon moieties, 3,3-and 5,5- sigmatropic rearrangements. Claisen, Cope and aza-Cope rearrangements. Fluxional tautomerism. Ene reaction.

Course Outcome	At the end of the course, the students will be able to: i) Known the mechanism of various synthesized compounds. ii) Predict the mechanism of the newly synthesized compounds.

Books Recommended;

Text book:

1. Advanced organic chemistry: reactions, mechanisms, and structure, Jerry March, John Wiley.
2. Organic Chemistry by S. H. Pine, McGraw Hill, 1987
3. Pericyclic reactions by Ian Fleming, Oxford University Press.

Reference book:

1. Some Modern Method of Organic Synthesis, W. Carruthers, 3rd Edition, Cambridge University Press.
2. Organic Chemistry by J Clayden, N Greeves, S Warren & P. Wothers, Oxford University Press
3. Advanced Organic Chemistry, Part – A/Part B by F. A Carey and R. J Sundberg, Plenum Press
4. Pericyclic Reactions by R. T. Morrison and R. N. Boyd
5. Modern Synthetic Reactions by H. O. House, W.A. Benjamin, Inc., 1972
6. Understanding Organic Reaction Mechanism by A. Jacobs, Cambridge 1998.
7. Organic Chemistry by J. M. Hornback, Books Coley, 1998.
8. Organic Chemistry by P.Y. Bruice, Prentice Hall, 1998.
9. Principles of Organic Synthesis by R.O.C Norman and J. m. Coxon, Blackie Academic & Professional.
10. Modern Methods of Organic Synthesis: William Carruthers, Iain Coldham
11. Organic Chemistry, L. G. Wade, Pearson Prentice Hall, 2006

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-422	**INORGANIC CHEMISTRY- II**	4	10	40

Objectives	The basic objective of this course is to introduce students the different theory, spectral and magnetic properties of transition metal complexes as well as mechanism of various organometallic compounds.
Pre-Requisites	Knowledge on transition metals and their electronic structure.
Teaching Scheme	Regular classroom lectures with use of chalk and black board. Sessions are planned to be interactive with focus on problem solving activities.

Detailed Syllabus

Unit I– Metal- Ligand Bonding

Crystal field theory, limitations of Crystal field theory; CFSE, Crystal Field Stabilization in Octahedral, Tetragonal, Square Planar and Pyramidal Fields. ACFT / Ligand Field Theory (LFT), molecular orbital theory (qualitative) for octahedral, tetrahedral and square planar complexes. o and K -bonding in molecular orbital theory. Elementary idea of angular overlap model.

Unit II– Spectral Properties and magnetic properties of Transition Metal Complexes.

Spectroscopic ground states, Elementary idea about spectral properties of simple metal complexes. Electronic spectra and Orgel Diagrams of some simple complexes of ions like Co^{2+}, Cr^{2+}, Ti^{2+} in Octahedral and Tetrahedral fields. Tanabe-Sugano diagrams, Measurement of Dq, B and þ Parameters.

Elementary idea about magnetochemistry of metal complexes; diamagnetism, paramagnetisim, temperature independent paramagnetisim. Susceptibility and its measurements. Ferromagnetism and Anti- Ferromagnetism. Determination of magnetic susceptibility, spin-only formula, spin-orbit coupling, spin crossover.

Unit III– Metal n - Complexes and Metal Clusters

Metal Complexes: Metal Carbonyls, Structure and Bonding, Vibrational Spectra of Metal Carbonyls for bonding and structural elucidation, 18-electron rule, important reactions of metal Carbonyls, Preparation, bonding, structure and important reactions of Transition Metal Nitrosyls, dinitrogen, and dioxygen Complexes, isolobal analogy, tertiary Phosphine as a ligand.

Metal Clusters: Higher boranes, Carboranes, Metalloboranes and Metallocarboranes. Metal Carbonyl and halide cluster, Compounds with metal- metal bonding.

Unit IV– Inorganic Reaction mechanism and organometallics

Metal alkyls, carbenes, carbynes, alkenes, alkynes, and allyl complexes. Hydrides, Metallocenes, Metal arene complexes. Carbonylate anions, agostic interaction, Oxidative addition and reductive elimination, insertion reactions (insertion of CO, SO_2, alkenes) and elimination reactions. Homogeneous and heterogeneous catalysis. Fluxional molecules, Fluxonality and dynamic equilibrium in compounds such as 52 - olefin and 53 – allyl and dienyl complexes.

Course Outcome	At the end of the course, the students will be able to: i) Various theories of transition metal complexes. ii) Mechanism of various organometallic compounds. iii) Know the spectral and magnetic properties of materials.

Books Recommended;

Text book:

1. Inorganic Chemistry: Principles of Structure and Reactivity by J. E. Huheey, E. A. Keiter and R. L. Keiter, 4th Ed. Harper Collins 1993.

2. Concepts and Models of Inorganic Chemistry by B. E. Douglas, D. H. McDaniel, J. J. Alexander, John Wiley, 1993, 3rd Ed.

3. The Organometallic Chemistry of Transition Metals by R. H. Carbtree, John Wiely

Reference book:

1. Physical Inorganic Chemistry: A Coordination Chemistry Approach by S. F. A. Kettle, Spektrum, 1996
2. Advanced Inorganic Chemistry by F.A.Cotton and G. W. Wilkinson, 5th edition, John Wiley
3. Mechanism of Inorganic Reactions: Fred Basolo, Ralph G. Pearson.
4. Introduction to Magnetochemistry by A. Ernshaw, Academic press, 1968
5. Elements of Magnetochemistry by R. L. Dutta and A Syamal, 2nd edition.
6. Organotransition metal chemistry; Fundamental concept and applications by A.Yamamoto, John Wiley, 1986
7. Inorganic Chemistry: Catherine E. Housecraft, Aian G. Sharpe

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-423	**PHYSICAL CHEMISTRY-II**	4	10	40

Objectives	The basic objective of this course is to introduce students about the thermodynamic properties of microscopic particles. They know the chemical dynamics of various chemical reactions. They also able to know the ion solvent interaction and adsorption process.
Pre-Requisites	Knowledge state function and variables, basic concept of kinetics, adsorption and interaction of ions in solvent.
Teaching Scheme	Regular classroom lectures with use of chalk and black board. Sessions are planned to be interactive with focus on problem solving activities.

Detailed Syllabus

Unit I– Statistical Thermodynamics

Thermodynamic probability and entropy, Maxwell-Boltzmann statistics, partition function for diatomic molecules (translational, vibrational, rotational and electronic), 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 and Helium.

Unit II– Chemical Dynamics

Methods of determining the rate law, collision theory of reaction rates, steric factor, activated complex theory and Arrhenius equation. ionic reactions, kinetic salt effects, steady state kinetics, kinetic and thermodynamic control of reactions.

Dynamic chain (hydrogen-bromine reaction, decomposition of ethane), photochemical (hydrogen-bromine and hydrogen-chlorine reactions) and oscillatory reactions (Belousov-Zhabotinsky reaction), homogenous catalysis, kinetics of enzyme reactions, general features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis method.

Unit III– Adsorption and Micelles

Adsorption: Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET equation).

Micelles: Surface active agents, classification, Micellization, hydrophobic interaction, critical micelles concentration (CMC), Factors affecting CMC of surfactants, thermodynamics of micellazation, reverse micelles.

Unit IV– Electrochemistry

Electro chemistry of solution, Debye-Huckel-Onsager treatment, ion solvent interaction, Debye-Huckel-Jerum model, thermodynamics of electrified interface equations, Derivation of electrocapilarity, Lippmann equation, structure of electrified interface (Guoy, Champman, Stern model) over potential, exchange current density, derivation of Butler-Volmer equation, Tafel plot.

Course Outcome	At the end of the course, the students will be able to: i) Known the thermodynamic properties of microscopic particles. ii) Chemical dynamics of simple to complex reactions. iii) Process of adsorption as well as ion-ion/solvent interaction.

Books Recommended;

Text book:

1. Chemical Kinetics by Keith Laidler, Harper and Row, 1995.
2. Chemical Kinetics: The study of reaction rates in solution by Kenneth A. Connors, VCH, 1990
3. Electrochemistry by Carl H. Hamann, Andrew Hamnett and Wolf Vielstich, Wiley VCH, 1998.
4. Statistical Thermodynamics by Donald A. McQuarrie,

Reference book:

1. Thermodynamics: Statistical Thermodynamics and Kinetics by Thomas Engel and Philip Reid, Pearson
2. Reaction Kinetics by M. J. Pilling and P. W. Seakins, Oxford Press, 1997
3. Modern Electrochemistry 1. Volume 1 and 2, by J. O'M. Bockris and A. K. N. Reddy, Kluwer Academic, 2000.
4. Electrochemical Methods, by A. J. Bard and L. R. Faulkner, John Willey, 1980
5. Advanced Physical Chemisry, (vol- I, II, III, IV, V) K. L. Kapoor, Macmillan, 2004
6. Statistical Thermodynamics by M. C. Gupta

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-424	**SPECTROSCOPY-II**	4	10	40

Objectives	The basic objective of this course is to introduce students about the deep knowledge about the various analytical instruments.
Pre-Requisites	Knowledge about the basic principles of instruments.
Teaching Scheme	Regular classroom lectures with use of chalk and black board. Sessions are planned to be interactive with focus on problem solving activities.

Detailed Syllabus

Unit I– Ultraviolet and Visible Spectroscopy

Various electronic transitions (185-800 nm); Beer Lambert Law, effect of solvent on electronic transitions, ultraviolet bonds for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, Fieser-Woodward rule for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds.

Optical Rotatory Dispersion (ORD) and Circular Dichrosim (CD): Definition, deduction of absolute configuration, octant rule for ketones.

Unit-II Infrared Spectroscopy

Instrumentation and sample handling, Characteristic Vibrational frequencies of alkane, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of Vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amide, conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands, Fermi resonance, FTIR.

Unit III– NMR Spectroscopy

Nuclear Magnetic Resonance Spectroscopy: Nuclear Spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift, deshielding, spin-spin interactions, factors influencing coupling constant 'J'. Classification (ABX, AMX, ABC, A2B2), spin decoupling, basic ideas about instrument, NMR studies of nuclei other than proton ^{13}C, ^{19}F, and ^{31}P. FT NMR, use of NMR in medical diagnostics.

Carbon -13 NMR (^{13}C- nmr) Spectroscopy: General considerations, chemical shift, (Aliphatic, olefinic, alkyne,aromatic, heteroaromatic and carbonyl carbon), coupling constants. Two dimension NMR spectroscopy- COSY, NOESY, DEPT, INEPT, APT and INDIQUATE techniques.

Unit IV– Mass Spectroscopy

Introduction, ion production – EI, CI and FAB factors affecting fragmentation, ion-analysis, ion analysis, ion abundance, mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement, nitrogen rule, high resolution mass spectrometry, examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

Course Outcome	At the end of the course, the students will be able to: i) Identify precisely the unknown materials. ii) Know the various complicated principles of different analytical instruments.

Books Recommended;

Text book:

1. Physical Methods in Chemistry by R. S. Drago, Saunders, 1992
2. Inorganic Electronic Spectroscopy by A. B. P. Lever, Elsevier, 1984, 2nd Ed.
3. Chemical Applications of Group Theory by F A Cotton
4. Introduction to Spectroscopy by D.L. Pavia, G. M. Lampman, G. S. Kriz, Harcourt College Publisher, NY, 2001

Reference book:

1. Windawi Applied Electron Spectroscopy for Chemical Analysis by H. Windawi and F. L. Ho, Wiley Interscience
2. Spectrometric Identifications of Organic Compounds by R. M. Silverstein, John Wiley, 1991.
3. Modern Spectroscopy by J. M. Hollas, John Wiley
4. Mössbauer Spectroscopy by Y. Yoshida and G. Langouche, Springer
5. Basic Principle of Spectroscopy by R Chang, McGraw Hill
6. Theory and Application of UV Spectroscopy, H. H. Jafee and M. Orchin, IBH- Oxford.
7. Introduction to Magnetic Resonance by A. Carrington and A. D. Maclachalan, Harper and Row
8. Inorganic Spectroscopic Method by A. K. Brisdon , Oxford Chem. Primers
9. NMR, NQR, EPR and Mössbauer Spectroscopy in Inorganic Chemistry by R. V. Parish, Ellis Harwood

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-425	**INORGANIC CHEMISTRY PRACTICAL**	8	-	100

Objectives	The basic objective of this course is to introduce students to identify the unknown inorganic compounds using not only chemical tests but also using various spectroscopies. They also synthesize various inorganic compounds as well as estimation.
Pre-Requisites	Knowledge about properties of various inorganic elements and concept of various analytical instruments.
Teaching Scheme	Regular laboratory using test tube, chemicals and instruments. Sessions are planned to be interactive with focus on problem solving activities.

Detailed Syllabus

1. Mixture analysis

   The supplied Mixture Must Contains Any one of the:

   a. Rare metal ions – Mo, W, Ti , V , U .

   b. Insoluble oxides, Sulfates, and Halides.

2. Reaction of Cr(III) with a Multidentate ligand; A kinetic study experiment.

   (Visible Spectra Cr- EDTA Complex) J.A.C.S., 1953, 75, 5670

3. Preparation of the following compounds and their studies by I.R., Electronics spectra measurements.

   a. Cis/ Trans- K $[Cr(C_2O_4)_2(OH_2)_2]$

   b. $[Ni(NH_3)_6]\ Cl_2$

   c. $Ni(dmg)_2$

   d. $K_3[Fe(C_2O_4)_3]$

   e. $Mn(acac)_3$

4. Spectrophotometric determination of;

   a. Iron- Phenanthroline complex; Job's Continious variation method

   b. Mn/Cr/ V in steel sample

5. *Synthesis and characterization of inorganic compound including co-ordination complexes, assemblies*;

Synthetic methods: solution chemistry, solid state synthesis, sol-gel methods, multi step synthesis, preparation of isomers, synthesis under inert atmosphere, electrosynthesis.

Characterization: quantitative and qualitative determination of ligand and metal, use of spectral techniques (UV - visible, IR, NMR, ESR, magnetic moment, analytical methods (conductance, TG, DSC, cyclic voltametry, coulometry).

Course Outcome	At the end of the course, the students will be able to: i) Identify the unknown inorganic compound. ii) Synthesize high purity inorganic compounds as well as its characterization.

Books Recommended;

Text Books:

1. Synthesis and Technique in Inorganic Chemistry: A Laboratory Manual,
2. Gregory S. Girolami, Thomas B. Rauchfuss and Robert J. Angelici. University
3. Science Books.2. Synthetic methods of organometallic and inorganic chemistry ed. by Wolfgang A. Herrmann, Georg Thieme Verlag, New York, 1997, Vol 7 and 8
4. Vogel's qualitative inorganic analysis, by Svehla, G. Publisher: Harlow :
5. Longman, 1996. 4. Vogel's textbook of quantitative inorganic analysis: including elementary instrumental analysis. By: Arthur Israel Vogel; John Bassett Publisher: London; New York: Longman, 1978.

SEMESTER-III

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-531	**ORGANIC CHEMISTRY-III**	4	10	40

Objectives	The basic objective of this course is to introduce students about the photochemical reaction and their mechanisms. They also know the oxidation reduction of various organic compounds and some of the organometallic reagents.
Pre-Requisites	Knowledge about basic idea on oxidation, reduction, photochemistry.
Teaching Scheme	Regular classroom lectures with use of chalk and black board. Sessions are planned to be interactive with focus on problem solving activities.

Detailed Syllabus

Unit I– Photochemical Reaction mechanisms

Photochemical Reactions: Interaction of electromagnetic radiation with matter, types of excitations, fate of the excited molecule, quantum yield, transfer of excitation energy, actinometry.

Determination of Reaction mechanism: Classification, rate constants, life time of reactive energy states-determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions; Types of photochemical reactions-photo dissociation, gas-phase photolysis.

Unit II– Photo Chemistry of Alkenes and Carbonyl Compounds

Photo Chemistry of Alkenes: Intramolecular reactions of olefinic bond- geometrical isomerism, cyclisation reactions, rearrangement of 1, 4- and 1, 5-dienes.

Photo Chemistry of Carbonyl Compounds: Intramolecular reactions of carbonyl compounds-saturated, cyclic and acyclic, β, γ -unsaturated and α, β- unsaturated compounds. Cyclohexadienones.

Photochemistry of Aromatic Compounds: Isomerisations, additions & substitutions.

Miscellaneous Photochemical Reactions: Photo-Fries reactions of anilides. Photo-Fries rearrangement, Barton reaction, Singlet molecular reactions, Photochemical formation of smog, Photo-degradation of polymers, Photochemistry of vision.

Unit III– Oxidations and reductions

Different oxidative processes, Oxidation of hydrocarbon, Alkenes, Aromatic rings, Alcohol, 1,2-diol, Allylic & benzylic alcohols, Aldehydes, ketones, Carboxylic acids, amines.

Different Reductive processes, Reduction of alkenes, alkynes, aromatic ring, cycloalkanes, carbonyl compounds, aldehydes, ketones, acids, Hydrogenesis.

Unit IV– Organometallic reagents

metal atom functionality in organometallic reactions, organometallics as protecting and stabilizing groups, palladium catalyzed reactions, Heck reaction, cross coupling reactions (Suzuki, Stille, Negishi, Kumada, Hiyama, Sonogashira, Buchwald-Hartwig), Fischer carbenes, Schrock carbenes, Olefin metathesis, Shi epoxidation, Jacobsen epoxidation. Introduction to domino/tandem/cascade reaction concepts with selected examples.

Course Outcome	At the end of the course, the students will be able to: i) Photochemical reaction and various mechanisms deals with it. ii) Oxidized and reduced products of organic compounds. iii) Known some of the important metal catalyzed reactions.

Books Recommended;

Text book:

1. Frontier Orbitals and Organic Chemical Reactions by I. Fleming, John Wiley, 1976.
2. Introduction to Organic Photochemistry by J. D. Coyle, John Wiley & Sons
3. G. S. Zweifel and M. H. Nantz, Modern Organic Synthesis-An Introduction, W. H. Freeman and Company, 2006

Reference book:

1. Fundamental of Photochemistry by K. K. Rohatgi and S. M. Mukherji, Wiley Eastern
2. Introduction to Photochemistry by A Cox and T. Camp, McGraw-Hill
3. Organic Photochemistry by J. Coxon and B. Halton, Cambridge Univ. Press
4. Some Modern Method of Organic Synthesis, W. Carruthers, 3rd Edition, Cambridge University Press.
5. Principle and Application of Photochemistry by B. Wardle, John Wiley & Sons
6. Comprehensive organic synthesis, B. M. Trost and I. Fleming, Pergamon Press, 1992.
7. Organanometallics in Organic Synthesis, J. M. Swan, D. St. C. Black, Chapman and Hall, London, 1974
8. Organotransition Metal Chemistry: Applications to Organic Synthesis, S. G. Davis, Pergamon Press, Oxford, 1982.
9. Basic Organometallic Chemistry, B. D. Gupta, A J Elias, Universities Press, Chennai, 2010
10. Transition Metals in the total synthesis of complex organic molecules, L. S. Hegedus, University Science Books, 1994.
11. Strategic Application of Named Reactions in Organic synthesis by L. Kurti and B. Czako, Elsevier Academic Publication
12. Application of Redox and Reagents in Organic Synthesis/ vol-I by Ratan Kumar Kar,2008, new Central Agency (P) Ltd.
13. Basic Organometallic chemistry by Anil Elias, Univ. Publication

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-532	**BIOINORGANIC AND SUPRAMOLECULAR CHEMISTRY**	4	10	40

Objectives	The basic objective of this course is to introduce students about the basic knowledge on the role of different metals in biological systems as well as its characterization. They also know about photosynthesis and role of hazardous materials on biological system.
Pre-Requisites	Knowledge about basic concept about the properties of various metal ions as well as principle of instruments such as NMR, EXAFS, XANES and ENDOR.
Teaching Scheme	Regular classroom lectures with use of chalk and black board. Sessions are planned to be interactive with focus on problem solving activities.

Detailed Syllabus

Unit I–Metal Ions in Biological Systems & Biomineralization

Essential trace elements, Na^+/K^+ pump, Ferritin, transferrin, and siderophores; Calcium in Biology: Transported regulation, Intracellular Ca^{2+} transport, Ca^{2+} ATpase, Na^+/ Ca^{2+} exchange, mitochondrial influx and efflux. Inositol triphosphate, Ca^{2+} regulated intracellular processes: Calmodulin, Troponin C.

Metals in Medicines: Metal deficiency and disease, toxic effects of metals, metals used for diagnosis and chemotherapy with particular reference to anticancer drugs.

Unit II– Chemistry of Nitrogenase, Photosynthesis, Transport and Storage of Dioxygen

Nitrogenase: Biological nitrogen fixation, molybdenum nitrogenase, spectroscopy and other evidence, other nitrogenases model systems; *Photosynthesis*: Chlorophylls, photo system I and photo system II in cleavage of water model system; *Transport and Storage of Dioxygen*: Heme-proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanins and hemerthrin, model synthetic complexes of iron, cobalt and copper.

Coenzyme: Vitamin B_{12}. Role of hazardous materials such as nitric oxide, cyanide and methyl isocyanate etc. in biological systems.

Unit III– Metalloenzymes and their characterisation techniques

*Metalloenzymes***:** Zinc enzymes: Carboxypeptidase and carbonic anhydrase; Iron enzymes: Catalase, peroxidase and cytochrome P-450; Copper enzymes: Superoxide dismutase; Molybdenum oxatransferase enzyme: Xanthine oxidase; electronic spectra, EPR (emphasis on first row transition metal ions and their spectra), brief description of CD / MCD and multinuclear NMR. Applications of newer methods like EXAFS, XANES and ENDOR in characterization of biological molecules.

Unit IV– Supramolecular Chemistry

Molecular recognition: Molecular receptors for different type of molecules, Design and synthesis of co receptor molecules and multiple recognition; Supramolecular reactivity and catalysis; Transport process and carrier design; Supramolecular devices, self-assembly in Supramolecular chemistry.

Course Outcome	At the end of the course, the students will be able to: i) The role of metal ions in biological systems. ii) Characterize various biological compounds. iii) Know supramolecular compounds and their reactivity..

Books

Recommended; Text

book:

1. S. J. Lippard and J. M. Berg, Principle of Bioinorganic Chemistry, University Science Books (1994).
2. Lawrence Que, Jr, Physical Methods in Bioinorganic Chemistry: Spectroscopy and Magnetism, University Science Books (2000).
3. Supramolecular Chemistry by J. W. Steed and J. L. Atwood, Wiley

Reference book:

1. Progress in inorganic Chemistry, vol.18 and 38 ed, J.J.Lippard, Wiley
2. Bioinorganic Chemistry: A chemical Approach to enzyme action, Hermann Dugas and C. Penny,Springer Verlag.
3. Inorganic Biochemistry, Vol.I and IIed, G.L. Eichhorn,Elsevier.
4. Supramolecular Chemistry, J.M. Lehn,VCH.

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-533	**ANALYTICAL AND ENVIRONMENTAL CHEMISTRY**	4	10	40

Objectives	The basic objective of this course is to introduce students about the environment and measurement of various components as well as the sampling procedure. They are able to know fertilizers along with basic principle of some instrument such as various chromatography, TGA, DTA, DSC, SEM, TEM, XRD, XRF.
Pre-Requisites	Knowledge about basic concept about the environment and its components, fertilizer and fuel.
Teaching Scheme	Regular classroom lectures with use of chalk and black board. Sessions are planned to be interactive with focus on problem solving activities.

Detailed Syllabus

UNIT- I Sampling & Data handling

Sample Handling: Classification of Analytical Methods; Types of samples, Preparation of sample for analysis, effect of sampling uncertainties, sample treatment, moisture in sample, decomposition of organic & inorganic compounds, procedure of sampling of solids, liquids and gases.

Errors and Evaluation: Definition of terms in mean and median; Precision- standard deviation; Accuracy, absolute and relative errors, detection limits, significant figures, rounding off; Types of errors – determinate and indeterminate errors; Ways of expressing; Confidence limit, Test of significance – the F-test and T-test. The statistical Q-test for rejection of a result, statistics for small data sets. Linear least squares method; the correlation coefficient; Calculation for the above parameters.

UNIT- II Agricultural and Fuel Analysis

Agricultural Analysis: Analysis of soils for available Major Nutrients - Estimation of available Nitrogen (Kjeldahl Method), Phosphorus (Olsen's Method and Bray and Kurtz Method), and Exchangeable Calcium & Magnesium (by EDTA); Soil analysis for Micronutrients and Pesticide Residues.

Fuel Analysis: Solid, liquid, gas; Ultimate and proximate analysis- heating values grading of coal. liquid fuels- flash point, aniline point, octane number and carbon residue; Gaseous fuel- producer gas, water gas-calorific value.

UNIT- III- Industrial Pollution and their Management

*Water Pollution Management***:** Sources and characteristics of industrial wastewater, Standards related to industrial wastewater; Primary, Secondary and Tertiary treatment of industrial wastewater.

Advanced technology for removal of toxic ions from industrial effluents such as Ion exchange, Electro dialysis, Reverse osmosis, Membrane technology, Ozonation, Wet air oxidation.

Air Pollution Management: Permissible limit of pollutants in ambient air and emission standards, Monitoring technique of particulate and gaseous pollutants (SPM, RSPM, SO_2, NOx, Ozone), Principles and operations of gravity settling chamber, cyclones, scrubbers, filters, ESP; Control gaseous pollutants through adsorption, absorption, mass transfer, condensation, and combustion; Control of motor vehicle emissions, Stack monitoring.

UNIT- IV – Analytical Techniques

Principle and Application of Chromatography (Paper, TLC, HPLC and GC), AAS, Bomb Calorimeter, Flame Photometry, XRD, XRF.

Thermal Methods: TGA, DSC and DTA.

General idea on advance microscopic techniques; SEM, TEM

Course Outcome	At the end of the course, the students will be able to: i) The sample collection and its measurement using various techniques. ii) Know the basic principle of various instruments. iii) Know about fuels and determination its calorific value.

Books Recommended;

Text book:

1. Analytical Chemistry by G. D. Christian, John Wiley.
2. Quantitative Analysis by R. A. Day Jr. and A. L. Underwood, 6th edition, Pearson
3. Analytical Chemistry; Principle and Techniques by L. G. Hargis, Prentice Hall
4. Environmental Chemistry and Pollution Control by S. S. Dara, S Chand

Reference book:

1. Analytical Chemistry by A Gupta, Pragati Prakashan
2. Handbook of Analytical Instruments by R. S. Khandtur, Tata Mcgraw-Hill
3. Environmental Engineering by Gerard Kiely, Tata Mcgraw Hill

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-534	**The Chemistry of Life and Surroundings**	4	10	40

Objectives	The basic objective of this course is to introduce students about the environment, measurement of various components and its impact. They are aware about various commonly used chemical products such as soap, detergents, sanitizer, fuel, battery as well as vitamins and drugs with its impact.
Pre-Requisites	Knowledge about basic concept of atoms and its components.
Teaching Scheme	Regular classroom lectures with use of chalk and black board. Sessions are planned to be interactive with focus on problem solving activities.

Detailed Syllabus

Unit-I: History of Chemistry

Father of Alchemist and Modern chemistry, History of Organic chemistry, Matter (Physical and chemical classification), Chemical classification (Pure substance and mixture), Pure substance (Elements and compounds) Mixture (Homogeneous and heterogeneous), Atom and atomic mass, Molecule and molecular mass, Atomic structure (Basic idea), atomic number, mass number, Isotope, Isobars and Isotones, Symbol up to atomic number 30, Basic concept of periodic table.

Unit-II: Chemistry of life; A basic concepts

Water, Types of water (Soft and Hard water), Types of hardness (temporary and permanent), acidic and basic concept of aqueous solution, Concept of pH with simple problem, Carbohydrates, Protein, Vitamins (Utility to human body), nutrients.

Unit-III: Chemistry in day to day life

Chemistry of Battery, Primary and Secondary battery, Lead-acid storage cell, Difference between primary and secondary battery, Solar cells, Chemistry of light (photosynthesis) and heat (thermal reaction), Chemistry of fuel and foods (Determination of calorific value), Chemistry of detergent, soap and beauty products, medicines and drugs, sanitization.

Unit-IV: Chemistry in our surrounding

Air Pollution: Types of air pollution, Acid rain, Global warming, Methods to control the air pollution.

Water Pollution: Types of water pollution, Primary treatment of water pollution, Methods to control water pollution, Quality of drinking water.

Eco system: Types of ecosystem (Briefly describe each ecosystem)

Course Outcome	At the end of the course, the students will be able to: i) History of chemistry, knowledge about various household products. ii) Know the environment and its impact. iii) Know about commonly used daily products.

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-535	**PHYSICAL CHEMISTRY PRACTICAL**	8	-	100

Detailed Syllabus

Objectives	The basic objective of this course is to introduce students to determine dynamics various chemical reactions as well as various properties of electrolytes.
Pre-Requisites	Knowledge about rate, order of chemical reaction and concept of strong and weak electrolyte.
Teaching Scheme	Regular laboratory using test tube, chemicals and instruments. Sessions are planned to be interactive with focus on problem solving activities.

1.Chemical Dynamics

(a) Determination of effect of (i) Change of Temperature (ii) Change of Conc. of reactants and Catalyst and (b) Ionic Strength of the media on the velocity constant of hydrolysis an Ester/ ionic reaction. (c) Determination of the velocity constant of Hydrolysis of an Ester / Ionic reaction in miceller media. (d) Determination of the rate constant for the oxidation of Iodide ions by Hydrogen peroxide, Studying the Kinetics as an Iodine Clock Reaction.

2. Electrochemistry, Counductometry, Potentiometry and Spectroscopy

Electrochemistry

(i) Determination of degree of dissociation of weak electrolyte and to study the deviation from Ideal behavior that occurs with a strong Electrolyte.

Counductometry

(i) Determination of velocity constant, Order of the reaction and energy of activation for saponification of ethyl acetate by Sodium hydroxide conductometrically.

(ii) Determination of Solubility and solubility product of sparingly soluble ($PbSO_4$, $BaSO_4$) conductometrically.

(iii) Determination of the Strength of Strong and Weak Acids in a given mixture Conductometrically.

(iv) Determination of Activity coefficients of Zinc ions in the solution of 0.002M zinc Sulfate using Debye- Huckel's limiting low.

Potentiometry/pH metry

(i) Determination of strength of halides in a mixture Potentiometrically.

(ii) Determination of the valency of mercurious ions potentiometrically.

(iii) Determination of the strength of strong and weak acids in a given mixture using Potentiometer.

(iv)Acid-base titration in a Non-aqous media using a pH meter.

(v) Determination of dissociation constant of Acetic acid in an acetone by titrating it with KOH.

Spectroscopy

(i) Determination of pKa of an Indicator (e.g., Methyl red) in aqueous and micellar media.

(ii) Determination of stoichiometry and stability constant of inorganic (e.g., ferric-salicyclic acid) and Organic (e.g., amine- iodine) complexes.

3. Determination of viscosity average molecular weight of Polystyrene.
4. Synthesis of Polymethylmethacrylate by emulsion polymerization.
5. Viscosity average molecular mass of Polyacrylonitrile.

Course Outcome	At the end of the course, the students will be able to: i) Determine order and rate constant of chemical reaction. ii) Determine the various properties of electrolytes as well as some organic compounds.

Books Recommended;

Text book:

1. Practical Physcial Chemistry, A. M. James and F. E. Prichard, Longman.
2. Finley's Practical Physical Chemistry by B. P. Levitt, LongMan.
3. Experimental physical Chemistry by R. C. Das and B. Behera, Tata Mcgraw Hill.

SEMESTER-IV

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-541	**ORGANIC SYNTHESES**	4	10	40

Objectives	The basic objective of this course is to introduce students about the synthesis of various organic compounds using some reagents and their mechanism.
Pre-Requisites	Knowledge about basic concept various organic reaction mechanism.
Teaching Scheme	Regular classroom lectures with use of chalk and black board. Sessions are planned to be interactive with focus on problem solving activities.

Detailed Syllabus

Unit I–Reagents in Organic Synthesis

Use of the following reagents in organic synthesis and functional group transformations; complex metal hydrides, Gilman's reagent, lithium dimethylcuprate, lithium diisopropylamide (LDA), dicyclohexylcarbodiimide, 1,3-dithiane (reactivity Umpoloung), trimethylsilyl iodide, tri-n-butyltin hydride, Woodward and pervost hydroxylation, osmium tetroxide, DDQ, selenium dioxide, Phase transfer catalysts, crown ethers and Merrifield resin, Peterson's synthesis, Wilkinson's catalyst, Baker yeast. Role of silicon in organic synthesis.

Unit II– Disconnection Approach and C-C Disconnection

An introduction to synthon and synthetic equivalents. Disconnection approach. Functional group Inter conversions. The importance of the order of events in organic Synthesis. one group C-X and two group C-X disconnections. Chemoselectivity. Reversal of polarity.cyclisation reactions. Amine synthesis.

One Group C-C Disconnection: Alcohols and carbonyl compounds. Regioselectivity, Alkene synthesis.use of acetylenes and aliphatic nitro compounds in organic Synthesis.

Two Group C-C Disconnection: Diels-Alder reaction.1,3-functionalised compounds. A, þ- unsaturated carbonyl compounds. Control in carbonyl condensations.1,5-di functionalised compounds. Micheal addition and Robinson annulation.

Unit III– Protecting groups and Ring Synthesis

Protecting groups: Principle of protection of alcohols, amine, carbonyl and carboxyl groups *Ring Synthesis*: Saturated heterocycles, synthesis of 3-, 4-, 5- and 6- membered rings, aromatic heterocycles in Organic Synthesis.

Unit IV– Synthesis of some common Molecules

Application of the above in the synthesis of following compounds: Camphor, Longifoline, Juvabione, Vitamin D, Cortisone, Reserpine, Fredericamycin A.

Course Outcome	At the end of the course, the students will be able to: i) Synthesize various organic compounds. ii) Know the mechanism and role of protecting groups on the synthesis of desired organic compound.

Books

Recommended; Text

book:

1. G. S. Zweifel and M. H. Nantz, Modern Organic Synthesis-An Introduction, W. H. Freeman and Company, 2006
2. Some Modern Method of Organic Synthesis by W. Carruthers and I. Coldham, Cambridge University Press
3. Organic Synthesis: The Disconnection Approach by Stuart Warren, Wiley
4. Protective Groups in Organic Synthesis by T.W. Greene, Wiley-VCH, 1999
5. Heterocyclic Chemistry by J. A. Joule and K. Mills, Blackwell

publishing Reference book:

1. The Logic of Chemical Synthesis by E. J. Corey and Xue-Min Cheng, John Wiley and Sons
2. Classics in Total Synthesis: Targets, Strategies, Methods by K. C. Nicolaou and E. J. Sorensen, VCH
3. Classics in Total Synthesis II: More Targets, Strategies, Methods by K. C. Nicolaou and S. A. Snyder, Wiley –VCH.Designing Organic Syntheses: A programmed Introduction to the Synthon Approach by S. Warren, John Wiley and Sons
4. Organic Synthesis: Concept, Methods and Starting material by J. Fuhrhop and G. Penzillin, VCH, Weinheim, Germany
5. Classics in Stereoselective Synthesis by E. M. Carreira and L. Kvaerno, Wiley-VCH Verlag GmbH & Co

6. Organic Synthesis: Strategy and Control by P. Wyatt and S. Warren, Wiley
7. Workbook of Organic Synthesis: The Disconnection Approach by P. Wyatt and S. Warren, Wiley
8. Strategic Application of Named Reactions in Organic synthesis by L. Kurti and B. Czako, Elsevier Academic Publication
9. Organic Chemistry from Retrosynthesis to Asymmetric Synthesis by Vitomir Šunjic and Vesna Petrovic Perokovic, Springer
10. Biocatalysis in Organic Synthesis: The Disconnection Approach by N. Turner, Royal Society of Chemistry
11. Heterocyclic Chemistry by T. R. Gilchrist, Longman,1989.
12. Selectivity in Organic Synthesis by Ward, Wiley-VCH, 1999
13. Fundamentals of Organic Synthesis: The Retrosynthetic Analysis/ vol-I & II Ratan Kumar Kar,2008, new Central Agency (P) Ltd.

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-542	**BIO PHYSICAL AND SOLID STATE CHEMISTRY**	4	10	40

Objectives	The basic objective of this course is to introduce students about the knowledge of biochemical reactions and ion transport. They also able to understand the defects of solids and its properties.
Pre-Requisites	Knowledge about basic concept various biochemical reagents and electronic structure of metals.
Teaching Scheme	Regular classroom lectures with use of chalk and black board. Sessions are planned to be interactive with focus on problem solving activities.

Detailed Syllabus

Unit I– Biophysical Chemistry I

Bioenergetics: Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, Synthesis of ATP from ADP.

Statistical Mechanics: Chain configuration of macromolecules, statistical distribution end to end dimensions, calculation of average dimensions for various chain structures, Polypeptide and protein structures, introduction to protein folding problem.

Unit II– Biophysical Chemistry II

Biopolymer Interactions: Forces involved in biopolymer interactions, Electrostatic charges and molecular expansions, hydrophobic forces. Multiple Equilibria and various types of binding processes in biological systems, Hydrogen ion titration curve.

Thermodynamics of biopolymer Solutions: Thermodynamics of biopolymer Solutions, osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechanochemical reactions.

Transport of Ions: Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport, Nerve conduction.

Unit III– Solid State Chemistry I

Crystal Defects and Non-stoichiometry: Perfect and imperfect crystal, intrinsic and extrinsic defects, point defects, line and plane defects, vacancies-Schottky defects and frenkel defects, Thermodynamics of Schottky and frenkel defect formation, colour centers, non- stoichiometry and defects.

Solid State Reactions: General principles, experimental procedures, co-precipitation as a precursor to solid state reactions, kinetics of solid state reactions. Principle and Application of X-ray and Neutron Diffraction.

Unit IV– Solid State Chemistry II

Electronic Properties of Solids: Metals, insulators and semiconductors, electronic structure of Solids-Band theory, band structure of metals, insulators and semiconductors. Intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, super-conductors. *Organic Solids:* Electrically conducting solids, organic charge transfer complex, organic metals, new superconductors.

Course Outcome	At the end of the course, the students will be able to: i) Know various biochemical reactions and its properties. ii) Know the properties of solids.

Books

Recommended; Text

book:

1. Principle of Bio-Chemistry, A. L. Lehninger, Worth Publishers
2. Biophysical Chemistry by J. P. Allen, Blackwell Publishing
3. Solid State Chemistry: An Introduction by L. E. Smart and E. A. Moore, Taylor and Francis

Reference book:

1. Modern Aspects of Solid State Chemistry by C. N. R. Rao, Springer
2. Introduction to Biomolecular Energetics by I. M. Klotz, Academic Press, London
3. Amino Acids and Peptides by J. S. Davies, Chapmann and Hall
4. Principle of Nucleic Acid Structure by W. Saenger, Springer
5. Solid State Chemistry and Its Application by A. R. West, Wiley
6. Principle of Solid State, H. V. Keer, Wiley Eastern
7. Solid State chemistry, D. K. Chakrabarty, New

8. Macromolecules by H. G. Elias, Sringer
9. Biophysical Chemistry by Dagmar Klostermeier, Markus G. Rudolph, CRC Press/ Taylor and Francis
10. Biophysical Chemistry: Molecules to Membranes P. R. Bergethon and E. R. Simons, Springer

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-543	**GRAND VIVA**	4	-	50

This is a face to face Viva-voce by the Experts; comprises all faculty members of the Department and at least one member (External) from outside to gauge the overall depth and control of a student on entire syllabus of all four semesters.

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-544	**ANALYTICAL CHEMISTRY PRACTICAL**	4	-	50

Detailed Syllabus

1. Verification of Beer- Lambart's Low by Colorimetric method.
2. Determination of Na^+/K^+ ion by Flame Photometry.
3. Determination of Ascorbic acid in tablets.
4. Determination of Dissolved Oxygen(DO) in Water sample.
5. Measurements of pH of soils by a pH meter.
6. Determination of chemical oxygen demand(COD) in water sample.
7. Determination of moisture contents in soils by gravimetric method.
8. Analysis of fat in butter sample.
9. Determination of Biochemical Oxygen Demand(BOD) in water sample.
10. Estimation of metal ion by ion-exchange method.

Books

Recommended; Text

book:

1. Instrumental techniques for Analytical Chemistry by Frank Settle, Prentice
2. Analytical Chemistry: Principles by J. H. Kennedy, Brooks/ Coole
3. Standard methods for the Examination of Water and Waste Water, APHA, Washington DC.
4. Analytical Chemistry; A Practical Approach by E. E. Hywel, Oxford University Press
5. Analytical Chemistry, G.D. Christian, J. Wiley.
6. Analytical Chemistry-Principle and Techniques, L.G. Hargis, Prentice Hall.

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
CH-545	**DISSERTATION WORK PRESENTATION & DEFENSE**	8	-	100

This is a project/ review type of work, has to be carried out by each Final year student under direct supervision of faculty member(s) allotted against his/her name by the Department, that shall be notified by the Department in the due course of time in second year and the report shall be submitted by the students during end term Examination of the fourth semester.

**********End of The Syllabus**********