FACULTY OF SCIENCES

SYLLABUS FOR

Programme Code: *MCHH*
Programme Name: M.Sc. (UHS) Chemistry
Academic Session 2024-25

Batch 2024: **Semester I-II**

Batch 2023: **Semester III-IV**

Department of Chemistry
Khalsa College, Amritsar

S.No.	PROGRAMME OBJECTIVES
1.	This programme was designed for the students of B. Sc. (Honours) Chemistry students to keep their knowledge a step ahead.
2.	The course was introduced to cater the needs of Academic Institutes (Universities, College, and Schools), Chemical, Pharmaceutical industry, Textile, Sugar industry, Research Institutes so that these students can better serve the field in which working.
3.	Students will be able to develop the theoretical aspects of all the fields of chemistry Organic, Inorganic, Physical and Analytical Chemistry and some interdisciplinary courses needed for better understanding the subject from technology point of view.
4.	Students will be able to develop the better understanding of the Practical aspect of chemistry through lab work and research project.
5.	Prepare students for pursuing research or careers in industry in concerned subject and allied fields. Capability to use appropriate software to solve various problems and to apply programming concepts of C++ and Mathematical / Matlab to various scientific investigations, problem solving and interpretation
6.	The programme continues to develop the ability to identify unethical behavior such as fabrication, falsification or misrepresentation of data and adoptive objective, unbiased and truthful actions in all aspects will be developed.
7.	Integrating multicultural awareness such as race, gender, physical ability, age, income and other social variables, and by creating an environment that is, “welcoming for all students”.
8.	Ability to think, acquire knowledge and skills through logical reasoning and to inculcate the habit of self-learning throughout life, through self- paced and self- directed learning aimed at personal development, and adapting to changing academic demands of work place through knowledge/ skill development.

S.No.	PROGRAMME SPECIFIC OUTCOMES (PSOS)
PSO-1	Students will develop the advanced theoretical and practical skills in the field of INORGANIC CHEMISTRY in specialized areas of Group Theory, Ligand Field Theory, *Metal-Carbon bonding and its applications*, Photo-inorganic chemistry, Oxidative addition and Insertion reactions, Structure and bonding of d-Block elements, *Techniques for Structure Elucidation of* Inor*ganic Compounds*, Practical Techniques of qualitative and quantitative analysis of inorganic compounds.
PSO-2	Students will develop the advanced theoretical and practical skills in the field of ORGANIC CHEMISTRY through some specialized areas like *Modern Methods of Organic Synthesis, Techniques for Structure Elucidation of Organic Compounds, Reaction Mechanism-Addition, Elimination and Rearrangements, Supramolecular, Reactive Intermediates and Disconnections, Natural Products, Pericyclic & Photochemistry, Asymmetric synthesis, Green Chemistry and Heterocyclic Chemistry,* Practical Techniques of qualitative and quantitative analysis of organic.
PSO-3	Students will develop the advanced theoretical and practical skills in the field of PHYSICAL CHEMISTRY through specialized areas of Thermodynamics, Quantum Chemistry, *Biophysical Chemistry*, Analytical Techniques, Surface and Polymer Chemistry Practical Techniques of qualitative and quantitative analysis and use of various electrical and non-electrical Instruments for analysis.
PSO-4	Student will develop the understanding regarding the use of mathematical tools, biological processes, use of computer and softwares for chemistry purpose.
PSO-5	The students to get knowledge of Research Methodology, Advance Analytical Techniques and learn about various tools of Organic and Inorganic synthesis

Eligibility:- The candidate having passed B.Sc. degree (10+2+3 system of education) ie B. Sc. (Medical), B. Sc. (Non-Medical), or equivalent with Chemistry as one of the elective subject in all semesters with at least 50% marks in aggregate from Guru Nanak Dev University or any other UGC recognized University.

Batch 2024: Semester I-II

COURSE SCHEME											
SEMESTER - I											
Course Code	**Course Name**	**Hours /Week**	**Credits**			**Total Credits**	**Max Marks**				**Page No.**
			L	**T**	**P**		**Th**	**P**	**IA**	**Total**	
CHE 411 /CHH 411	Inorganic Chemistry-I: (*Ligand Field and Group Theory)*	4	4	0	0	4	75		25	100	83-84
CHH 412	Organic Synthesis-I *Modern Methods of Organic Synthesis*	4	4	0	0	4	75		25	100	85-87
CHE 413 /CHH 413	Physical Chemistry-I: *Thermodynamics*	4	4	0	0	4	75		25	100	88-89
CHE 414 /CHH 414	Spectroscopy A: *Techniques for Structure Elucidation of Organic Compounds*	6	6	0	0	6	112		38	150	90-92
CHE 415 /CHH 415	Inorganic Chemistry Lab-I (*Quantitative Analysis*)	6	0	0	3	3		56	19	75	93-94
CHH416	Organic Chemistry Lab-I *Quantitative analysis and Multistep Synthesis*	6	0	0	3	3		56	19	75	95-96
CHE 417/CHH 417	Basics and Application of Chemistry Softwares	6	2	0	2	4	37	38	25	100	97-99
	TOTAL	**36**				**28**				**700**	

SEMESTER - II											
Course Code	**Course Name**	**Hours /Week**	**Credits**			**Total Credits**	**Max Marks**				**Page No.**
			L	**T**	**P**		**Th**	**P**	**IA**	**Total**	
Major Courses											
CHH421	Inorganic Chemistry-II (*Metal-Carbon bonding and its applications*)	4	4	0	0	4	75		25	100	101-102
CHE 422 / CHH 422	Organic Synthesis-II (*Reaction Mechanism-Addition, Elimination and Rearrangements)*	4	4	0	0	4	75		25	100	103-104
CHE 423/ CHH423	Physical Chemistry-II: *Quantum Chemistry*	4	4	0	0	4	75		25	100	105-106
CHE 424 / CHH 424	Spectroscopy B: *Techniques for Structure Elucidation of* Inorganic *Compounds*	6	6	0	0	6	112		38	150	107-109
CHE 425 / CHH 425	Organic synthesis-III(*Supramolecular, Reactive Intermediates and Disconnections)*	4	4	0	0	4	75		25	100	110-112
MH CHX 421 Or BT CHX 421	Mathematics for Chemists (Med. Students) Or Biology for Chemists (Non Med. Students)	3	2	1	0	3	56		19	75	113-114 115-116
CHE 426 / CHH 426	Physical Chemistry Lab-I	6	0	0	3	3		56	19	75	117-118
CHE 427 /CHH 427	Inorganic Chemistry Lab- II	6	0	0	3	3		56	19	75	119-121
	TOTAL	**37**				**31**				**775**	

Important Note: M. Sc. (Chemistry) and M. Sc. Chemistry (Under the Honours Scheme) have some common subjects.
The subject code of M. Sc. (Chemistry) starts with CHE
The subject codes of M. Sc. Chemistry (Under the Honours Scheme) starts with CHH

Batch 2023: Semester III-IV

SEMESTER - III											
Course Code	**Course Name**	**Hours /Week**	**Credits**			**Total Credits**	**Max Marks**				**Page No.**
			L	**T**	**P**		**Th**	**P**	**IA**	**Total**	
Major Courses											
CHE 531 / CHH 531	Inorganic Chemistry-III: (*Bioinorganic and Metal Clusters)*	4	3	1	0	4	75		25	100	123-125
CHE 532/ CHH 532	Organic Synthesis-IV (*Natural Products)*	4	3	1	0	4	75		25	100	126-128
CHE 533	Physical Chemistry-III *(Electrochemistry and Chemical Dynamics)*	6	5	1	0	6	112		38	150	129-130
CHE 534/ CHH 534	Organic Synthesis-V (*Pericyclic & Photochemistry*)	4	3	1	0	4	75		25	100	131-133
CHE 535/ CHH 535	Physical Chemistry-IV *(Analytical Techniques)*	4	3	1	0	4	75		25	100	134-136
CHH 536	Project Work ***(Continue to Sem. IV.***	8	0	0	4	4	Marks to be counted in Semester IV				137
	TOTAL	**30**				**26**				**550**	

SEMESTER - IV											
Course Code	**Course Name**	**Hours /Week**	**Credits**			**Total Credits**	**Max Marks**				**Page No.**
			L	**T**	**P**		**Th**	**P**	**IA**	**Total**	
Major Courses											
CHE 541/ CHH 541	Inorganic Chemistry-IV: *(Advanced Inorganic Chemistry)*	6	5	1	0	6	112		38	150	139-140
CHE 542/ CHH 542	*Organic Synthesis-VI (Asymmetric synthesis, Green Chemistry and Heterocyclic Chemistry)*	6	5	1	0	6	112		38	150	141-143
CHE 543/ CHH 543	Physical Chemistry-V *(Surface and Polymer Chemistry)*	6	5	1	0	6	112		38	150	144-145
CHH 536	Project Work ***(Continue from Sem. III)***	8	0	0	8	4				200	146
	TOTAL	**26**				**22**				**650**	

Semester-I

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-I)

CHE 411/CHH 411: Inorganic Chemistry-I

Ligand Field and Group Theory

Total Hours: 60
Total Hours/week: 4
Total Credits: 4
L T P
4 0 0

Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 2.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 15 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVES:

The main objective of this course is to teach the use of mathematical tool of Group Theory in the field of chemistry for evaluating the properties of the molecules. The Ligand field Theory and its use to predict spectral, magnetic and other physical properties of inorganic compounds will also be the main focus of this course.

COURSE CONTENTS:

UNIT-I

1. **Group theory and its applications-I** 15 Hrs

Symmetry, symmetry elements and operations, Determination of point groups (flow chart), Order and class of point group, Reducible and irreducible representations (H_2O and BF_3).
Multiplication tables and derivation of character tables for C_{2V}, C_{3V} and cyclic group, Great orthogonality theorem, Mullikens notations.

UNIT-II

2. **Group theory and its applications-II** 15 Hrs

Crystallographic Symmetry, Sub groups, determination of symmetry of atomic orbitals under different point groups. Hybridization of atomic orbitals: sp, sp^2,sp^3,dsp^2,sp^3d and d^2sp^3 and group theory, Matric representation of symmetry operations, group theory and CFT.
Separation of d-orbitals under the influence of T_d, square planar, O_h and trigonal bipyramid symmetry, Vibrational modes in non-linear molecules, representation of vibrational modes in H_2O,

NH_3 and BF_3. Group theory and linear molecules.

UNIT-III

3. **Ligand Fields-I** 15Hrs

Concept and scope of ligand fields, d and other orbitals, Qualitative determination of ligand field effects, the physical properties affected by LF, Ionic model of coordination compounds, Spin-orbit coupling, free ion in weak CF, Effect of cubic field on S,P,D,F,G,H,I terms.

Heat of ligation and CFSE, Standard electrode potential and CFSE, Cation distribution in lattice, spinels, interionic separation and CFSE and chemical stability.

UNIT-IV

4. **Ligand Fields-2** 15Hrs

Free ion in medium and strong fields. Transition from weak to strong fields, Correlation and Tanabe Sugano diagrams for d^2 to d^9 (O_h and T_d), Elementary MOT, Bonding in octahedral and tetrahedral complexes.

Qualitative calculations of 10 Dq. Electronic spectra of complexes, Selection rules and band widths and factors, Jahn Teller effect. Spectra of $[M(H_2O)_6]^{+2}$.

Spectra of spin free and paired complexes, distorted O_h and T_d complexes, Spectrochemical and Nephelauxetic series and CT spectra.

BOOKS PRESCRIBED:

1) Chemical applications of group theory by F.A. Cotton.
2) Introduction to Ligand fields by B.N. Figgis.
3) Group theory by Raman.
4) Group theory in Chemistry by Gopinathan and Ramakrishnan.

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	Identify elements of symmetry on chemical compounds on the basis of their structure and correlate these elements of symmetry with point groups to which the molecule belongs
CO2	Apply the mathematical concepts of matrices, determinants on various symmetry operations.
CO3	Apply the mathematical tool of 'Group Theory' on various molecules to derive reducible and irreducible representation. This also leads to the use of group theory derive the type of hybridisations and IR active and Raman active modes of vibrations in the molecules
CO4	Develop the understanding of Bonding in coordination compounds in terms of CFT and LFT.
CO5	Construct orgel diagrams, Correlation diagrams and Tunabe-Sugano diagrams along with the study of electronic, magnetic and spectrochemical properties of the coordination compounds.

M.Sc. Chemistry (Under the Honours Scheme) (Semester-I)

CHH 412

Organic Synthesis-I

Modern Methods of Organic Synthesis

Total Hours: 60
Total Hours/week: 4
Total Credits: 4
L T P
4 0 0

Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 2.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 15 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVES:

This course aims is to provide the knowledge to students regarding the following:
(a) Formation of carbon-carbon single bonds that involves the main group chemistry as well as transition metal chemistry
(b) Various types of reactions that involves formation of carbon-carbon double bonds
(c) Synthesis and applications of selected reagents used for various organic transformations.
(d) Widely used name reactions and rearrangements for the synthesis of industrially and pharmaceutically important compounds.

COURSE CONTENTS:

UNIT-I

1. **Formation of carbon-carbon single bonds** 15 Hrs

Main-group chemistry: Alkylation of enolates and enamines, Conjugate addition reactions of enolates and enamines, The aldol reaction, Asymmetric methodology with enolates and enamines, Organolithium reagents, Organomagnesium reagents, Organozinc reagents, Allylic organometallics of boron, silicon and tin
Transition-metal chemistry: Organocopper reagents, Organochromium chemistry, Organocobalt chemistry, Organopalladium chemistry.

UNIT-II

2. **Formation of carbon-carbon double bonds** 15 Hrs

Elimination reactions, Pyrolytic syn eliminations, Fragmentation reactions, Alkenes from hydrazones, Alkenes from 1,2-diols, Alkenes from alkynes, The Wittig and related reactions, Alkenes from sulfones, Alkenes using titanium or chromium reagents, Alkene metathesis reactions

UNIT-III

3. **Radical and carbene chemistry** 5 Hrs

Radicals: Radical abstraction reactions, Radical addition reactions, Carbenes.

4. **Functionalization of alkenes** 10 Hrs

Hydroboration: Reactions of organoboranes, Epoxidation and aziridination: Epoxidation, Asymmetric epoxidation, Aziridination, Dihydroxylation: Dihydroxylation with osmium tetroxide, Other methods of dihydroxylation, Amino-hydroxylation, Oxidative cleavage, Palladium-catalysed oxidation of alkenes.

UNIT-IV

5. **Oxidation and Reduction** 15 Hrs

Oxidation: Oxidation of hydrocarbons, Alkanes , Aromatic hydrocarbons, Alkenes, Oxidation of alcohols, Chromium reagents, Oxidation via alkoxysulfonium salts, Manganese reagents, Other metal-based oxidants, Other non-metal-based oxidants, Oxidation to carboxylic acids or esters Oxidation of ketones, α, β-Unsaturated ketones, α-Hydroxy-ketones, Baeyer–Villiger oxidation of ketones

Catalytic hydrogenation, Reduction by dissolving metals, Reduction by hydride-transfer reagents: Derivatives of lithium aluminium hydride and sodium Borohydride, Mixed lithium aluminium hydride–aluminium chloride, Reagents: Diisobutylaluminium hydride (DIBAL-H), Sodium cyanoborohydride and sodium Triacetoxyborohydride, Borane and derivatives

Other methods of reduction: Enzyme catalysed, Wolff–Kishner reduction, Reductions with diimides, Reductions with trialkylsilanes

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BOOKS PRESCRIBED:

1. Topics in Organometallic Chemistry: 'Palladium in Organic Synthesis' (Editor: Jiro Tsuji) Volume 14, **2005**
2. Advanced Organic Chemistry, 4th Edition, Part B: Reactions and Synthesis by Francis A. Carey and Richard J. Sundberg, Plenum Press, N.York, **2001**, 4th edition.
3. *Modern Methods of Organic Synthesis*, 4th Edition by W. Carruthers and L. Coldham, Cambridge University Press, **1971**, 2nd edition.
4. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford)

COURSE OUTCOMES:

S. No.	On completing the course, students will be able to
CO1	Learn about carbon-carbon bond formation in both main group chemistry and transition metal chemistry
CO2	Develop the understanding of radical and carbene chemistry
CO3	Learn the concept of functionalization of alkenes

CO4	Learn about oxidation and reduction reactions
CO5	Form of carbon-carbon double bond

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-I)

CHE 413/CHH 413

Physical Chemistry-I

Thermodynamics

Total Hours: 60
Total Hours/week: 4
Total Credits: 4
L T P
4 0 0

Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 2.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 15 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVE:

The Course is thoughtfully prepared to give first the overview of the classical laws of thermodynamics and its applications. Further, the course elaborates the concept of statistical thermodynamics to inter-relate the quantum mechanics and thermodynamics. Also, the irreversible thermodynamics based on real life examples has been formulated.

COURSE CONTENTS:

UNIT-I

1. **Classical Thermodynamics-I** 15Hrs

Brief resume of concepts of thermodynamics, Helmholtz and Gibb's free energy, chemical potential and entropy. Partial molar properties, partial molar free energy, partial molar volume and partial molar heat content and their significances. Determination of these quantities. Concept of fugacity and determination of fugacity.

UNIT-II

2. **Classical Thermodynamics-II** 15 Hrs

Non-ideal systems: Excess functions for non-ideal solutions. Activity, activity coefficients, Debye-Huckel theory for activity coefficient of electrolytic solutions, determination of activity and activity coefficients, ionic strength.

UNIT-III

3. **Statistical Thermodynamics**: 15Hrs

Thermodynamic probability, Most probable distribution, Stirling approximation,

Maxwell-Boltzmann distribution law, Entropy and probability, Ensemble averaging, postulates of ensemble averaging. Types of ensemble systems, Lagrange's method of undetermined multipliers. Partition functions: Translational, rotational, vibrational and electronic partition function, calculation of thermodynamic properties in terms of partition functions. Application of partition functions in the determination of equilibrium constants and heat capacity behavior of solids-chemical equilibria. Types of statistics: Fermi-Dirac statistics-distribution laws, Bose-Einstein statistics- distribution law and application to helium.

UNIT-IV

4. **Non Equilibrium Thermodynamics**: 15 Hrs

Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, entropy balance equations for different irreversible processes: heat flow, chemical reactions. transformations of generalized fluxes and forces, non-equilibrium stationary states, phenomenological equations, microscopic reversibility, irreversible thermodynamics for biological systems, coupled reactions.

BOOKS PRESCRIBED:

1. S. Glasstone: Thermodynamics for Chemists
2. P.W. Atkins: Physical Chemistry
3. S.H. Maron& C.F. Prutton: Principles of Physical Chemistry
4. Introduction to the Thermodynamics of Biological Processes by D. Jou& J. E. LLebot.
5. Pitts: Non equilibrium thermodynamics
6. I Prigogine: Introduction to thermodynamics of irreversible processes

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	Students will learn about the classical thermodynamics and revise the basic concepts
CO2	Learn to conceptualise the statistical mechanics derivations
CO3	Understands the link between classical mechanics and quantum mechanics by studying statistical mechanics
CO4	Deriving the thermodynamic parameters from quantum chemistry
CO5	Studying the irreversible thermodynamics and correlating real life problems

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-I)

CHE 414/CHH 414

Spectroscopy-A

Techniques for Structure Elucidation of Organic Compounds

Total Hours: 90
Total Hours/week: 6
Total Credits: 6
L T P
6 0 0

Maximum Marks: 150
Theory: 112
Internal Assessment: 38

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 4 Marks each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 22 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVE:

The course is well designed for the introduction of various concepts in molecular spectroscopy covering UV, IR, 1HNMR, 13C-NMR, 2D NMR and mass spectroscopy. It enables the students for interpretation of spectra and data analysis leading to skill enhancement. This course makes students employable in industries.

COURSE CONTENTS:

UNIT-I

1. **General Features of Spectroscopy**: 7 Hrs

The Electromagnetic Spectrum, Characteristics of Electromagnetic Radiations, Units of Frequency, Wavelength, Wave number and their conversion factors, Interaction of radiation with matter, Absorption of Electromagnetic Radiation by Organic Molecules, Absorption and emission spectroscopy, electronic and nuclear energy levels, Transition probability and Selection Rules, Basic features of different spectrometers, Line widths and Broadening.

2. **Nuclear Magnetic Resonance Spectroscopy-I** 15Hrs

Principal of NMR, Natural abundance of ^{13}C, ^{19}F and ^{31}P nuclei; The spinning nucleus, effect of external magnetic field, precessional motion and frequency, Chemical shift and its measurements. Factors influencing chemical shift, anisotropic effect, vander Waals deshielding, Integrals of protons, proton exchange, spin-spin coupling- splitting theory, one, two and three bond coupling, virtual, long range and allylic coupling, magnitude of coupling constant; factors affecting the coupling constant, Chemical and magnetic equivalence, First and second order spectra, A_2, AB, AX, AB_2, AX_2, A_2B_2 and A_2X_2 AX_3, A_2X_3, AMX , ABC spin systems.

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UNIT-II

3. **Nuclear Magnetic Resonance Spectroscopy-2** 23 Hrs

Simplification of complex spectra: increased field strength, spin decoupling or double resonance and lanthanide shift reagents, ^{13}C-NMR: Natural Abundance ^{13}C, Resolution and multiplicity of ^{13}C NMR, Proton coupled ^{13}C spectra, ^{1}H Decoupled ^{13}C spectra; off-resonance ^{13}C spectra. NOE effect, Cross polarization and origin of nuclear overhauser effect. ^{13}C Solvents, Heteronuclear coupling. NMR spectra of diastereotopic systems.

Structural applications of ^{13}C-NMR., pulse sequences, pulse widths, spins and magnetization vectors, The DEPT experiment & its use in structural elucidation, INEPT.

Introduction to 2D-NMR, COSY, TOCSY, & HETCOR, HSQC spectra, NOE-based experiments: NOESY.

UNIT-III

3. **Mass Spectra**: 11 **Hrs**

Introduction, methods of ionization EI & CI, Brief description of LD, FAB, SIMS, FD etc., Ion analysis methods (in brief), isotope abundance, Metastable ions, general rules predicting the fragmentation patterns. Nitrogen rule, determination of molecular ion peak, index of H deficiency, fragmentation patterns for aliphatic compounds, amines, aldehydes, Ketons, esters, amides, nitriles, carboxylic acids ethers, aromatic compounds etc.

4. **UV and Visible Spectroscopy of organic molecules**: 12 Hrs

Measurement techniques, Beer – Lambert's Law, molar extinction coefficient, oscillator strength and intensity of the electronic transition, Frank Condon Principle, Ground and first excited electronic states of diatomic molecules, relationship of potential energy curves to electronic spectra, Chromophores, auxochromes, blue shift, red shift, hypo and hyperchromic effect, n-σ*,π-π*, n-π* transitions in organic molecules.

Woodward rules for conjugated dienes and α,β-unsaturated carbonyl groups, extended conjugation and aromatic sterically hindered systems.

UNIT-IV

5. **Infrared Spectroscopy** 11 Hrs

Vibrational Energy Levels, Degree of freedom, Selection Rules, Force Constant, Fundamental Vibrational frequencies, Factors influencing Vibrational Frequencies (Vibrational Coupling, Hydrogen Bonding, electronic effect, Bond Angles, Field Effect). Sampling Techniques, Absorption of Common functional Groups, Interpretation, Finger print Regions.

Applications in Organic Chemistry

(a) Determining purity
(b) Studying reaction kinetics.
(c) Studying hydrogen bonding.
(d) Studying molecular geometry & conformational analysis.
(e) Studying reactive species

6. **Solution of Structural Problems by Combined Use of the following Spectroscopic Techniques** 11Hrs

(a) Electronic spectra
(b) Vibrational spectroscopy

(c) NMR (1H and 13C) spectroscopy
(d) Mass Spectroscopy

BOOKS PRESCRIBED:

1. Pavia, Lampman&Kriz, Introduction to Spectroscopy.
2. C.N Banwell "Fundamentals of Molecular Spectroscopy".
3. R. M. Silverstein, G.C.Bassler, T.C. Morrill, "Spectrometic Identification of Organic Compounds.
4. W. Kemp, "Organic Spectroscopy".
5. D.H. Williams, I. Fleming, "Spectroscopic Methods in Organic Chemistry".
6. D.H. Williams, I. Fleming, "Spectroscopic Problems in Organic Chemistry", 1967.
7. R.C. Banks, E.R. Matjeka, G. Mercer, "Introductory Problems in Spectroscopy", 1980.
8. G.M. Barrow "Introduction to Molecular Spectroscopy".

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	Learn the basic principles of interpret uv-visible, vibrational, 1-D and 2-D NMR and Mass spectroscopy for the structure identification of organic compounds
CO2	Students will gain an understanding of molecular-level critical thinking skills
CO3	Analyse and interpret uv-visible, vibrational, 1-D and 2-D NMR and Mass spectral data of organic compounds
CO4	Analyse the mass of organic molecule and fragments present in the molecule from mass spectral studies
CO5	Evaluate various structural possibilities and arrive at the most logical structure of organic compounds by analysis and interpretation of uv-visible, vibrational, 1-D/ 2-D NMR and Mass spectral data.

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-I)

CHE 415/CHH 415

Inorganic Chemistry Lab-I

Quantitative analysis

Total Hours: 90
Total Hours/week: 6
Total Credits: 3
L T P
0 0 3

Maximum Marks: 75
Theory: 56
Internal Assessment: 19

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES:

I. The exam will be conducted on two sessions ie Morning and Evening
II. Students will perform two practicals.
III Students will be asked to complete write up of both practical within first 30 minutes on the first sheet provided.
IV. On the second sheet provided after 30 minutes, students will perform and note the record on second sheet during the conduct of practical exam
V. The split of marks will be as under:
(Write-up = 20, Performance = 20, Viva-Voce = 10, Practical notebook = 6)

COURSE OBJECTIVES:

To analyse quantitative estimation of metal ions and anions using Oxidation-Reduction Titrations, . Precipitation Titrations, Complexometric Titrations and Gravimetric Analysis

COURSE CONTENTS:

I. **Oxidation-Reduction Titrations**

1. Standardization with sodium oxalate of $KMnO_4$ and determination of Ca^{2+} ion.
2. Standardization of ceric sulphate with Mohr's salt and determination of Cu^{2+}, NO_3^{-1} and $C_2O_4^{-2}$ ions.
3. Standardization of $K_2Cr_2O_7$ with Fe^{2+} and determination of Fe^{3+} (Ferric alum)
4. Standardization of hypo solution with potassium iodate / $K_2Cr_2O_7$ and determination of available Cl_2 in bleaching powder, Sb^{3+} and Cu^{2+}.
5. Determination of hydrazine with KIO_3 titration.

II. **Precipitation Titrations**

1. $AgNO_3$ standardization by Mohr's method by using adsorption indicator.
2. Volhard's method for Cl^- determination.
3. Determination of ammonium / potassium thiocyanate.

III. **Complexometric Titrations**

1. Determination of Cu^{2+} and Ni^{2+} by using masking reagent by EDTA titration.
2. Determination of Ni^{2+} (back titration).
3. Determination of Ca^{2+} (by substitution method).

IV. **Gravimetric Analysis**

1. Determination of Ba^{2+} as its chromate.
2. Estimation of lead as its lead molybdate.
3. Estimation of chromium (III) as its lead chromate.
4. Estimation of Cu^{2+} using Ammonium/ Sodium thiocyanate.

BOOKS PRESCRIBED:
Book: Vogel's book on Inorganic Quantitative Analysis.

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	Prepare the exact solution and Standardization for quantitative analysis of the solutions.
CO2	Determine of different ions like Ca^{2+}, Fe^{2+}, Oxalate, nitrate, available chlorine in bleaching powder using oxidation reduction titrations
CO3	Able to perform Precipitation Titrations using Volhard's method and Mohr's methods
CO4	Determine of different ions (Cu^{2+}, Ni^{2+} and Ca^{2+}) using complexometric Titrations
CO5	Estimate of ions using gravimetric techniques.

M.Sc. Chemistry (Semester-I)
CHE416: Organic Chemistry Lab-I
Quantitative analysis and Multistep Synthesis

Total Hours 90
Total Hours/week: 6
Total Credits: 3
L T P
0 0 3

Maximum Marks: 75
Theory: 56
Internal Assessment: 19

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES:

I. The exam will be conducted on two sessions ie Morning and Evening
II. Students will perform two practicals.
III Students will be asked to complete write up of both practical within first 30 minutes on the first sheet provided.
IV. On the second sheet provided after 30 minutes, students will perform and note the record on second sheet during the conduct of practical exam
V. The split of marks will be as under:
(Write-up = 20, Performance = 20, Viva-Voce = 10, Practical notebook = 6)

COURSE OBJECTIVES:

This course aims to impart to the student knowledge of: Laboratory set up, safe handling of chemicals, workup procedures and effective disposal of organic waste. The practicals include various methods of preparing organic compounds in a multiple step as well as Quantitative Analysis of Organic Compounds.

COURSE CONTENTS:

1. Quantitative Analysis

(a) Extraction of Organic Compounds from Natural Sources

1. Extraction of Caffeine from tea leaves
2. Isolation of casein from milk
3. Extraction of natural products using Soxhlet apparatus

(b) Quantitative Analysis of Organic Compounds:

1. Estimation of phenol/aniline using bromate-bromide solution.
2. Estimation of reducing sugar by Fehling solution method.
3. To determine the saponification value of the given fat or oil sample.
4. To determine the iodine number of the given fat or oil sample.

2. **Multistep Organic Synthesis**

1. Synthesis of 2-chloro-4-bromoaniline from aniline (Bromination and chlorination)
2. Photochemical synthesis of benzpinacol and its pinacol rearrangement.
3. Synthesis of 2,4-dinitrophenyl hydrazine from chloro benzene. (Electrophilic and nucleophilic substitution reactions on aromatic ring).

4. Synthesis of 2-phenyllndole-Fischer Indole Synthesis. Synthesis of 3-nitrobenzoic from benzoic acid
5. Cannizaro's reaction of 4-chlorobenzaldehyde.
6. Green synthesis of dihydropyrimidones and their structure confirmation by spectroscopic techniques

4. Applications of chromatographic techniques

1. TLC analysis:

TLC Analysis of the the purified samples along with the mixture in same TLC plates (component 1 with mixture and component 2 with mixture on separate TLC plate) and calculation of Rf values-Reporting and recording

2. Column Chromatography:

Separation of a mixture by column chromatography of o-nitroaniline and p-nitroaniline.

3. UV, IR, ^{1}H NMR, ^{13}C NMR, EI mass spectral identification of drug molecules from a library of compounds

3. **Microwave Organic Synthesis**

MW-assisted synthesis of substituted pyridines under solvent and catalyst free conditions

BOOK PRESCRIBED:

1. Vogel's Textbook of Practical Organic Chemistry
2. Advanced Practical Organic Chemistry by N. K. Vishnoi
3. Lab Mehods in Organic Chemistry by Solomon Marmor
4. Yin G, Liu Q, Maa J, She N. Solvent and catalyst free synthesis of new hydroxylated trisubstituted pyridines under microwave irradiation. Green Chemistry, 2012, 14, 1796-98.

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	Predict the results and identify errors associated with a chemical analysis based on the analytical technique and nature of the sample.
CO2	Justify the steps to prepare and standardize different solutions.
CO3	Do hands on expertise to synthesize organic compounds.Able to check Purity of organic compounds & the progress of the reaction by performing TLC Techniques individually
CO4	Characterize the structure of the organic compound by interpreting IR, UV, 1H NMR and Mass spectral data.
CO5	Gain hands-on practice of handling Laboratory Equipment.

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-I)
Basics and Applications of Chemistry Softwares (Theory)
CHE 417/CHH 417

Total Hours: 90
Total Hours/week: 6
Total Credits: 4
L T P
2 0 2

Maximum Marks: 100
Theory + Practical: 37 + 38
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES (Theory):

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 1.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 7 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVES:

1. *To comprehend how to use MS Excel for data processing to generate various types of graphs, carry out calculation based upon formulae and curve fitting of the data along with systematic presentation of graph.*
2. *To comprehend how to use MS power point for presentation of theoretical articles and research outcomes.*
3. *To comprehend how to use Chem Draw for structure drawing, equation writing, IR and NMR data analysis.*
4. *To comprehend how to use Origin Software for data processing.*

COURSE CONTENTS:

Unit-I

1. **MS Excel**

Excel Basics, Work with Cells and Worksheets, Entering Text and Numbers, Entering Excel Formulas and Formatting Data, Creating Excel Functions, Creating Charts, More on Entering Excel Formulas, Format your Workbook, Add Charts and Graphics, Collaborate with Others, Analyze your Data, Work with Macros and the Web, functions and formulas, charts, data analysis,

2. **MS Power Point**

Create and Manage Presentations, Create a Presentation, Insert and Format Slides, Modify Slides, Handouts, and Notes, Change Presentation Options and Views, Configure a Presentation for Print, Configure and Present a Slide Show, Insert Tables, Charts, Smart Art, and Media., Insert and Format Smart Art graphics, Insert and Manage Media, Apply Transitions and Animations, Apply Slide

Transitions, Animate Slide Content, Set Timing for Transitions and Animations.

Unit-II

3. **ChemDraw**

Chem Draw Ultra 8.0 software, Introduction, Download and installation process, Drawing various chemical structures (acyclic, cyclic, polycyclic, heterocyclic), Nomenclature generation, conversion of name into molecular structure, Calculation of physical properties such as density, molecular weight, molecular formula, refractive index from structural formula,. ^{1}H, ^{13}C NMR prediction from molecular structure, Drawing structure of bigger molecules such as proteins, carbohydrates, and RNA/DNA, bio arts, Use of templates, Comparison of various Chem Draw software.

Unit-III

4. **Origin 8.5 Software**

The Origin Workspace. Multi-sheet Workbooks Managing Data and Metadata. Importing Data from different sources. Working with Origin. Basic Data processing. Creating and Customizing Graphs. Custom Graph Templates and Themes. Publishing Graphs. Basic Data Analysis.

Unit IV

5**. Introduction to Molecular Docking**

Definition and introduction to Molecular Docking, Softwares used for Docking, Types of Molecular docking: Rigid docking, flexible docking, Ligand sources – Natural, synthetic and semi -synthetics, Protein Structure Basics, Protein Databases, Force fields, Ligand Preparation, Protein Preparation, Receptor Grid Generation, Ligand Docking, Analysis of ligand protein interactions, ADME properties. Any two Case studies.

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CHE 417/CHH 417

Practicals

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES (Theory):

1. Invigilator to assign two practical tasks to each student.
2. Students need to complete both practicals within 3 Hrs.
3. Invigilator to vary out the split of marks as per nature of experiment assigned

CONTENTS OF PRACTICAL SYLLABUS

1. Create presentations from a template. Add text, images, art, and videos.
2. Design a poster in MS powerpoint based upon the
3. Draw the structure of following compounds using ChemDraw

(a) Paracetamol (b) Chloramphenicol (c) Amoxicillin (d) Urotropine (e) Morphine

4. Draw the graph based upon data provided from a manuscript and carry out curve fitting of the data for various orders using Origin Sofware.
5. Draw multiple curves on the same axis using Excel and present each curve with different colour and mark the peaks in a separate box within the graph.
6. Draw 3D graphs based upon the three variables provided by using Origin software.
7. To write chemical reaction and mechanism for the following reaction using ChemDraw

(a) Aldol condensation of acetophenone
(b) Cannizarro reaction of benzaldehyde in 50% NaOH solution
(c) Fries Rearrangement
(d) Mannich reaction
(e) HVZ reaction and subsequent hydrolysis with aq KOH.

8 Export data of IR spectrum and plot the IR spectrum using Origin software/Excel.
9. Export data of UV-spectrum and plot the spectru using Origin software/Excel.
10. Molecular docking of Aspirin (Anti-inflammatory Drug) in the crystal coordinate of COX-2.
11. Molecular docking of Trimethoprim (Antibiotic Drug) in the crystal coordinate of DHFR.

BOOKS PRESCRIBED:

1. K.V. Raman, Computers in Chemistry, Tata McGraw Hill.
2. Tamanna Anwar, Pawan Kumar, Asad U. Khan,Chapter 1 - Modern Tools and Techniques in Computer-Aided Drug Design,Editor(s): Mohane S. Coumar, in book Fundamentals, Techniques, Resources and Applications2021, Pages 1-3
https://www.sciencedirect.com/book/9780128223123/molecular-docking-for-computer-aided-drug-design
3. https://www.nature.com/articles/s41429-019-0240-6
4. https://www.sciencedirect.com/science/article/pii/S1878535221005554
5. Chem Draw 7.0: Chemical Structure Drawing Standard - User's Guide Paperback , 2001 by Cambridge Scientific Computing .
6. Tutorial to ChemDraw: For beginner Kindle Edition by JUHN MORTON .
7. Origin Software Complete Usage Instruction and Graph Representation: A complete Guide for new users by Muhammad Arsalan, Azka Awais

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	Carry out formula based calculation, plot graphs, carry out curve fitting of the data for research purposes.
CO2	Plot graphs and process research data using Origin software
CO3	Draw the chemical structures and write chemical reactions using ChemDraw software.
CO4	Convert chemical name to structure, structure to chemical name and predict 1H and 13C -NMR data of the compound.
CO5	Make power point slides for presentation of research work.

Semester-II

M. Sc. Chemistry (Under the Honours Scheme) (Semester-II)

CHH 421: Inorganic Chemistry-II

Metal-Carbon bonding and its applications

Total Hours: 60
Total Hours/week: 4
Total Credits: 4
L T P
4 0 0

Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 2.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 15 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVES:

The aim of the course is to impart knowledge about the formation, structure and reactivity of transition metal-carbon (M-C) bonds and their utility in catalysis. The stoichiometric reactivity of transition metal-ligand complexes will provide the basis for our study of catalytic transformations in which we will combine these individual reactions to complete a variety of catalytic cycles.

COURSE CONTENTS:

UNIT I 15 Hrs

Introduction, The 18 Valence Electron Rule: Introduction, The 18 electron rule, counting of electrons and finding metal-metal bonds and related problems. Recaptulation of Metal carbonyls. Alkyl, Aryl and Ligands with Higher Hapticity: (i) Sigma bonded alkyl groups as ligands: Synthesis of metal-alkyl compounds, β-hydride elimination, σ-bonded η1 -aryl ligands. (ii) Cyclic and acyclic polyenyl π-bonded ligands: Cyclopentdienyl (Cp-), Synthesis of Cp based sandwich compounds, Structure and properties of MCp2 complexes, The first metal- sandwich compound Ferrocene, Reactions of metal-sandwich compounds, Bent sandwich compounds, Schwartz reagent and hydrozirconation, Chemistry of Cp* , Chemistry of arene sandwich compounds, Allyl groups as ligands, 1,3-Butadiene complexes, Cyclobutadiene complexes, Cycloheptatriene and Cyclooctatetraene as ligands. Davies-Green-Mingos (DGM) rules.

UNIT II 15 Hrs

Ferrocene: Structure and bonding of ferrocenes, Basic chemical reactions of Ferrocene, Reactions of Acetyl Ferrocene and formyl Ferrocene, lithiated ferrocenes and their reactions,

(Dimethylaminomethyl)Ferrocene and its methiodide salt, Ferroceneboronic acid and haloferrocenes, Chirality in Ferrocene derivatives, Synthesis of chiral Ferrocene based compounds, Ferrocene based condensation polymers

UNIT-III 15 Hrs

Catalytic reactions and 16/18 electron rule, alkene metathesis, Chauvin mechanism, Olefin polymerization, Ziggler-Natta polymerization, Cossee mechanism, hydrogenation of alkenes Wilkinson's catalyst, Fischer-Tropsch reactions, water gas shift reactions, Monsanto acetic acid process, hydrocyantion, Reppecarbonylation, hydroformylation of unsaturated compounds. Reductive carbonylation of alcohols and other compounds, carbonylation reactions: methanol and methyl acetate, adipic ester and other compounds,

UNIT IV 15 Hrs

Synthesis and carbonylation reactions, decarbonylation reaction, catalytic addition of molecules to carbon-carbon multiple bonds, homogeneous hydrogenation, hydro cyanation and hydro silation of unsaturated compounds, polymerization. Oligomerisation and metathesis of alkene and alkynes. Cluster compounds in catalysis, supported homogeneous and phase transfer catalysis, oxidation reactions, and oxidative carbonylation. Pd catalysed oxidation of ethylene, acrylonitrile synthesis, oxygen transfer from peroxo and oxo species and NO_2 groups

BOOKS PRESCRIBED:

1. J.E. Huheey, Inorganic Chemistry Principles of Structure and Reactivity, Harper Inter- Science.
2. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, Wiley Inter-Science.
3. B.D. Gupta and A.J. Elias, Basic Organomettallic Chemistry, Universities Press.
4. C.E.A. Salzer and E. Elchinbroich, Organometallics, A Concise Introduction Chemistry, VCH.

COURSE OUTCOMES:

S. No.	On completing the course, students will be able to
CO1	Understand organometallic chemistry with focus on the transition metals. catalysis
CO2	Study the wide variety of organometallic compounds and the choice of hapticity in different conditions.
CO3	Students will be able to understand the role of coordination number, coordination geometry and oxidation state of metal in catalytic cycles.
CO4	Learn Structure and bonding issues in organometallic compounds are discussed in view of the 18-electron rule.
CO5	Learn to go through some important emerging compounds especially multi decker sandwich compounds

M. Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-II)

CHE 422/CHH 422

Organic Synthesis-II

Reaction Mechanism- Addition, Elimination and Rearrangements

Total Hours: 60
Total Hours/week: 4
Total Credits: 4
L T P
4 0 0

Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 2.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 15 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVES:

The course aims to provide students with an in-depth knowledge of different types of reaction mechanisms i.e. addition, elimination, coupling and rearrangement reactions of aliphatic and aromatic organic compounds. The course further provides the insights into the utility of various oxidising and reducing agents.

COURSE CONTENTS:

UNIT-I

1. **Addition to Carbon-carbon and Carbon-Hetero Multiple Bonds-I** 15Hrs

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation. Addition of Grignard reagents, organozinc, organolithium and Gillman reagents to carbonyl and unsaturated carbonyl compounds. Use of other organometallic reagents in addition reactions. Wittig reaction,

UNIT-II

2. **Addition to Carbon-carbon and Carbon-Hetero Multiple Bonds-II** 5Hrs

Mechanism of condensation reactions involving enolates - Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.

3. **Rearrangements and Coupling Reactions** 10 Hrs

General mechanistic consideration - nature of migration, migratory aptitude, memory effects. A detailed study of the following rearrangements, Pinacol-pinacolone, Wagner-Meerwein, Demjanov,

Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hofman, Curtius, Schmidt, Shapiro reaction, Fries rearrangement. Reaction and mechanism of Diazo coupling, Glaser coupling, Heck reaction, Mcmurry reaction, Stille coupling, Suzuki coupling, Sonogashira reaction. Negishi and Hiyama coupling.

UNIT-III

4. **Elimination Reactions**: 7 Hrs

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.

5. **Oxidation Reactions**: 8 Hrs

Indtoduction. Different oxidative processes. Hydrocarbons- alkenes, aromatic rings, saturated C-H groups (activated and unactivated). Alcohols, diols, aldehydes, ketones, ketals and carboxyalic acids. Amines, hydrazines, and sulphides. Oxidations with ruthenium tetraoxide, iodobenzenediacetate and thallium (III) nitrate, DDQ, PCC, CAN, selenium dioxide, peroxyacids, DCC. Oxidation reactions with special emphasis on Baeyer-villeger reaction, Cannizarro oxidation-reduction reaction,

UNIT-IV

6. **Reduction Reactions**: 15 Hrs

Introduction. Different reductive processes, Hydrocarbons- alkanes, alkenes, alkynes and aromatic rings, Carbonyl compounds - aldehydes, ketones, acids, ester and nitriles. Epoxides, Nitro, nitroso, azo and oxime groups, Hydrogenolysis. Sodium borohydride, sodium cyanoborohydride, LAH, disobutylaluminium hydride, tin hydride, trialkyl tin hydride, trialkylsilanes, alkoxy substituted LAH, DIBAL, diborane, diisoamylborane, hexyl borane, 9-BBN, isopinocamphenyl and disiopinocamphenylborane. Reduction reactions with particular emphasis on Wolf-Kishner reduction, Clemensen reduction.

BOOK PRESCRIBED:

1. Organic Reaction Mechanism by Jerry March, John Wiley Ed. 5, 2002.
2. Advanced Organic Chemistry by Francis Carey, Vol A and Vol. B

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	Learn about the various chemical reagents available for addition to carbon-carbon/carbon-heteroatom multiple bonds.
CO2	Explain the mechanism of different types of elimination, and rearrangement reactions.
CO3	Get insight into the utilization of Pd, Ni, Titanium and silicon in coupling of two molecular entities and their vast applications in organic synthesis.
CO4	Study important oxidizing agents and oxidation reactions used in organic synthesis.
CO5	Acquire knowledge of reducing agents and their applications in organic synthesis.

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-II)

CHE 423/CHH 423

Physical Chemistry-II

Quantum Chemistry

Total Hours: 60
Total Hours/week: 4
Total Credits: 4
L T P
4 0 0

Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 2.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 15 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVES:

The main objective of the course is to train the students for applying the principles of Quantum Mechanics on different type of motions like translation, rotation, vibration and electronic motions to show the quantisation of related energies. Moreover the simple solution of Uni-electron system will be extended to the solution of multi-electron systems through approximation methods.

COURSE CONTENTS:

UNIT-I

1. **Quantum Theory: Introduction and Principles** 15Hrs

Black body radiations, Planck's radiation law, photoelectric effect, Compton effect, De- Broglie hypothesis, the Heisenberg's uncertainty principle, Rydberg relation for explaining atomic spectrum of hydrogen. Bohr's Theory and its limitation solution of classical wave equation by separation of variables method.

UNIT-II

2**. Quantum mechanical operators** 6 Hrs

Operators and observations, normal and orthogonal functions, hermitian and unitary operators, introduction to differentiation and integration, Eigen value equation. Hamiltonian operator, interpretation of wave function, postulates of quantum mechanics.

3. **Applications of Quantum Postulates** 9Hrs

Solution of particle in one and three dimensional box, degeneracy, the linear harmonic oscillator, rigid rotators, quantization of vibrational and rotational energy levels, hydrogen atom.

UNIT-III

3. **Angular Momentum** 7 Hrs

Commutative laws, need of polar coordinates, transformation of Cartesian coordinate into polar coordinate, angular momentum of one particle system, orbital angular momentum, the ladder operator for angular momentum, spin angular momentum and their relations.

4. **The Approximate Methods** 8 Hrs

Need for approximation methods, Perturbation and Variation methods and their application to Helium atom.

UNIT-IV

4. **General Orbital Theory of Conjugated Systems** 15Hrs

Chemical bonding, linear combination of atomic orbital, overlap integral, coulomb's integral, bond order, charge density calculations for ethylene, allyl system, butadiene system, cyclo butadiene cyclopropenyl system.

BOOK PRESCRIBED:

1. Physical Chemistry, A Molecular Approach by MacQuarrie and Simon.
2. Quantum Chemistry, Ira N. Levine, Prentice Hall.
3. Quantum Chemistry, H. Eyring, Kimball and Walter.
4. Quantum Chemistry, Atkin.
5. Fundamentals of Quantum Chemistry, Anantharaman. R.

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	Understand phenomenon of Black body radiation, photoelectric effect, Compton effect, De- Broglie hypothesis, the Heisenberg's uncertainty and classical wave equation and its solutions
CO2	Understand Concepts of operators, their types, uses and Quantum Mechanical Model of atom.
CO3	Apply of Quantum Mechanics to deduce the quantization of Translational, Rotational, Vibrational and Electronic energies.
CO4	Apply of Quantum Mechanical model on Single electron system like H-atom and Solution for multi-electron system through Approximation methods
CO5	Understand orbital and spin angular momentum and related Ladder Operators along with HMO theory and its application on various conjugated pi-electron systems

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-II)

CHE 424/CHH 424

Spectroscopy-B

Techniques for Structure Elucidation of Inorganic Compounds

Total Hours: 90
Total Hours/week: 6
Total Credits: 6
L T P
6 0 0

Maximum Marks: 150
Theory: 112
Internal Assessment: 38

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 4 Marks each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 22 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVES:

This course aims to impart to the student the knowledge of basic concepts of vibrational spectroscopy and its applications. The fundamental aspects of classifying molecules based on moment of inertia. The students will learn about the principles, applications and instrumentation of different molecular spectroscopic methods like Raman spectroscopy, NQR, Photo Electron Spectroscopy, Mössbauer Spectroscopy and Electron Spin Resonance Spectroscopy.

COURSE CONTENTS:

UNIT-I

1. **Vibrational Spectroscopy** 20 hrs

Theory of Infrared Absorption: Harmonic and anhormonic oscillators, absorptions of radiation by molecular vibrations, selection rules, force constant, frequency of vibrational transitions of HCl, vibrations in a polyatomic molecule, 3N-6 and 3N-5 rules, types of vibrations, overtones, combination and difference bands, examples of CO_2, SO_2, and H_2O, Fermi resonance, group vibrations.

Raman Spectroscopy: Introduction, selection rules, anisotropic polarizability, Stokes, anti-Stokes lines, vibrational Raman spectra of CO_2 and H_2O, polarised and depolarised Raman lines, rule of mutual exclusion, vibronic coupling.

Determination of I.R/Raman Active Modes**:** Significance of nomenclature: used to describe various vibrations, use of symmetry considerations to determining the number of active infrared and Raman

lines (character tables to be provided in the Examination).
Sample handling. Factors affecting absorption frequencies. Interpretation and finger printing regions. Applications of Raman and I.R selection rules to the determination of Inorganic structure with special emphasis on:

i) Metal carbonyls
ii) NSF_3
iii) Geometrical isomerism – differentiation between Cis and trans $[Co(bipy)_2Cl_2]Cl$.
iv) Structures of CO_2, N_2O, H_2O, chlorocomplexes of mercury, cadmium and zinc, and octahedral complexes SiF_6^{2-}, PF_6^-, SF_6.
v) Changes in the spectra of donor molecules upon coordination with special emphasis on N, N-dimethylacetamide and DMSO with Fe^{3+}, Cr^{3+}, Zn^{2+}, Pd^{2+} and Pt^{2+} ions. I.R spectroscopy and modes of coordination of SO_4^{2-}, N_2, O_2, NO, CO_3^{2-}, NO_3^-.

UNIT-II

2. **Pure Rotational Spectra** 10 **hrs**

Classification of molecules according to their moment of inertia.Rotational spectra of diatomic molecules (rigid rotator), Intensities of spectral lines, isotopic substitution effects, non-rigid rotator, polyatomic linear and symmetric top molecules, Stark effect.

3. **Nuclear Quadruple Resonance Spectroscopy** 10 hrs

Introduction, Experimental considerations, fundamentals of NQR spectroscopy, origin of EFG, measurement of energy differences between two nuclear spin states, the asymmetry parameters, effects of magnetic field, crystal field. Interpretation of spectra, application of the technique to halogen compounds (Organic), group elements, transition metals. Double resonance technique.

UNIT-III

4. **Photo Electron Spectroscopy** 10 hrs

Introduction, excitation and ejection of electrons, electronic energy in atoms and molecules, core level PES, symmetry and molecular orbitals, molecular orbital diagrams of dinitrogen and dioxygen, their XPS spectra, Valence electron photoelectron spectroscopy, Franck Condon principle, dissociation, predissociation, change of shapes of molecules on excitation.

5. **Mössbauer Spectroscopy** 10hrs

Principle, experimental considerations, conditions of MB Spectra, the spectrum and its parameters, simple spin states (I ½, 3/2), higher spin states (I > 3/2), magnetic splitting significance of parameters obtained from spectra, quadruple splitting, additive model, interpretation of MB Spectra of ^{57}Fe, ^{119}Sn. Application to biological systems, surface study, and compounds of group elements.

UNIT-IV

6. **Electron Spin Resonance Spectroscopy** 20hrs

Introduction, principle, brief instrumentation of spectrum, hyperfine splitting in isotropic systems involving more than one nucleus, ESR spectrum of benzene radical anion, methyl radical, CH_2OH, H_3CCH_2 radical, cyclopentadienyl, cycloheptatrienyl radical, pyrazine anion, pyrazine anion with ^{23}Na and ^{39}K counter ion and p-benzosemiquinone, DPPH, Naphthalene. Factors affecting magnitude of g values, zero field splitting, and Krammer's degeneracy. Qualitative survey of EPR spectra of first row transition metal ion complexes (d^1, d^2, d^3, low spin d^5, high spin d^6, d^7, d^9 system). Spectra of

triplet states, rate of electron exchange, double resonance (ENDOR, ELDOR)

BOOK PRESCRIBED:

1) R. S. Drago, "Physical Methods in Chemistry". W.B Saunders Company.
2) C. N. Banwell, "Fundamentals of Molecular Spectroscopy".
3) R. V. Parish, "NMR, NQR, EPR & Mossbauer spectroscopy in Inorganic Chemistry". Ellis Horwood, London, 1990.
4) G. M. Barrow, "Introduction to Molecular Spectroscopy".
5) E. A. Ebsworth, S. Craddock and D. W. H. Rankin, "Structural methods in Inorganic Chemistry".Blackwell Scientific Publications (1991).
6) C. N. R. Rao and J. R. Ferraro, "Spectroscopy in Organic Chemistry, Vol. I". Academic Press (1971)
7) Walker and Straughan, "Spectroscopy, Vol I and III".

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	Get basic idea and application of IR spectroscopy and Raman spectroscopy
CO2	Learn applications of Rotational spectroscopy in inorganic molecules.
CO3	Learn about NQR spectroscopy.
CO4	Apply of photoelectron spectroscopy
CO5	Learn principle of EPR spectroscopy and Mossbauer spectroscopy and structure elucidation of inorganic compounds

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) Semester-II)

CHE 425/CHH 425

Organic Synthesis-III

Supramolecular, Reactive Intermediates and Disconnections

Total Hours: 90
Total Hours/week: 4
Total Credits: 4
L T P
4 0 0

Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 2.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 15 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVE:

The course aims to design and develop novel technique in the planning of organic syntheses for functional systems by joining multiple chemical components through non-covalent interactions.

COURSE CONTENTS:

UNIT-I

1. **Supramolecular Chemistry-I**

(a) **Concepts** 5Hrs

Definition and Development of Supramolecular Chemistry, classification of Supramolecular Host-Guest compounds, Pre- organization and Complementarily, Receptors, Nature of Supramolecular interactions.

(b)**Binding of anions and neutral molecules** 10Hrs

Biological anion receptors, concepts on anion host design, Fromcation to anion hosts-a simple change in pH, Guanidinium- based receptors, Neutral receptors, organometallic receptors, coordination interactions. Inorganic solid state clathrate compounds, solid state clathrates of organic hosts, intracavity complexes of neutral molecules, supramolecular chemistry of fullerenes.

UNIT-II

2. **Supramolecular Chemistry-II**

(c) **Cation Binding Host** 7Hrs

Crown ethers, Lariat ether and Podands, Cryptands, spherands, selectivity, Macro cyclic, Macrobicyclic and Template effects, soft ligands, calixarenes, carbon donor and - acid ligands,

siderophores.

(d) **Crystal Engineering and Molecular Devices** 8Hrs

Concepts, crystal structure prediction, Crystal Engineering with hydrogen bonds, weak hydrogen bonds, hydrogen bonds to metals and metal hydrides, π- πstacking, coordination polymers. Introduction, Supramolecular photochemistry, molecular electronic devices: Switches, wires and rectifiers, machines based on catenanes and rotaxanes.

UNIT-III

3. **Organic Reactive Intermediates-I** 15Hrs

(a) **Carbanions**: Chemistry of enolates and enamines, kinetic and thermodynamic enolates, Lithium and boron enolates in aldol and Michael reactions, alkylation and acylation of enolates, Nucleophilic additions to carbonyls and streroechemical aspects through various models (crams / cram chelation / Felkin-Anh models)

(b) **Carbocations**: Structure and stability of carbocations, classical and non classicalcarbocations, Neighbouring group participation.

(c) **Carbenes and Nitrenes**: Structute, generation addition and insertion and rearrangement reactions of carbenes such as wolf rearrangement. Generation of ylids by wolf decomposition.Structure, generation and reactions of nitrene and related electron deficient nitrogen intermediates.

UNIT-IV

4. **Organic Reactive Intermediates** 8Hrs

(d) **Ylids**: Chemistry of Phosphorous and Sulphurylids-Wittig and related reactions, Peterson olefination etc.

(e) **Radicals**: Generation of radical intermediates and its addition to alkenes, alkynes for C-C bond formation and Baldwins rule. Fragmanetation and rearrangements reactions like decarboxylation, McMurry coupling etc.

5. **Disconnection approach** 7Hrs

An introduction to synthons and synthetic equivalents, disconnection approach, functional group interconversions, 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.

BOOK PRESCRIBED:

1. J.W Steed and J.L Atwood, Supramolecular chemistry, John Wiley & Sons, Ltd. New York.
2. Designing Organic Synthesis, S. Warren, Wiley
3. Organic Synthesis- Concepts, Methods and Starting Materials, J. Fuhrhop and G. Penzillin, Verlag VCH.
4. Advanced Organic Synthesis Part A and B, F.A. Carey and R. J. Sundberg, Plenum Press.
5. Principles of Organic Synthesis, R. Norman and J. M. Coxon, Blackie Acdemic& Professional
6. *Modern Methods of Organic Synthesis* Cambridge University Press (1971). Carruthers,
7. Reactive Intermediates, Gilchrist and Rees

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	Learn introductory concepts of supramolecular chemistry
CO2	Learn the binding of various metals with synthetic and natural cationic hosts
CO3	Understand the logics involved in anion binding by different hosts including solid state clatharates and fullerenes
CO4	Develop the concept involved in Crystal Engineering
CO5	Learn the construction of molecular devices such as molecular wires, rectifiers and switches
CO6	Acquire an in depth knowledge of various reactive intermediates viz. Carbocations, carbanions, free radicals, carbenes and nitrenes.
CO7	Understand retrosynthetic methodology of going from a target molecule to simple starting compound
CO8	Learn the concept of disconnection, functional group interconversions, synthons and their corresponding synthetic equivalents

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-II)

MH CHX 421: Mathematics for Chemists

For Medical Students

Total Hours: 45
Total Hours/week: 3
Total Credits: 3
L T P
3 0 0

Maximum Marks: 75
Theory: 56
Internal Assessment: 19

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi and TWO questions from each unit.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 2 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question will carry 11 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVES:

1. To help the students to understand the relationships between side lengths and angles of triangles.
2. To make the students able to describe the angles that are created when atoms bond together to form molecules in molecular geometry.
3. To acquaint the students with the trigonometry and its properties.
4. To solve problems related to matrices, determinants, derivatives and integrals.
5. To calculate Area under a curve using integration.

COURSE CONTENT:

UNIT-I

Trigonometry and Determinants: Definition of sin, cos, tan, cot, sec, cosec functions with the help of unit circle, values of sin x, cos x for x = 0, $\pi/6$, $\pi/3$, $\pi/2$. Trigonometric identities (without proofs) and their applications.Definition and expansion, properties of determinants, product of two determinants of 3rd order.

UNIT-II

Matrices: Introduction to various forms of Matrices, row, column, diagonal unit, Submatrix, square, equal matrices, null, symmetric and skew symmetric matrices, transpose of a matrix, adjoint and inverse of matrices. Addition, multiplication, characteristic equation of a matrix, statement of Cayley Hamilton theorem. Rank of matrix, condition of consistency of a system of linear equations. Eigen vectors and Eigen values ofmatrices.

UNIT-III

Differential Calculus : Differentiation of standard functions, theorems relating to the derivative of the sum, difference, product and quotient of functions (without proofs), derivative of trigonometric functions, inverse trigonometric functions, logarithmic functions and exponential functions, differentiation of implict functions, logarithmic differentiation.

UNIT-IV

Integral Calculus: Integration as an inverse of differentiation, summation, area under a curve, indefinite integrals of standard forms, method of substitution, method of partial fractions, integration by parts, definite integrals, reduction formulae, definite integrals as limit of a sum and geometrical interpretation.

BOOKS PRESCRIBED:

1. Santi Narayan – Differential Calculus.
2. Santi Narayan - Integral Calculus.
3. B.S. Grewal – Higher Engineering Mathematics.
4. Joseph B. Dence – Mathematical Techniques in Chemistry.
5. Margenau and Murphy, the Mathematics of Physics and Chemistry.
6. B.L. Moncha and H.R. Choudhary – A Text Book of Engineering Mathematics.

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	Understand the relationships between side lengths and angles of triangles.
CO2	Describe the angles that are created when atoms bond together to form molecules in molecular geometry.
CO3	Work with the matrices, determinants, derivatives and integrals.
CO4	Calculate Area under a curve using integration.

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-II)
BT CHX 421
Biology for Chemists
For Non-Medical Students

Total Hours/week: 3
Total Credits: 3
L T P
2 1 0

Maximum Marks: 75
Theory: 56
Internal Assessment: 19

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V

II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi and TWO questions from each unit.

III. Section-I will consist of eight questions and student has to attempt any six short questions carrying 2 Mark each.

IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question will carry 11 Marks.

V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVES:

1. To understand the basic cell structure and role of biologically important molecules.

2. To study the basic principle of heredity and gene expression.

3. To learn the taxonomic criteria of classification of living things.

4. To study the basic structure of viruses.

COURSE CONTENTS:

UNIT-I

1. The Organization of life

- **Biologically important molecules:** Carbohydrates, lipids, proteins and nucleic acids.
- **The life of cells:** The cell theory, general characteristics of cells, difference between prokaryotic and eukaryotic cells, difference between plant and animal cells, Cell organelles (Mitochondria, Golgi apparatus, Ribosome, Endoplasmic reticulum, Chloroplast & Nucleus).

UNIT-II

- **Animal tissues**; epithelial tissues, connective tissues, muscle tissue, nervous tissue.
- **Plant tissue:** meristematic tissue, permanent tissues.

UNIT-III

2. Genetics

- **The basic principle of heredity:** Mendel's laws, monohybrid cross, dihybrid cross.
- **DNA:** Double helix structure and replication.

UNIT-IV

3. The Diversity of Life

- **The classification of living things:** criteria of classification, Whittaker's system of classification.
- **Viruses:** Structure & types of viruses.

BOOKS PRESCRIBED:

1. Cord Biology – South Western Educational Publications, Texas, 2000

COURSE OUTCOMES:

CO-1	The chemical structure of biologically important molecules: Carbohydrates, lipids, proteins and nucleic acids and how physiological conditions influence the structures and reactivates of these biomolecules.
CO-2	The life of cells – The cell theory, general characteristics of cells, difference between prokaryotic and eukaryotic cells, difference between plant and animal cell and will know about the structure and functions of various cell organells.
CO-3	The anatomical structure of plants and animals by studying the Tissues, organs and organ systems: Animal tissues; epithelial tissues, connective tissues, muscle tissue, nervous tissue and neoplasias; plant tissue: maristematic tissue, permanent tissues.
CO-4	The scope and significance of genetics by imbibing the principles of hereditary genetic transmission and interactions of gene with environment.
CO-5	The genes at molecular level, structure of DNA, DNA replication. Gene expression: transcription and translation and genetic code.
CO-6	The taxonomic nomenclature and criteria of classification, Whittaker's systems of Classification and their characteristics.
CO-7	The important and diversified groups of microorganism in nature and their classification.

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-II)

CHE 426/CHH 426

Physical Chemistry Lab-I

Total Hours: 90
Total Hours/week: 6
Total Credits: 3
L T P
0 0 3

Maximum Marks: 75
Theory: 56
Internal Assessment: 19

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES:

I. The exam will be conducted on two sessions i.e. Morning and Evening
II. Students will perform two practical's.
III Students will be asked to complete write up of both practical within first 30 minutes on the first sheet provided.
IV. On the second sheet provided after 30 minutes, students will perform and note the record on second sheet during the conduct of practical exam
V. The split of marks will be as under:
(Write-up = 20, Performance = 20, Viva-Voce = 10, Practical notebook = 6)

COURSE OBJECTIVES:

This course aims to impart to the student knowledge of: Laboratory set up, calibration and handling and use of instruments like pH-meter, Conductometer, potentiometer, tensiometer, Abbe's Refractometer and Polarimeter for the qualitative and quantitative analysis.

COURSE CONTENTS:

1. To determine the strength of given acid by *p*H metrically.
2. To determine dissociation constant of given acid *p*H metrically
3. Titration of weak acid conductometrically
4. Titration of strong acid conductometrically
5. To determine dissociation constant of given acid conductometrically
6. Determine the dissociation constant of acetic acid in DMSO, DMF, dioxane by titrating it withKOH.
7. Determine the activity coefficient of an electrolyte at different molalities by e.m.f. measurements.
8. Compare the cleansing powers of samples of two detergents from surface tension measurements.
9. Determine the specific refraction, molar refraction and atomic parachor with the help of Abbe's refractometer.
10. To study the distribution of benzoic acid between benzene and water.
11. Determine the equilibrium constant of reaction K_1+ +l_2→ Kl_3 by distribution law and hence Find the value of GO of the above reaction
12. Compare the relative strength of CH_3COOH and $ClCH_2COOH$ from conductance measurements.
13. Determine the solubility (g/litre) of sparingly soluble lead sulphate from conductance measurements.

14. Titrate a given mixture of HCl and CH_3COOH against NaOH solution conductometrically.

15. Compare the relative strength of:
i) HCl
ii) H_2SO_4
by following the kinetics of inversion of cane sugar polarimetrically.

BOOK PRESCRIBED:
Advance Practical Chemistry by J. B. Yadav

COURSE OUTCOMES:

S. No.	On completing the course, students will be able to
CO1	Use of Electro-methods like conductivity meter *p*H-meter for quantitative analysis.
CO2	Use of Electro-methods like *p*H-meter for quantitative analysis.
CO3	Use of Optical-methods like Abbe's refractometer for quantitative analysis
CO4	Use of Optical-methods like Polarimeter for quantitative analysis
CO5	Use of non-electrical methods like surface tension, distribution law and study of equilibrium

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-II)

CHE 427/CHH 27

Inorganic Chemistry Lab-II

Total Hours: 90
Total Hours/week: 6
Total Credits: 3
L T P
0 0 3

Maximum Marks: 75
Theory: 56
Internal Assessment: 19

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES:

I. The exam will be conducted on two sessions i.e. Morning and Evening
II. Students will perform two practicals.
III Students will be asked to complete write up of both practical within first 30 minutes on the first sheet provided.
IV. On the second sheet provided after 30 minutes, students will perform and note the record on second sheet during the conduct of practical exam
V. The split of marks will be as under:
(Write-up = 20, Performance = 20, Viva-Voce = 10, Practical notebook = 6)

COURSE OBJECTIVE:

The aim of this course is to impart practical skill to the pupil for synthesis and structure analysis of inorganic complexes.

COURSE CONTENTS:

(Any 8 Complexes.)

1. Preparation of $Co(acac)_3$, its characterization using NMR, IR, UV-Vis and analysis of Cobalt (ref. J. Chem. Edu., 1980, 57, 7, 525)

2. Preparation of Co. $(acac\text{-}NO_2)_3$, its characterization using NMR, IR, UV-Vis and analysis of Cobalt. (ref. J. Chem. Edu., 1980, 57, 7, 525)

3. Preparation of $[Fe(H_2O)_6][Fe(N\text{-salicyldeneglycinato})_2]_2.3H_2O$, its characterization using IR, UV-Vis, magnetic susceptibility and analysis of Iron.(ref. InorganicaChimicaActa, 1977, 23, 35).

4. Preparation of $[Ni(NH_3)_6]Cl_2$its characterization using IR, UV-Vis, magnetic susceptibility and analysis of Nickel and NH_3. (ref. Marr and Rockett, 1972).

5. Preparation of $[Ni(ethylenediamine)_3]Cl_2$ its characterization using IR, UV-Vis, magnetic susceptibility and analysis of Nickel. (ref. Marr and Rockett, 1972, page 270).

6. Preparation of $[Fe(NO)(S_2CN(Et)_2)_2]$ its characterization using IR, UV-Vis, magnetic susceptibility and analysis of Fe(II). (ref. Marr and Rockett, 1972, page 262, J. Chem. Soc. 1962, 84, 3404).

7. Preparation of octahedral and tetrahedral complexes of dichlorodipyridylcobalt(II), differentiate them using IR, UV and magnetic properties. Estimate Co(II) from one of them. (ref. Marr and Rockett, 1972, page 375, Inorganic Chemistry, 1966, 5, 615).

8. Preparation of $VO(acac)_2$and its piperidine complex, characterize using IR, UV and magnetic moment. Estimate for V(IV). (ref. Marr and Rockett, 1972, 243).

9. Preparation of diaquotetraacetataocopper(II), magnetic susceptibility IR and UV-Vis, analysis of Copper(II).

10. Preparation of cis- and trans- potassium dioxalatodiaquochromate(III). Interpretation of IR, UV and magnetic properties.Estimation of Chromium. (ref. Marr and Rockett, 1972, page 386).

11. Preparation of $HgCo(NCS)_4$, its IR and measure its magnetic moment. (ref. Marr and Rockett, 1972, page 365).

12. Preparation of sodium tetrathionate, interpretation of its IR and analysis using potassium iodate. (ref. Marr and Rockett, 1972, page 214).

13. Preparation of Potassium dithionate, interpretation of its IR and analysis using potassium iodate. (ref. Marr and Rockett, 1972, page 214).

14. Preparation of bis(acetylacetonato)copper(II), UV-Vis, and IR, magnetic studies, Demonstration of Jahn Teller effect by solution spectral studies. (ref. Bull. Chem. Soc. Japan, 1965, 29, 852).

15. Preparation of salicylamide complexes of Copper(II). IR, UV, magnetic data and analysis of Cu(II). (ref. Indian J. of Chem., 1977, 15A, No. 5, 459; ibid, 1971, 9, 1396).

16. To prepare a macrocyclic ligand 5,7,7,12,14,14-hexamethyl-1,4,8,11-tetraazacyclotetradeca-4,11-dienedi(hydrogeniodide) and its complex with Ni(II). Study IR, NMR and UV-Vis of ligand and complex and magnetic properties of complex. To analyze for Ni and I. (J. Chem. Edu. 1977, 79, 581).

17. Preparation and resolution of tris (ethylenediamine) cobalt (III). UV-Vis, NMR, IR, optical rotation of the resolved complexes. ((ref. Marr and Rockett, 1972, page 386).

BOOK PRESCRIBED:

1. B.N. Figgis, Introduction to Ligand Field, Wiley Eastern.
2. A.B.P. Lever, Inorganic Electronic Spectroscopy, Elsevier.
3. A.Earnshaw, Introduction to Magnetochemistry, Academic Press.
4. J.E. Huheey, Inorganic Chemistry Principles of Structure and Reactivity, Harper Interscience.
5. R.S. Drago, Physical Medhod in Chemistry, W.B.Saunders Company.
6. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, Wiley Int.

COURSE OUTCOMES:

S. No.	On completing the course, students will be able to
CO1	Learn how to synthesize inorganic complexes
CO2	Synthesize the geometrical isomers of the complexes
CO3	Analyze structure of inorganic complexes from spectral data
CO4	Have hands-on experience/ practical knowledge in performing experiments
CO5	Get Practical knowledge about UV and FTIR

Semester-III

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-III)
CHE 531 / CHH 531
Inorganic Chemistry-III
Bioinorganic and Metal Clusters

Total Hours: 60
Total Hours/week: 4
Total Credits: 4
L T P
3 1 0

Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 2.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 15 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVES:

The main objective of this course is to help the students to understand the use of metals in biological systems, various aspects of coordination chemistry related to bioinorganic research, metallo biopolymers, their structure, function, role of metal ion, etc.

COURSE CONTENTS:

UNIT-I

1. (a) **Bioinorganic Chemistry** 15 Hrs

Periodic survey of essential and trace elements, biological importance and relative abundance, Na^+/ K^+ ion pump and its mechanism.

Porphyrine and metalloporphyrins, Oxygen carriers/storage-Hb and Mb: Structure and mechanism of their function, cooperativity and Bohr effect. Synthetic models of Hb, Cyanide, phosphine and carbon monoxide poisoning.

Inhibition and poisoning by ligand and metal ions, hemocyanin and hemerythrin, models of iron, coalt and copper.

Bioenergetic and ATP cycle process coupled to phosphate hydrolysis, Nucleotide transfer-DNA polymerase, phosphate transfer pyruvate kinase, phosphoglucomutase, creatin kinase, ATPase.

UNIT-II

1. (b)**Bioinorganic Chemistry** 15 Hrs

Photosynthesis and respiration - chlorophyll: structure, function and its synthetic model. Xanthine

oxidase, Gout Disease and its remedy.
Enzymes and their functioning, Bioredox agents, Zn-enzymes carboxipeptidase, carbonic anhydrase, superoxide dismutase, peroxidases and catalases,
Vitamin B_{12} coenzyme, structure, function and "Mn" mechanism and its application in organic synthesis, intake of alcohol and its remedy.
Cytochromes-structure and function, Cytochrome P_{450} enzymes.
Ferrodoxins and rubredoxins their structure and function. Abiological and biological N_2 fixation and mechanism.

UNIT-III

1. (c) **Bioinorganic Chemistry** 15 Hrs

Ferritin, transferring and siderophores and their structure and function.
Availability, competition, toxicity and nutrition of Iron, metal deficiency and diseases, toxic effects of antibiotics, chealte therapy, synthetic metal chelates as antimicrobial agents.
Calcium in living cell, transport and regulation and its mechanism.
Molecular aspects of intramolecular processes and their mechanisms.

2. **Metal Clusters**

(a)**Reaction at Coordinated ligands**

The role of metal ions in the hydrolysis of amino acid esters, peptides, and amides Molecular orbital concept of role of metal ions participation, Modified aldol condensation, Imine formation, Template and Macrocyclic effect in detail.

UNIT-IV

(b) **Metal to Metal Bonds and Metal atom Clusters** 15 Hrs

Metal carbonyl clusters, isoelectronic and isolobal relationship, high nuclearity carbonyl clusters (HNCC), Structural Patterns, synthetic methods, heteroatoms in metal atom clusters
Carbide and nitride containing clusters, electron counting scheme for HNCC's, the capping rule, HNCC's for Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt.
Lower halides and chalcogenides clusters, octahedral metal halides and chalcogenides clusters($M_6M_8M_6M_{12}$ type).
Cheveral phases, triangular clusters and solid state extended arrays. Compound with M-M multiple bonds, major structural types, quadruple bonds, and other bond orders.
Intragoonal context relation of clusters to multiple bonds and one dimensional solids.

BOOK PRESCRIBED:

1. Principles of Bioinorganic Chemistry, S. J. Lippard and Berg, University Science Books.
2. J.E. Huheey : Inorganic Chemistry III & IV Ed. Pearson Education Asia – (2002).
3. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 5th Edition.
4. Purcell and Kotz: Inorganic chemistry. W. B. Saunders and Co., London
5. Bioinorganic Chemistry by D. Banergia.

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	Students will be able to analyse the relation between oxidation state of metals and their biological behaviour.
CO2	Students will be able to understand the role of metals and chemicals in biological systems.
CO3	Students will learn the use of porphyrins of different metal ions in biological systems
CO4	Students will be able to make a correlation between enzymatic functions and metals.
CO5	students will understand the structural features of biological systems involving metal ions and their activities and mechanisms

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-III)
CHE 532/ CHH 532
Organic Synthesis-IV
Natural Products

Total Hours: 60
Total Hours/week: 4
Total Credits: 4
L T P
3 1 0

Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 2.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 15 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVES:

The aim of this course is to make the students familiar with nomenclature, methods of structure elucidation, general properties and methods of synthesis of natural products.

COURSE CONTENTS:

UNIT-I

1. **Studies on Biosynthetic Pathways of Natural Products and Terpenoids** 10 Hrs

a)Primary and Secondary reactions of Biosynthesis, Biosynthesis of AcetylCoA, Shikmic acid pathway.

b) Isoprene rule, mechanism of formation of mevalonic acid from acctyl coenzyme, Biogenetic isoprene rule. Geranyl pyrophosphates and its conversion into alphapinene, thujene and borneol. Farnesyl pyrophosphate, geranyl, geranyl pyrophosphate and mechanistic considerations for their interconversions into cadinene and abietic acid.

2. **Terpenoids** 5 hrs

General classification, General Methods of structure determination, Chemistry of Camphor, Abietic acid and Menthol. Biosynthesis of Squalene and Phytoene.

UNIT-II

3. **Carbohydrates** 9 Hrs

Nomenclature and Classification, Structure of Maltose, Lactose, Sucrose, Starch and cellulose. Structure elucidation of cellulose.structure and functions of glycosides, deoxy sugars, myoinositol, amino sugars, N-acetylmuramic acid, sialic acid and chitin. Structure and biological functions of glucosaminoglycans or mucopolysaccharides. Carbohydrate metabolism-Kreb's cycle, glycolysis, glycogenesis and glycogenolysis, gluconeogenesis, pentose phosphate pathway.

4. **Amino-acids, Peptides and Proteins** 6 Hrs

Nomenclature and symbols of amino acids. Chemical and enzymatic hydrolysis of proteins to peptides. Secondary and Tertiary structure of proteins. Biosynthesis of aliphatic and aromatic Amino acids. Structure elucidation of oxytocin and Insulin

UNIT-III

5. **Steroids** 10 Hrs

Biosynthesis of steroids, Diels hydrocarbon, Structure elucidation of Cholesterol and estrone. Synthesis of Cholesterol, Progesterone, Oestrone, Testosterone and Androsterone.

6. **Alkaloids** 5 Hrs

Classification of alkaloids, Methods of structure determination of Alkaloids, Structure elucidation and synthesis of Nicotine, Quinine, Morphine, Coniine and Ephiderene

UNIT-IV

6. **Haemin and Chlorophyll** 5 Hrs

Structure and synthesis of Porphyrins. Chemistry of Haemin and chlorophyll.

7. **Antibiotics** 5 Hrs

Introduction, chemistry of pencillins, streptomycines, chloromphenicol, tetracyclins.

8. **Prostaglandins** 5 Hrs

General study, nomenclature, structure of PGE and synthesis of PGE1, PGE2, PGF2x

BOOK PRESCRIBED:

1. Primary Metabolism: A Mechanistic Approach by J. Staunton, Oxford University Press, 1978.
2. Secondary Metabolism by J. Mann, Oxford University Press, Oxford, 1980.
3. Natural Product Chemistry - A mechanistic, Biosynthetic and Ecological Approach by Kurt B. G. Torssell, Swadish Pharmaceutical Society, 1997.
4. Principles of Biochemistry by A. L. Lehninger, CBS Publishers, New Delhi.
5. Fundamental of Biochemistry by D. Voet, J.G. Voet and C.W. Pratt, John Willey & Sons Inc., New York,1999.

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	Students will be able to draw structures of monosaccharides, disaccharides and polysaccharides and learn their functions.
CO2	Students will be capable of drawing the structures of amino acids and proteins.
CO3	Learn general as well as advanced methods of structural elucidation and chemistry of important natural products such as steroids, alkaloids, Porphyrins, Nucleic acids, Peptides, antibiotics and prostaglandins.
CO4	Study biosynthesis and chemistry of terpenoids
CO5	Students become familiar with reagents used in organic synthesis and structure elucidation.

M. Sc. Chemistry (Under the Honours Scheme) (Semester-III)

CHH 533

Physical Chemistry-III

Biophysical Chemistry

Total Hours: 60
Total Hours/week: 6
Total Credits: 6
L T P
5 1 0

Maximum Marks: 150
Theory: 112
Internal Assessment: 38

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 4 Marks each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 22 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVES:

The main aim of this course is to learn the biological perspectives of the living things and studying the physical and chemical changes occurring in them. The course also focuses on the multidisciplinary nature of learning biology and physical chemistry. Also, the molecular mass determination techniques are designed to help in future for research purpose.

COURSE CONTENTS:

UNIT-I 20 Hrs

Biological Cell and its Constituents: Biological Cell, structure and functions of proteins, enzymes, DNA and RNA in living systems. Helix coil transition.
Bioenergetics: Standard free energy change in biochemical reactions, exergonic, endergonic, Hydrolysis of ATP, synthesis of ATP from ADP, coupled reactions, degree of coupling.
Statistical Mechanics in Biopolymers: 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 20 Hrs

Biopolymer Interactions: Forces involved in biopolymer interactions, Electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interactions. Multiple equilibria and various types of binding processes in biological systems. Hydrogen ion titration curves.
Thermodynamics of Biopolymer Solutions: Thermodynamics of biopolymer solutions, osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechanochemical system.
Cell Membrane and Transport of Ions: Structure and functions of cell membrane. Active

transport across cell membrane, irreversible thermodynamics treatment of membrane transport.

UNIT-III 20 Hrs

Bio-Polymers and their Molecular Weights: Evaluation of size, shape, molecular weight and extent of hydration of biopolymers by various experimental techniques. Viscosity: Measurement, relation to geometry and correlation with hydrodynamic properties. Diffusion: Fick's Law of diffusion, diffusion coefficient and its interpretation, frictional coefficient.

UNIT-IV 20 Hrs

Ultracentrifugation: Svedberg equation, sedimentation equilibrium, density gradient sedimentation.
Electrophoresis: General principles, Double layer techniques, moving boundary electrophoresis, zonal electrophoresis, isoelectric focusing.
Osmotic Pressure: Second virial coefficient, Donnan effect, molecular mass and geometry from O.P. data.
Optical Properties of Biomacromolecules: Light scattering, fundamental concepts, Rayleigh Scattering, Scattering by Larger particles.

BOOKS PRESCRIBED:

1. Principles of Biochemistry, A.L. Lehninger, Worth Publishers.
2. Biochemistry, L. Stryer, W.H. Freeman.
3. Biochemistry, Voet and Voet, John Wiley.
4. Macromolecules: Structure and Function, F.Wold., Prentice Hall.
5. Text Book of Polymer Science, F.W. Billmeyer.
6. Physical Chemistry of Polymers, A. Tager.

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	Understand the chemistry of cell and small biological molecules
CO2	Learn detailed interpretation of structures and functions of proteins, nucleic acids and enzymes, biopolymer interactions and thermodynamics of biopolymer solutions
CO3	Learn working of cell membrane and functions in terms of transport, bioenergetics and statistical mechanics of biopolymers.
CO4	Learn various physical techniques to obtain molecular weight of biomolecules
CO5	Learn light scattering, osmosis, diffusion, X-ray diffraction, CD spectroscopy.

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-III)
CHE 534/ CHH 534
Organic Synthesis-V
Pericyclic and Photochemistry

Total Hours: 60
Total Hours/week: 4
Total Credits: 4
L T P
3 1 0

Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 2.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 15 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECIVES:

The aim of the course is to make students familiar with the concepts and applications in two important topics in advanced organic chemistry, namely concerted organic reactions and organic photochemistry.

COURSE CONTENTS:

UNIT-I

1. (a)**Pericyclic Reactions** 15 Hrs

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene, allyl system, classification of pericyclic reactions FMO approach. Woodward-Hoffmann correlation diagrams method and Perturbation of molecular orbital (PMC) approach for he explanation of pericyclic reactions under thermal and photo-chemical conditions.

Electrocyclic reactions - controtatory and disrotatory motions, 4n, 4n+2, allylsystems secondary effects. Cycloadditions - antrafacial and suprafacial additions, notation of cylcoadditions (4n) and [4n+2] systems with a greater emphasis on [2+2] and [4+2] cycloaddition-stereochemical effects and effects of substituents on the rates of cycloadditions, 1,3-dipolar cycloadditions and cheleotropic reactions.

UNIT-II

1. (b)**Pericyclic Reactions** 15 Hrs

Sigmatropic Rearrangements-suprafacial and antrafacial shifts [1,2]- sigmatropic shifts involving carbon moieties retention and invertion of configuration, [3,3] and [5,5] sigma-tropic rearrangements, detailed treatment of Claisen and Cope rearrangements, fluxional tautomerism, aza-cope rearrangements, introductions to Ene reactions, simple problems on pericyclic reactions. Elecrocyclic

rearrangement of cyclobutenes and 1,3cyclohexadienes.

UNIT-III

2. **Photochemistry**

(i) **Photochemical Reactions** 5 Hrs

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

(ii) **Determination of Reaction Mechanism** 5 Hrs

Classification, rate constants and life times of reactive energy states-determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions.

Types of photochemical reactions -photodissociation, gas-phase photolysis.

(iii) **Photochemistry of Alkenes** 5 Hrs

Intramolecular reactions of the olefinic bond – geometrical isomerism, cyclisation reactions, rearrangement of 1,4- and 1,5- dienes.

UNIT-IV

(iv) **Photochemistry of Carbonyl Compounds** 7 Hrs

Intramolecular reactions of carbonyl compounds – saturated, cyclic and acyclic, β, γ- unsaturated and α,β-unsaturated compounds, Cyclohexadienones. Intermolecular cycloaddition reactions – dimerisations and oxetane formation.

(v) **Photochemistry of Aromatic Compounds** 4 Hrs

Isomerisations, additions and substitutions.

(vi) **Miscellaneous Photochemical Reactions** 4 Hrs

Photo-Fries reactions of anilides. Photo-Fries rearrangement. Barton reaction. Singlet molecular oxygen reactions. Photochemical formation of smog. Photodegradation of polymers. Photochemistry of vision.

BOOK PRESCRIBED:

1. Pericyclic reactions: A Mechanistic study by S. M. Mukherji
2. The Conservation of Orbital Symmetry by R. B. Woodward and R. Hoffman
3. Pericylic Reactions by Ian Flemming
3. Organic Photochemistry – Chapman and Depuy.
4. Organic Photochemistry – W.H. Horsepool.
5. Photochemistry of Excited States – J.D.Goyle.
6. Fundamentals of Photochemistry by K.K. Rohtagi Mukherji

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	To learn the fundamentals of pericyclic reactions
CO2	To understand the various types pericyclic reactions viz. Cycloaddition reactions, Electrocyclic reactions and Sigmatropic reactions
CO3	To understand the logic of working out the reaction pathway of pericyclic reactions using Woodward-Hoffmann rules, Frontier Molecular Method(FMO) and Orbital correlation method(OCD) etc.
CO4	To acquire knowledge to control the kinetics of pericyclic reactions.
CO5	To develop an insight into various types of pericyclic reactions like cope, claisen and ene. Learning flutionality due to these reactions.
CO6	To learn the fate of an excited state molecule, various ways of excitation energy transfers and actinometry
CO7	To determine rate constants and develop stern volmer plots
CO8	To learn photochemical reactions of various functional groups viz. Alkenes, carbonyl compounds, aromatic compounds.
CO9	To develop an insight into Photo fries, barton, singlet molecular oxygen reactions
CO10	To understand the photochemical formation of smog, photodegradation of polymers and photochemistry of vision

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-III)
CHE 535/ CHH 535
Physical Chemistry-IV
Analytical Techniques

Total Hours: 60
Total Hours/week: 4
Total Credits: 4
L T P
3 1 0

Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 2.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 15 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVES:

The course is designed to introduce the advance techniques of analysis like Potentiometry leading to the designing and use of pH electrodes, Thermogravimetric methods (TG), Differential thermal Analysis (DTA), Differential Scanning Calorimetry, Coulometric technique and Chromatographic Advance Techniques for identification and purification of the chemical compounds. Some advance solid state reactions will also be introduced

COURSE CONTENTS:

UNIT-I

1(a) **Potentiometric Methods** 10Hrs

Reference electrodes: Calomel electrodes, silver- silver chloride electrodes, precautions in the use of reference electrodes, metallic indicator electrodes and its types, metallic redox indicators, membrane indicator electrodes, classification of membranes, properties of ion-selective electrodes, the glass electrodes for pH measurement, composition and structure of glass membrane, the hygroscopicity of glass membrane, conduction across glass membrane, the membrane potential, the boundary potential, the potential of glass electrode, the alkaline and error, the glass electrodes for other cations, crystalline membrane electrode and their conductivity, the fluoride electrode, the electrode based on silver salts.

1.(b) **Potentiometric Methods** 5Hrs

Direct potentiometric measurement, sign conventions, the electrode calibration method, calibration curves for concentration measurements, potentiometric pH measurements with a glass electrode, errors affecting pH measurements with glass electrode.

UNIT-II

2. **Thermal Methods** 8Hrs

Thermogravimetric methods(TG) :Instrumentation, The balance, Furnace, instrument control, applications, Differential thermal analysis(DTA), instrumentation, general principles, applications, Differential scanning calorimetry(DSC), applications.

3. **Solid State Chemistry** 7Hrs

Types of solids, band and band theories, point defects in metals and ionic compounds, energy and entropy defects and their concentration, diffusion and electrical conduction via defects, non-stoichiometric defects, color centers and electrical properties of alkali metals halides, impurity semi-conductors reactions in organic solids, photochemical reactions, sintering solid state reactions, decomposition and dehydration reaction

UNIT-III

4. **Coulometric Methods** 15Hrs

Current-Voltage relationships during an electrolysis, operation of a cell at a fixed applied potential, initial thermodynamic potential, estimation of required potential , current changes during an electrolysis at constant applied potential, potential changes during an electrolysis at constant applied potential, constant current electrolysis, electrolysis at a constant working electrode potential, An introduction to coulometric methods of analysis, units for quantity of electricity, types of coulometric methods, applications, coulometric titrations, applications of coulometric titrations, comparison of coulometric and volumetric titrations.

UNIT-IV

5. **An Introduction to Chromatographic Separations** 8Hrs

General description of chromatography, classification of chromatographic methods, Elution chromatography on columns, chromatograms, effect of migration rates and band broadening on resolution, Migration rates of species, partition coefficients, retention time, relationship between retention time and partition coefficients, the rates of solute migration(capacity factor), differential migration rates, the shape of chromatographic peaks, methods for describing column efficiency, definition of plate height, experimental evaluation of H and N, kinetic variables affecting band broadening, relationship between plate height and column variables.

6. Gas Chromatography 7Hrs

Principles of Gas-Liquid chromatography, Instrumentation: carrier gas supply, sample injection system, column configuration and column ovens, detectors, Flame ionization detectors (FID), Thermal conductivity detectors (TCD), Thermionic detectors (TID), Electron capture detectors (ECD), Atomic emission detector (AED), Gas chromatographic columns and stationary phase: packed column, open tubular column, adsorption on column packing, stationary phases.

BOOK PRESCRIBED:

1. Solid State Chemistry: A.R.WEST
2. Principles of Instrumental Analysis: Skoog and West
3. Principles of Instrumental Analysis: Willard, Merit and Dean
4. Solid state physics: A J Dekker, Macmillan Publishers
5. Principles of physical chemistry: Puri, Sharma, Pathania.
6. Chemistry of solid state: W E Garner, Butterworth

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	To learn about structure and working of different reference electrodes and working electrodes
CO2	To develop complete study skills of potentiometric method of analysis of various analytes
CO3	To learn about various thermal methods of analysis like DTA, TG, DSC and their applications
CO4	To understand solids and point defects in solids
CO5	To understand coulometric methods of analysis and current-voltage relation and coulometric titrations.

M.Sc. Chemistry (Under the Honours Scheme) (Semester-III)

CHH 536

PROJECT WORK

Semester-IV

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-IV)
CHE 541/ CHH 541
Inorganic Chemistry-IV
Advanced Inorganic Chemistry

Total Hours: 90
Total Hours/week: 6
Total Credits: 6
L T P
5 1 0

Maximum Marks: 150
Theory: 112
Internal Assessment: 38

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

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II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 4 Marks each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 22 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COOURSE OBJECTIVES:

To study photoinorganic chemistry and oxidative addition and insertion reactions with suitable examples as well as students also get knowledge on structure and bonding of d-Block elements

COOURSE CONTENTS:

UNIT-I

1. **Photoinorganic chemistry** 20Hrs

Basics of photochemistry, Absorption, excitation, photochemical laws, quantum yield, electronically excited states, life times, measurements of the times, flash photolysis, energy diddipation by radiative and non-radiative processes, absorption spectra, franckcondon principle, photochemical stages-primary and secondary processes, kashia's rules, thexi states, photosubstitution reactions, adamson's rules, photo substitution reactions of Cr(III) and Rupolypyridyles. Rh(III) ammine complexes. Ligand photoreactions, photoredox reactions, comparision of Fe^{2+} and Ru^{2+} complexes. Photo reactions and solar energy conversion, photosynthesis in plants and bacteriocholophyll synthesis, photolysis of water using inorganic precursors.

UNIT-II

2. **Oxidative addition and Insersion reactions** 20Hrs

Acid base behavior of metal atom in complexes, protonation and lewis base behavior, acceptor properties of lewis acidity of complexes, oxad and reductive elimination and their mechanism, addition of specific molecules, H_2 , HX and organic halide addition of some others molecules, reductive elimination, migration reactions their types, promotion of alkyl migration, insertion of CO into M-H bonds, other aspects of CO insertion reactions, transfer of other molecules, CO_2, SO_2, NO_2, RCN.

UNIT-III

3. **Transition metal compounds with hydrogen and oxad reactions** 20Hrs

Insertion of alkenes and C-C unsaturated compounds, cleavage of C-H bonds, alkane activation.Cyclometallation reactions in detail, reactions of free hydrocarbons.

Characterstics of hydride complexes, synthetic methods, chemical behavior of H^- complexes, mononuclear and homolepticpolyhydride anions, carbonyl H^- and anion H_2 compounds, M-H interactions. Complexes of boron and aluminium hydrides, synthetic applications of metal hydrides.

UNIT-IV

4. **Structure and bonding of d-Block elements** 20Hrs

Pervoskite, $Ti(NO_3)_4$, $TiCl_4(diars)_2$, $[Ti(OEt)_4]_4$, $Zr(BH_4)_4$, $[M_6X_{12}]^+$ (M= Nb& Ta; X= halide); $VO(acac)_2$; $VOCl_2(NMe_3)_2$, $[Nb(n^5\text{-}C_5H_5)H\text{-}\square\ (n^5,n^1\text{-}C_5H_4)]_2$; Isopoly and heteropoly acids of MO, W & V; $[M_6X_8]^{4+}$ M= MO & W; $CrO(O_2)$ (bipy); $[MO_2O_4(C_2O_4)_2\ (H_2O)_2]^{2+}$; $[W_3O_2\ (O_2CMe)_6\ (H_2O)_3]^{2+}$;$[Cr_3O(O_2CMe)_6\ L_3]^+$;$[H_2W_2(CO)_9]^{2+}$; Re_3Cl_9;$[ReH_9]^{3+}$; $ReCl_6(Pet_3)_2$; $Re_2Cl_6(PEt_3)_2$; $Re_2Cl_5\ (DTH)_2$, Roussin's salts; $[Ir_3O(SiO_4)9]^{10-}$; $[Ir_3N(SiO4)_6(H2O)_3]^{4-}$;$[Co(acac)_2]_4$, α and β-$MCl_2$ (M=Pd,Pt);Wolffram's salt;$[Ni(acac)_2]_3$; $Ni(Me_6\text{-}acac)_2$; Ni (Me-sal)$_2$; $[Cren_3]$ $[Ni(CN)_5]$ 1.5 H_2O; $[Ni\ (CN)_2\ (NH_3)]$. xC_6H_6; $[Pd(O_2CMe)_2]_3$, $[pt(O_2CMe)_2]_4$; $[PtMe_3(acac)]_2$; helical chian of AuF_3, Silver (III) ethylenedibiguanide ion; $[CuXL]_4$ X=halide, L = P or As Ligand; $[Au_3Cl_2(PMe_2Ph)_{10}]^{3+}$; $[Zn(acac)_2]_3$; $[Cd\{S=C(NHCH_3)_2\}_2(SCN)_2]$; $Hg(NH_3)_2Cl_2$

BOOKS PRESCRIBED:

1. Chemistry of Elements by N. N. Greenwood and Earnshaw, Perganon Press
2. W. W. Portfield: Inorganic Chemistry: A Unified approach
3. Cotton and Wilkinson: Advanced inorganic Chemistry: Vth edition

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	The course provides the students with an overview of different oxidative- reductive reactions and their applications
CO2	understand the structure, bonding and reactivity of -Coordination of C-C multiple bonds
CO3	Students will be able to characterize theoretically the type of bond of hydrogen with the transition metal.
CO4	Students also learn the structure and bonding of different inorganic complexes.
CO5	Students will learn to make difference of terminal and bridging hydrogen bonds

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester- IV)
CHE 542/ CHH 542
Organic Chemistry-VI
Asymmetric synthesis, Green Chemistry and Heterocyclic Chemistry

Total Hours: 90
Total Hours/week: 6
Total Credits: 6
L T P
5 1 0

Maximum Marks: 150
Theory: 112
Internal Assessment: 38

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 4 Marks each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 22 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVES:

The aim of the course is to familiarize students with the concept of Asymmetric synthesis, enzymatic approach towards asymmetric synthesis, enzyme catalyzed reactions, co-enzyme and their function, green chemistry approach towards synthesis.

COURSE CONTENTS:

UNIT-I

1. Asymmetric Synthesis

(a) **General Aspects** 10Hrs

Introduction, Analytical methods for determination of enantiomeric purity - GC, HPLC and NMR. Natural sources of chiral starting materials, classification and methods of formation of new chiral compounds.

(b) **Non-Enzymatic Approaches towards asymmetric synthesis** 10Hrs

Methods of asymmetric synthesis using chiral pool synthesis, auxiliaries, chiral reagents and catalysts, Asymmetric carbon-carbon bond formation using alkylation, Michael reaction and addition to carbonyl compounds. Cram's rule and Felkin-Ahn model. Asymmetric oxidation and reductions.

UNIT-II

2. **Enzymatic approach towards asymmetric synthesis** 10Hrs

Bio transformations: Nomenclature and Classification of enzymes, advantages and disadvantages, Fischer's lock and key and koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labeling and enzyme modification by site-directed mutagenesis. Enzyme kinetics, Michaelis-Menten and line weaver-Burk plots, reversible and irreversible

inhibition. Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion.

3. **Reaction Catalysed by Enzymes** 10Hrs

Nucleophilic displacement on a phosphorus atom, multiple displacement reaction and thecoupling of ATP cleavage to endergonic processes. Transfer of sulphates, addition and elimination reactions, enolic intermediates in isomerization reactions, Enzyme catalyzed carboxylation and decarboxylation.

UNIT-III

4. **Co-Enzyme Chemistry** 8Hrs

Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological function of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD^+, $NADP^+$, FMN, FAD, Vitamin B_{12}. .

5. **Green Chemistry approach towards synthesis** 12Hrs

Principles and concepts of Green Chemistry, atom economic and uneconomic reactions, source and minimizing techniques of waste from chemical industry, homogeneous and heterogeneous catalysis, phase transfer catalysis, biocatalysis and photocatalysis. Principles of ultrasound and microwave assisted organic synthesis. Reactions in ionic liquids and other environmentally benign solvents, Future Prospects.

UNIT-IV

6. **Heterocyclic Synthesis** 20Hrs

(a) **Introduction**

Principles of heterocyclic synthesis involving cyclization reactions and cycloaddition reaction.

(b) **Small Ring Heterocycles**

Three-membered and four-membered heterocyclic -synthesis and reactions of aziridines, oxiranes, thiiranes, azetidines, oxetanes and thietanes

(c) **Six-Membered Heterocycles with one Heteroatom**

Synthesis and reactions of pyrylium salts and pyrones and their comparison with pyridinium & thiopyrylium salts and pyridones. Synthesis and reactions of quinolizinium and benzopyrylium salts, coumarins and chromones.

(d) **Seven-and Large-Membered Heterocycles**

Synthesis and reactions of azepines, oxepines, thiepines, diazepines, thiazepines, azocines, diazocines, dioxocines and dithiocines.

BOOKS PRESCRIBED:

1. Asymmetric Synthesis: The Essentials, Volume 1 Mathias Christmann, Stefan Bräse Wiley, 2008.
2. Principles of Biochemistry by Lehninger
3. Green Chemistry: An Introductory Textby Mike Lancaster, Royal Society of Chemistry, 2002
4. Principles of modern heterocyclic chemistry by Leo A. Paquette
5. Principles of Biochemistry By Voet and Voet

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	Student will be aware of the asymmetric synthesis and enantiomeric purity methods
CO2	Effective and modern synthetic techniques aimed at the production of enantiomerically pure organic molecules will be introduced. Know how to apply the Felkin-Anh model to predict which face nucleophilic attack will occur on an enantiotopic carbonyl group.
CO3	Explain and exemplify different enzyme catalyzed processes for stereoselective chemical production.· will able to define the mechanisms of enzyme activity regulation
CO4	To know the importance and applications of green chemistry techniques
CO5	Nomenclature, structure, properties, syntheses, and reactions of the simple 5 and 6-membered ring heterocycles, the benzene ring fused ring heterocycles, the pyridine group, and the quinoline and isoquinoline groups.

M.Sc. Chemistry/M. Sc. Chemistry (Under the Honours Scheme) (Semester-IV)
CHE 543/ CHH 543
Physical Chemistry-V
Surface and Polymer Chemistry

Total Hours: 90
Total Hours/week: 6
Total Credits: 6
L T P
5 1 0

Maximum Marks: 150
Theory: 112
Internal Assessment: 38

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi.
III. Section-I will consist of EIGHT questions and students are required to attempt any SIX short questions carrying 4 Marks each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 22 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

COURSE OBJECTIVES:

The objective of the course is to provide the descriptive knowledge on the topics of surface phenomenon and polymers as both o these fields find wide applications at industrial level.

COURSE CONTENTS:

UNIT-I

1. **Adsorption** 20Hrs

Surface tension, capillary action, pressure difference across curved surface (Laplace equations), Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (Electro-kinetic phenomena), and catalytic activity at surfaces.

UNIT-II

2. **Micelles** 20Hrs

Surface active agents, classification of surface active agents, micellization, hydrophobic interactions, critical micellar concentration (CMC), factors affecting CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization, solubilization, micro emulsion, reverse micelles, applications of microemulsions.

UNIT-III

3. **Macromolecules** 20Hrs

(a) Polymer – definition, Different classifications of polymers, Linear, branched and network polymers. Basic concepts: monomers, repeat units, degree of polymerization. Types of polymers:

electrically conducting polymers, doping of polymers, mechanism of conduction, polarones and bipolarons, fire resistant, liquids crystal polymers,
Molecular mass: number, mass and viscosity average weights; Molecular mass determination (osmometry, viscometry, diffusion and light scattering methods), sedimentation, chain configuration of macromolecules, kinetics of polymerization, thermodynamics of polymerization. calculations of average dimensions of various chain structures.Importance of polymers,
Polymerization: condensation, addition, radical chain-ionic and co-ordination and copolymerization. Polymerization conditions and polymer reactions.Polymerization in homogenous and heterogeneous systems.

UNIT-IV

(b) **Structure and Properties**: 20Hrs
Polymer structure and properties-crystalline melting point T_m-melting point of homogenous series, effect of chain flexibility and steric factors, entropy and heat of fusion. The glass transition temperature, T_g-Relationship between T_m and T_g, effects of molecular weight, diluents, chemical structure, chain topology, branching and chain linking. Property requirements and polymer utilization.

BOOKS PRESCRIBED:

1. Physical Chemistry, P. W. Atkins.
2. Textbook of polymer science, F. W. Billmeyer Jr. Wiley.
3. Polymer science, V. R. Gowariker, N. V. Viswanathan and J. Sreedhar, Wiley-Eastern.
4. Polymer Chemistry, Melcolm P. Stevens, Oxford University Press.
5. Physical chemistry of polymers, A. Tager, Mir Publisher, Moscow.

COURSE OUTCOMES:

S. No.	On completing the course, student will be able to
CO1	Understand about the surface tension, adsorption and various theories of adsorption
CO2	Learn about the surface films, catalytic activity at surfaces and surfactants.
CO3	Learn and understand the process of micellization, solubilization and the various factors affecting the process of micellization, solubilization.
CO4	Study about the polymers and polymer reactions in detail. The various types of polymerization. Kinetics and thermodynamics of polymerization.
CO5	Learn the structure and properties of polymers.

Project work continues

CHH 536	Project Work ***(Continue from Sem. III)***