NOTES ON COURSE STRUCTURE:

- The institute offers several courses under open elective and students have choice to opt those courses with the same credit (as per the following course structure) in same level. For example, one course has been suggested in course structure for the Minor & Multidisciplinary course, however student can opt other courses of their choice from available open electives.
- Students who take enough designated courses as per UGC guidelines (see above Table 1) in a discipline other than their major will qualify for a "minor" in that discipline.
- Students will get a dual degree of B.Sc. Chemistry (Honors) or B.Sc. Chemistry (Honors with Research) & M.Sc. Chemistry (Research) after completing the 5th year if required eligibility is fulfilled.

FIRST (1ST) YEAR

Semester	Course Category	Course Code	Course Name	L	T	P	Credit
FIRST (1ST) SEMESTER							
	Major	CH121	Basic Chemistry-I	3	0	0	3
	Minor	PH109	Physics I	4	0	0	4
	Multidisciplinary	ED103	Statistical Method-I	3	0	0	3
	Skill Enhancement	CH122	Laboratory Techniques for Chemists	1	0	2	3
	Ability Enhancement	MT132	Communication Skill - I	2	0	0	1.5
	Value Added	MC 101/4	NCC/NSS/PT-Games/Cr Arts	0	0	2	1
	Major	CH123	Basic Chemistry Lab-I	0	0	4	2
	Minor	PH110	Physics Lab	0	0	4	2
	Multidisciplinary	ED104	Statistical Method-I Lab	0	0	3	1.5
						Total Credit in First Semester	**21**
SECOND (2ND) SEMESTER							
	Major	CH124	Basic Chemistry-II	3	0	0	3
	Minor	MA108R1	Mathematics-III	5	1	0	6
	Multidisciplinary	BE210	Thermodynamics of Chemical & Biological Systems	3	0	0	3
	Skill Enhancement	CH125	Software Skill in Chemistry	1	0	2	3
	Ability Enhancement	CE101	Env. Science	2	0	0	2
	Value Added	MC 101/4	NCC/NSS/PT-Games/Cr Arts	0	0	2	1
	Major	CH126	Basic Chemistry Lab-II	0	0	4	2
	Vocational Summer Internship	CH127	Chemical Analysis & Instrumentation	1	0	3	4
						Total Credit in the Second Semester	**24**
Total Credit in First Year 45 (Certificate only for Taking Exit)							

SECOND (2ND) YEAR

Semester	Course Category	Course Code	Course Name	L	T	P	Credit
THIRD (3RD) SEMESTER							
	Major	CH221	Basic Chemistry-III	3	0	0	3
	Major	CH222	Basic Chemistry-IV	3	0	0	3
	Minor	ED107	Probability-I	3	1	0	4
	Multidisciplinary	BE205	Basics of Bioinformatics	3	0	0	3
	Skill Enhancement	CL217	Chemical Process Calculations	2	1	0	3
	Ability Enhancement	MT132	Communication Skill - II	2	0	0	1.5
	Value Added	MC 101/4	NCC/NSS/PT-Games/Cr Arts	0	0	2	1
	Major	CH223	Basic Chemistry Lab-III	0	0	4	2
	Major	CH224	Basic Chemistry Lab-IV	0	0	4	2
Total Credit in Third Semester							**22.5**
FOURTH (4TH) SEMESTER							
	Major	CH225	Basic Chemistry-V	3	0	0	3
	Major	CH226	Basic Chemistry-VI	3	0	0	3
	Minor	MA207R1	Mathematics IV	5	1	0	6
	Ability Enhancement	MT417/MT418	Foreign-Language French/German	3	0	0	3
	Value Added	MC 101/4	NCC/NSS/PT-Games/Cr Arts	0	0	2	1
	Major	CH227	Basic Chemistry Lab-V	0	0	4	2
	Major	CH228	Basic Chemistry Lab-VI	0	0	4	2
Total Credit in Forth Semester							**20**
Total Credit in Second Year: 42.5 (Diploma for Exit Students with 87.5 credit in 2 years)							

THIRD (3RD) YEAR

Semester	Course Category	Course Code	Course Name	L	T	P	Credit
FIFTH (5TH) SEMESTER							
	Major	CH331	Physical Chemistry-I	3	1	0	4
	Major	CH332	Organic Chemistry-I	3	1	0	4
	Major	CH333	Inorganic Chemistry-I	3	1	0	4
	Minor		Open Elective	3	0	0	3
	Value Added	MT131	Understanding Harmony	3	0	0	3
	Major	CH334	Inorganic Chemistry Lab-I	0	0	4	2
			Total Credit in FIFTH Semester				**20**
SIXTH (6TH) SEMESTER							
	Major	CH335	Physical Chemistry-II	3	1	0	4
	Major	CH336	Organic Chemistry-II	3	1	0	4
	Major	CH337	Inorganic Chemistry-II	3	1	0	4
	Minor		Open Elective	3	0	0	3
	Major	CH338	Physical Chemistry Lab-I	0	0	4	2
	Major	CH339	Organic Chemistry Lab-I	0	0	4	2
	Summer Internship	CH340	Summer Internship (Ins/Ind)				2
			Total Credit in the SIXTH Semester				**21**
Total Credit in Third Year: 41 (For Exit Students opting B.Sc. Chemistry: Total Credit= 87.5+41= 128.5)							

FOURTH (4TH) YEAR

Semester	Course Category	Course Code	Course Name	L	T	P	Credit
SEVENTH (7TH) SEMESTER							
	Major	CH421	Advanced Physical Chemistry-I	3	0	0	3
	Major	CH422	Advanced Organic Chemistry-I	3	0	0	3
	Major	CH423	Advanced Inorganic Chemistry-I	3	0	0	3
	Major	CH424	Theoretical and Computational Lab	0	0	4	2
	Minor	ED211	Linear Statistical Models and Regression Analysis	3	0	0	3
	Value added	MT204	Constitution of India	2	0	0	0
	Minor	ED212	Linear Statistical Models and Regression Analysis Lab	0	0	2	1
	@Research Dissertation	CH425	Research Thesis Dissertation-I				6
Total Credit in the 7th Semester							**21**
EIGHTH (8TH) SEMESTER							
	Major	CH426	Advanced Physical Chemistry-II	3	1	0	4
	Major	CH427	Advanced Organic Chemistry-II	3	1	0	4
	Major	CH428	Advanced Inorganic Chemistry-II	3	1	0	4
	Major	CH429	Separation & Purification Lab	0	0	2	2
	@Research Dissertation	CH430	Research Thesis Dissertation-II				6
Total Credit in the 8th Semester							**20**
128.5 + 41 = 169.5							

@NOTE: Honors students not undertaking research will do 12 Credit Courses in place of a research dissertation, and courses can be taken as per Annexure-I.

ANNEXURE-I for B.Sc. Hons. Students:

Semesters		Code No.	Name of the Courses	Prerequisites	L	T	P	C
SEM-VII	4	CH431	Analytical Chemistry	Intermediate Chemistry	3	1	0	4
		CH432	Analytical Chemistry Lab	Intermediate Chemistry	0	0	4	2
SEM-VIII	4	CH433	Polymer Chemistry	Intermediate Chemistry	3	1	0	4
		CH434	Polymer Chemistry Lab	Intermediate Chemistry	0	0	4	2

FIFTH (5TH) YEAR

Semester	Course Category	Course Code	Course Name	L	T	P	Credit
NINTH (9TH) SEMESTER							
	Major	CH521	Spectroscopic Analysis of Molecular Structures	3	1	0	4
	SEC	CH522	Problem-Solving Skills in Chemical Science	3	3	0	6
	Major	CH523	Advanced Characterization Lab	0	0	4	2
	Research Dissertation	CH524	Research Thesis Dissertation-I				8
						Total Credit in the 9th Semester	**20**
TENTH (10TH) SEMESTER							
	Major (Specialization)	CH525-530	Physical/Organic/Inorganic (Annexure-II)	3	1	0	4
	Research Dissertation	CH531	Research Thesis Dissertation-II				16
						Total Credit in the 10th Semester	**20**
Total Credit after 5th Year = 169.5+40 = 209.5							

ANNEXURE-II for M.Sc. Research with Specialization:

		Physical					
SEM-X	CH525	Advanced Electrochemistry	B.Sc. Chemistry	3	1	0	4
	CH526	Chemical Applications of Group Theory	B.Sc. Chemistry	3	1	0	4
		Organic					
SEM-X	CH527	Advanced Organic Synthesis	B.Sc. Chemistry	3	1	0	4
	CH528	Selected Topics in Organic Chemistry	B.Sc. Chemistry	3	1	0	4
		Inorganic					
SEM-X	CH529	Solid State & Bioinorganic Chemistry	B.Sc. Chemistry	3	1	0	4
	CH530	Selected Topics in Inorganic Chemistry	B.Sc. Chemistry	3	1	0	4

Course Code and Name: CH121 (Basic Chemistry-I);
Credits: 3 L: 3 T: 0 P: 0
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 03;
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To understand the concept of ideal and real gases from the molecular level energetic
B.	To understand the various theories of atomic structure and hybridization.
C.	To create concept of atomic orbitals and how chemical properties are related to the position of elements in the periodic table.
D.	To familiarize with different physical properties like viscosity, surface tension in liquids
E.	To have basic knowledge about reactive intermediates and reaction mechanism

Course Outcomes
After the completion of this course, students will be:

1.	Able to derive the Van der Waals equation of state and explain the deviation of real gases from ideal gases
2.	Able to explain the formation of molecular orbitals
3.	Able to understand the chemical behavior of various elements.
4.	Able to interpret the origin of surface tension and viscosity of liquids and gases and the effect of temperature on viscosity coefficient
5.	Able to explain the organic reaction mechanism

Syllabus
Module I: Gaseous State: (8 Lectures)
Kinetic molecular model of a gas, Maxwell-Boltzmann distribution: molecular velocities, collision frequency; collision diameter; mean free path, law of equipartition of energy, Degrees of freedom, molecular basis of heat capacities; Ideal gases, and deviations from ideal gas behaviour, van der Waals equation of state; compressibility factor, Z, and its Variation with pressure for different gases, calculation of Boyle temperature from virial form, Continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

Module II: Bonding and Physical Properties (8 lectures)
(i)Valence Bond Theory: Hybridisation, resonance, hyperconjugation, formal charges and DBE; orbital pictures of bonding systems. (ii)Electronic displacements: Inductive effect, field effect, mesomeric effect, resonance energy (iii) MO theory: Qualitative idea about molecular orbitals, bonding and antibonding interactions, idea about σ, σ*, π, π *, n – MOs; concept of HOMO, LUMO and SOMO, Frost diagram. (iv) Physical properties: BDE and bond energy; bond distances, bond angles; concept of bond angle strain; melting point/boiling point. v) Concept of organic acids and bases

Module III: Atomic Structure & Periodic Properties (8 Lectures)
Shapes of *s*, *p*, *d* and *f* orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.
s, *p*, *d*, *f* block elements, the long form of periodic table. Effective nuclear charge, Slater rules, Atomic, Ionic & Covalent radii, Ionization enthalpy, Electron gain enthalpy, Electronegativity scales, Variation of electronegativity with bond order, partial charge, group electronegativity. Sanderson's electron density ratio.

Module IV: Liquid State: (8 Lectures)
Physical properties of liquid, vapour pressure, surface tension and co-efficient of viscosity and their determination; effect of concentration of solutes on surface tension and viscosity; Explanation of cleansing action of detergents, viscosity of gases, relation between mean free path and coefficient of viscosity, effect of temperature on viscosity of liquids and gases.

Module V: General treatment of reaction mechanism **(8 Lectures)**
(i) Mechanistic classification: Nature of bond cleavage and bond formation, (elementary idea). *Reactive intermediates:* Carbocations, non-classical carbocations, carbanions, carbon radicals, carbenes. (ii) *Reaction thermodynamics:* Free energy and equilibrium, enthalpy and entropy factor, calculation of enthalpy change *via* BDE, intermolecular & intramolecular reactions. (iii) *Reaction kinetics:* Rate constant and free energy of activation; free energy profiles;

Text books:

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Douglas, B. E. and McDaniel, D. H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
3. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Kapoor, K. L. A Textbook of Physical Chemistry, Volume 1, Macmillan Publishers India Ltd, 2004
7. Puri, B. R.; Sharma, L. R. & Pathania, M. S. Principles of Physical Chemistry, 48th Ed. Vishal Publications (2021)

Reference books:

1. Atkins, P. W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.
2. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
3. Day, M. C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications, 1962.
4. Rodger, G. E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

<u>Course Outcome (CO) Attainment Assessment tools & Evaluation procedure</u>

<u>Direct Assessment</u>

Assessment Tool	**% Contribution during CO Assessment**
Teacher's Assessment	**5**
Mid Sem	**25**
Two Quizzes	**20**
End Sem Examination Marks	**50**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Mid Sem	√	√		
Quiz –I	√			
Quiz II			√	
Endsem Examination Marks	√	√	√	√

Indirect Assessment –
1. **Student Feedback on Faculty**
2. **Student Feedback on Course Outcome**

<u>Mapping between Objectives and Outcomes</u>

Course Outcome #	Program Outcomes			
	PO1	PO2	PO3	PO4
CO1	H	H	M	L
CO2	M	H	H	L
CO3	H	H	M	L
CO4	H	H	L	M
CO5	H	H	M	L

Mapping Between COs and Course Delivery (CD) methods

CD	Course Delivery methods	Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4, 5	CD1
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1, CD2
CD3	Seminars	CO 2, 3	CD3
CD4	Mini projects/Projects	CO3, 4	CD4
CD5	Laboratory experiments/teaching aids	CO 2	CD5
CD6	Self- learning such as use of NPTEL materials and internets	CO1, 2, 3, 4	CD6
CD7	Simulation	CO2, 4	CD7

Lecture wise Lesson planning Details.

Week No.	Lect. No.	Ch.No.	Topics to be covered	TextBook / References	COs mapped	Methodology used
1-2	**L1-8**	**1**	Gaseous State	**T1, R2, R3**	**1**	**PPT Digi Class/Chalk -Board**
3-4	**L 9-16**	**2**	Bonding and Physical Properties	**T1, R2, R3**	**2**	**-do-**
5-6	**L17-24**	**3**	Atomic Structure & Periodic Properties	**T1, T2**	**3**	**-do-**
7-8	**L25-32**	**4**	Liquid State	**T1, R2, R3**	**4**	**-do-**
9-10	**L33-40**	**5**	General treatment of reaction mechanism	**T1, R1, R3**	**5**	**-do-**

SKILL ENHANCEMENT COURSE
Course Code and Name: CH122 (Laboratory Techniques for Chemist);
Credits: 3 L: 1 T: 0 P: 2
Pre-requisite(s): Intermediate Level with Chemistry; Co- requisite(s):
Class schedule per week: 03; Class: B. Sc. Level: I; Branch: Chemistry

Course Objectives
This course enables the students:

A.	To ensure the quality and integrity of test data related to non-clinical safety studies.
B.	To control errors within measurement processes and to accurately determine the concentration of the analyte.

Course Outcomes
After the completion of this course, students will be:

1.	Able to provide knowledge and required skills to become a good laboratory Practice professional.
2.	Able to analyze MSDS of any chemical and ascertain its handling and storage accordingly.
3.	Able to prepare primary standard solutions and determine strength of secondary standards using it.
4.	Able to perform basic water analysis.
5.	Able to perform acid digestion of soil sample and determine heavy metals using ICP-AES.

Syllabus
Good Laboratory Practices
Introduction to GLP, safe laboratory practices, quality standards and control, classification of chemical hazards, material safety data sheet (MSDS), radiation hazard, fire prevention methods, protecting the environment and handling laboratory waste

Experiments
(1) To prepare a standard solution of oxalic acid and to standardize a sodium hydroxide solution using it.
(2) To standardize $KMnO_4$ solution using sodium oxalate.
(3) To determine the hydroxyl, carbonate and bicarbonate alkalinity separately of the given sample of water.
(4) Gravimetric estimation of Total Dissolved Solids (TDS) and Total Suspended Solids(TSS) of a given water sample.
(5) Estimation of oil & grease in a given water sample by solvent extraction followed by gravimetry.
(6) Estimation of Dissolved Oxygen (DO) by (a) Winkler's method (b) using DO meter.
(7) Quantitative estimation of chloride by Argentometric titration (Mohr's method).
(8) Quantitative estimation of Total Hardness (TH) of a given water sample by EDTA method.
(9) To verify Bears Law using Fe^{3+} solution by spectrophotometer/colorimeter and to determine the concentration of a given unknown Fe^{3+} solution.
(10) To perform acid digestion of soil and subsequent analysis of heavy metals using ICP-AES.
(11) Spectrophotometric estimation of soluble manganese in water sample by persulphate method.
(12) Spectrophotometric Estimation of nitrate in a water sample by PDA method.
(13) Titrimetric Estimation of free CO2 in a water sample.
(14) To determine the concentration of an unknown sugar solution by measurement of viscosity using an Ostwald viscometer.

Reference book:
1. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).

3. Mohrig, J. R., Techniques in Organic Chemistry, W. H. Freeman and Company, Newyork

Course Code and Name: CH123 (Basic Chemistry Lab-I);
Credits: 2 L: 0 T: 0 P: 4
Pre-requisite(s): Intermediate Level Chemistry; Co-requisite(s):
Class schedule per week: 04;
Class: B. Sc.
Level: I;
Branch: Chemistry

- Separation of binary organic mixture by solvent extraction (acid/base, weak acid/strong acid, acid/neutral, base/neutral) etc.
- Separation of binary mixture by liquid/liquid extraction (same mixture)
- Chromatography
- a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
- b. Separation of a mixture of two sugars by ascending paper chromatography
- c. Separation of a mixture of o-and p-nitrophenol or *o*-and *p*-aminophenol by thin layer chromatography (TLC)
- Surface tension measurements.
    - Determine the surface tension by (i) drop number and (ii) drop weight method.
    - Study the Variation of surface tension of detergent solutions with concentration.
- Viscosity measurement using Ostwald's viscometer.
    - Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
    - Study the Variation of viscosity of sucrose solution with the concentration of solute.

Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).
4. Mann, F. G. & Saunders, B. C. Practical Organic Chemistry, Pearson Education (2009).
5. Furniss, B. S.; Hannaford, A. J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).

Assessment Tool	% Contribution
Progressive Evaluation	**60 (Day to day performance: 30, Quiz: 10, Viva: 20)**
End Sem Examination	**40 (Experiment Performance: 30, Quiz: 10)**

Course Code and Name: CH124 (Basic Chemistry-II);
Credits: 3 L: 3 T: 0 P: 0
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 03;
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To understand the basic principles of thermodynamics in relation to work and heat
B.	To understand concept of chirality and symmetry
C.	To understand the nature of chemical bonding and its relationship to valence electron.
D.	To develop the thermodynamic concept of spontaneity and reversibility of physical and chemical processes
E.	To develop the concept of Chemical Bonding, Lewis structure, VSEPR theory

Course Outcomes
After the completion of this course, students will be:

1.	Able to explain the first law of thermodynamics with detailed understanding of state and path function
2.	Able to explain concept of chirality and symmetry
3.	Able to explain the cause and types of chemical bonding
4.	Able to calculate different thermodynamic parameters of reversible and irreversible processes using First, and Second Law of thermodynamics
5.	Able to explain Chemical Bonding, Lewis structure, VSEPR theory

Syllabus
Module I: Basic Thermodynamics I **(8 lectures)**
Intensive and extensive variables; state and path functions; isolated, closed and open systems; Zeroth law of thermodynamics. *First law*: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. Joule-Thomson coefficient. *Thermochemistry*: Heats of reactions: standard states; enthalpy of formation; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature.

Module II: Stereochemistry-I **(8 lectures)**
(i) Bonding geometries of carbon compounds and representation of molecules: Fischer, sawhorse, flying wedge and Newman projection. (ii) Concept of chirality and symmetry. (iii) Relative and absolute configuration. (iv) Optical activity of chiral compounds. Conformation: eclipsed, staggered, gauche, syn and anti; dihedral angle, torsion angle;

Module III: Chemical Bonding I **(8 Lectures)**
(i) *Ionic bond:* General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.
(ii) *Metallic Bond:* Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.
(iii) *Weak Chemical Forces:* van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

Module IV: Basic Thermodynamics II **(8 lectures)**
Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible

and irreversible processes. Gibbs and Helmholtz energy; spontaneity, Gibbs-Helmholtz equation, Maxwell relations.
Third Law: Statement of the third law, concept of residual entropy, calculation of absolute entropy of molecules.

Module V: Chemical Bonding II (8 Lectures)
Covalent bond: Lewis structure, Valence shell electron pair repulsion theory (VSEPR), Valence Bond theory, Hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of homo & hetero, di & triatomic molecules Covalent character in ionic compounds, Fajan's rules, Ionic character in covalent compounds: Bond moment, dipole moment and electronegativity difference.

Text books:

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Douglas, B. E. and McDaniel, D. H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
3. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Kapoor, K. L. A Textbook of Physical Chemistry, Volume 2, Mcmillan Publishers India Ltd, 2004.
7. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
8. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.

Reference books:

1. Atkins, P. W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.
2. Rodger, G. E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.
3. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
4. McMurry, J. E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Teacher's Assessment	**5**
Mid Sem	**25**
Two Quizzes	**20**
End Sem Examination Marks	**50**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Mid Sem	√	√		
Quiz –I	√			
Quiz II			√	
Endsem Examination	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty

2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Course Outcome #	Program Outcomes			
	PO1	PO2	PO3	PO4
CO1	H	H	M	L
CO2	M	H	H	L
CO3	H	H	M	L
CO4	H	H	L	M
CO5	H	H	M	L

Mapping Between COs and Course Delivery (CD) methods

CD	Course Delivery methods	Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4, 5	CD1
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1,CD2
CD3	Seminars	CO 2, 3	CD3
CD4	Mini projects/Projects	CO3, 4	CD4
CD5	Laboratory experiments/teaching aids	CO 2	CD5
CD6	Self- learning such as use of NPTEL materials and internets	CO1, 2, 3, 4	CD6
CD7	Simulation	CO2, 4	CD7

Lecture wise Lesson planning Details.

Week No.	Lect. No.	Ch.No.	Topics to be covered	Text Book / References	COs mapped	Methodology used
1-2	L1-8	1	Basic Thermodynamics I	T1, R2, R3	1	PPT DigiClass /Chalk-Board
3-4	L 9-16	2	Stereochemistry I	T1, R2, R3	2	-do-
5-6	L17-24	3	Chemical Bonding I	T1, T2	3	-do-
7-8	L25-32	4	Basic Thermodynamics II	T1, R2, R3	4	-do-
9-10	L33-40	5	Chemical Bonding II	T1, R1, R3	5	-do-

Course Code and Name: CH 125 (Software Skill in Chemistry);
Credits: 3 L: 2 T: 0 P: 2
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04;
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To understand the basic theory of 2D and 3D Chemical Structure.
B.	To understand the application of chemical science software to use computation in drawing, demonstration and calculation.
C.	To analyze the 3D molecular structure, bonding, and orbitals
D.	Using computational chemistry calculation to predict the physicochemical properties and spectroscopic properties of given molecules.
E.	Overall, to develop the concept of molecular structure, bonding, orbitals, electronic structure, potential energy, minimization and stereochemistry using computation.

Course Outcomes
After the completion of this course, students will be:

1.	Able to draw and demonstrate the 2D and 3D molecular structure.
2.	Able to optimize the 3D molecular structure using molecular mechanics calculation using software.
3.	Able to understand the 3D structure, bonding, orbital and stereochemistry.
4.	Able to predict physicochemical and spectroscopic properties through 3D structure and calculation.
5.	Able to understand the basics of structural chemistry such as bonding, non-covalent bonding, stereochemistry, electronic properties, etc, and presentation using computer application software.

Syllabus

Introduction to Chemistry Software and its Application

Useful Concepts in Molecular Modeling; Computer Hardware and Software; 2D & 3D Structure with Coordinate Systems; Force Fields; Nonbonded forces: Electrostatic interactions. van der Waals Interactions, Hydrogen bonding;

Experimentation:

- Compare the optimized C-C bond lengths in ethane, ethene, ethyne, and benzene. Visualize the molecular orbitals of the ethane σ bonds and ethene, ethyne, benzene, and pyridine π bonds.
- Perform a conformational analysis of butane.
- Determine the enthalpy of isomerization of *cis* and *trans*-2-butene.
- Compare the basicities of the nitrogen atoms in ammonia, methylamine, dimethylamine and trimethylamine.
- Compare the shapes of the molecules: 1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2-propanol. Note the dipole moment of each molecule. (b) Show how the shapes affect the trend in boiling points: (118 ºC, 100 ºC, 108 ºC, 82 ºC, respectively).
- (a) Determine the heat of hydration of ethylene. (b) Compute the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.
- Arrange 1-hexene, 2-methyl-2-pentene, (*E*)-3-methyl-2-pentene, (*Z*)-3-methyl-2-pentene, and 2,3-dimethyl-2-butene in order of increasing stability.
- Compare the optimized bond angles H_2O, H_2S, H_2Se. (b) Compare the HAH bond angles for the second-row dihydrides with the results from qualitative MO theory.

Note: Software: 2D & 3D ChemDraw; ChemSketch, ArgusLab (www.planaria-software.com), TINKER 6.2 (dasher.wustl.edu/ffe), WebLab Viewer, Hyperchem, or any similar software.

Reference Books:

1. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001.
2. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
3. Gupta, S.P. QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

Course Code and Name: CH126 (Basic Chemistry Lab-II);
Credits: 2 L: 0 T: 0 P: 4
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04;
Class: B. Sc.
Level: I;
Branch: Chemistry

➢ **Thermochemistry**

(i) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
(ii) Calculation of the enthalpy of ionization of ethanoic acid.
(iii) Determination of integral enthalpy (endothermic and exothermic) of salt solution.
(iv) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
(v) Determination of enthalpy of hydration of copper sulphate.
(vi) Study of the solubility of benzoic acid in water and determination of ΔH.

➢ **Acid-Base Titrations**

(i) Estimation of carbonate and bicarbonate present together in a mixture.
(ii) Estimation of free alkali present in different soaps/detergents

➢ **Oxidation-Reduction Titrimetry**

(i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.
(ii) Estimation of Fe(II) with K2Cr2O7 using internal (diphenylamine, anthranilic acid) and external indicator.
(iii) Estimation of mixture of Fe(II) and Fe(III) by permanganometry/dichromatometry

➢ **Complexometry**

(i) Estimation of Ca^{2+} and Mg^{2+} in a mixture

Reference Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Athawale, V. D. & Mathur, P. Experimental Physical Chemistry New Age International: New Delhi (2001).
3. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009

Assessment Tool	**% Contribution**
Progressive Evaluation	**60 (Day to day performance: 30, Quiz: 10, Viva: 20)**
End Sem Examination	**40 (Experiment Performance: 30, Quiz: 10)**

Course Code and Name: CH127 (Chemical Analysis and Instrumentation)

Vocational Summer Internship
Credits: 4 L: 1 T: 0 P: 3
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04;
Class: B. Sc. **Level: I;**
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To understand the basic theory and applications related to analytical chemistry
B.	To understand the principles of different instruments used for chemical analysis

Course Outcomes
After the completion of this course, students will be:

1.	Able to operate analytical instruments.
2.	Able to test and analyse samples from the real world for practical applications.
3.	Able to perform advanced water analysis.
4.	Able to perform proximate analysis of coal.
5.	Able to perform analysis of lubricating oil.

Syllabus

Scope and Importance of Analytical Chemistry, Introduction to Gravimetric Analysis, Theory of Potentiometric & pH metric titration, Reference and Indicator electrode, Fuel and Combustion, Solid fuel, Liquid Fuel, Gaseous Fuel, Properties of Lubricants, Water Pollution, Sources of Contamination and detrimental effect of pollutants.

Experiments:

1. Gravimetric estimation of Nickel by Dimethylglyoxime.
2. To determine BOD of a given water sample by direct and dilution method.
3. To determine the calcium and magnesium hardness by EDTA based complexometric method.
4. To determine the viscosity and viscosity index of a lubricating oil using Redwood viscometer.
5. To determine the strength of acid by strong base potentiometrically.
6. To draw the pH titration curve of strong acid vs strong base.
7. Colorimetric determination of copper using ammonia solution.
8. To determine the amount of free chlorine in a given water sample by iodometric method.
9. To analyze coal sample by proximate analysis method.
10. Estimation of Chemical Oxygen Demand (COD) of a given water sample by potassium-di-chromate open reflux method.
11. Estimation of Biochemical Oxygen Demand (BOD) by (a) Direct method (b) Dilution method (c) Seeded dilution method.
12. To determine the percentage of calcium oxide in cement.
13. To determine the acid value of a lubricating oil.
14. To determine the amount of sodium and potassium in a given sample by flame photometry.

Reference Books:

1 Connel, D. W, Basics Concepts of Environmental Chemistry.
2. G. D. Christian, Analytical Chemistry,5th Edition, John-Wiley and Sons Inc., 1994
3. Shashi Chawla, Essentials of Experimental Engineering Chemistry

Course Code and Name: CH221 (Basic Chemistry-III);
Credits: 3 L: 3 T: 0 P: 0
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 03;
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To understand the principles of reaction rates and mechanism of catalysis and apply those concepts in elementary to complex reactions
B	To develop knowledge on Stereochemical energetics of organic molecules
C	To create concept acid base reaction and redox reaction
D	To understand the basics of organic chemistry of alkenes and alkynes
E	To study the reactions of s and p block elements

Course Outcomes
After the completion of this course, students will be:

1.	Able to solve problems on rate constants for (i) unimolecular (ii) bimolecular and (iii) complex reactions and adsorption kinetics after deriving rate equations of chemical reactions
2.	Able to predict the energy of different stereochemical forms of organic molecules
3.	Able to explain the findings of acid base interactions, calculate the formal potential in different practical processes
4.	Able to write the reactions involving the synthesis and reactions of alkenes and alkynes
5	Able to predict the reactions or to explain the observations during the reaction of s, p block elements

Syllabus
Module I: Chemical Kinetics and Catalysis (8 lectures)
Order and molecularity, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. Arrhenius equation; activation energy. Collision theory, Transition state theory, Lindemann mechanism.
Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Module II: Stereochemistry-II (8 Lectures)
The energy barrier of rotation; concept of torsional and steric strains; dipole-dipole interaction and H-bonding; butane gauche interaction; conformational analysis of ethane, propane, n-butane.
Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

Module III: Acids - Bases and Redox reactions (8 Lectures)
Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle, Non aqueous solvents
Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class.

Module IV: Chemistry of alkenes and alkynes **(8 lectures)**

(i)Addition to C=C: Mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions: halogenation, hydrohalogenation, hydration, oxymercuration-demercuration, hydroboration-oxidation, epoxidation, electrophilic addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; use of NBS

(ii)Addition to C≡C (in comparison to C=C): Mechanism, reactivity, regioselectivity (Markownikoff and anti-Markownikoff addition) and stereoselectivity; reactions: ,alogenations, hydrohalogenation, hydration, oxymercuration-demercuration, hydroboration-oxidation, reactions of terminal alkynes by exploring its acidity; interconversion of terminal and non-terminal alkynes.

Module V: Chemistry of s and p Block Elements-I **(8 lectures)**

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses: Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur,

Text books:

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Douglas, B. E. and McDaniel, D. H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
3. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Kapoor, K. L. A Textbook of Physical Chemistry, Volume 5, Mcmillan Publishers India Ltd, 2004.
7. Puri, B. R.; Sharma, L. R. & Pathania, M. S. Principles of Physical Chemistry, 48th Ed. Vishal Publications (2021)
8. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.

Reference books:

1. Atkins, P. W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.
2. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
3. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
4. McMurry, J. E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Teacher's Assessment	5
Mid Sem	25
Two Quizzes	20
End Sem Examination Marks	50

Assessment Components	CO1	CO2	CO3	CO4
Mid Sem	√	√		
Quiz –I	√			
Quiz II			√	
Endsem Examination Marks	√	√	√	√

Indirect Assessment –

1. **Student Feedback on Faculty**
2. **Student Feedback on Course Outcome**

Mapping between Objectives and Outcomes

Course Outcome #	Program Outcomes			
	PO1	PO2	PO3	PO4
CO1	H	H	L	L
CO2	M	H	H	L
CO3	H	H	M	L
CO4	H	H	M	M
CO5	H	H	M	M

Mapping Between COs and Course Delivery (CD) methods

CD	Course Delivery methods	Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4, 5	CD1
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1,CD2
CD3	Seminars	CO 2, 3	CD3
CD4	Mini projects/Projects	CO3, 4	CD4
CD5	Laboratory experiments/teaching aids	CO 2	CD5
CD6	Self- learning such as use of NPTEL materials and internets	CO1, 2, 3, 4	CD6
CD7	Simulation	CO2, 4	CD7

Lecture wise Lesson planning Details.

Week No.	**Lect. No.**	**Ch.No.**	**Topics to be covered**	**Text Book / References**	**COs mapped**	**Methodology used**
1-2	**L1-8**	**1**	Chemical Kinetics	**T1, R2,R3**	**1**	**PPT DigiClass/ Chalk-Board**
3-4	**L 9-16**	**2**	Stereochemistry of organic molecules	**T1, R2,R3**	**2**	**-do-**
5-6	**L17-24**	**3**	Acid base and redox reactions	**T1, T2**	**3**	**-do-**
7-8	**L25-32**	**4**	Synthesis and reactivity of alkenes and alkynes	**T1, R2,R3**	**4**	**-do-**
9-10	**L33-40**	**5**	s, p block elements	**T1, R1,R3**	**5**	**-do-**

Course Code and Name: CH222 (Basic Chemistry-IV);
Credits: 3 L: 3 T: 0 P: 0
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 03;
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To acquire knowledge of the quantum chemical description of chemical bonding, reactivity and energy of the molecular system
B.	To understand the various type of reactions with carbonyl and related compounds
C.	To create concept of atomic orbitals and how chemical properties are related to the position of elements in the periodic table.
D.	To understand the basic principles of molecular spectroscopy and derive essential mathematical relationships in quantum mechanics and spectroscopy
E.	To have basic knowledge about reactive intermediates and reaction mechanism

Course Outcomes
After the completion of this course, students will be:

1.	Able to interpret (and normalize) a wavefunction, calculate a probability using a wavefunction, calculate and interpret an expectation value, utilize and interpret the Heisenberg Uncertainty Principle and solve Schrodinger equation for a particle in a box and spherical harmonics
2.	Able to explain the various type of reactions with carbonyl and related compounds
3.	Able to understand the chemical behavior of various elements.
4.	Able to interpret microwave, infrared and Raman spectra of simple molecules
5.	Able to explain the organic reaction mechanism

Syllabus

Module I: Quantum Chemistry (8 lectures)
Black body radiation, Planck's quantum theory, wave – particle duality, uncertainty principle, Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (1D, 2D and 3D rigorous treatment). Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy.
Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component. Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, Spherical harmonics, discussion of solution.

Module II: Carbonyl and related compounds (8 lectures)
(i) *Addition to C=O:* Structure, reactivity and preparation of carbonyl compounds; mechanism (with evidence), reactions: benzoin condensation, Cannizzaro reaction, reactions with ylides: Wittig oxidations and reductions: Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, Oppenauer, (ii) *Nucleophilic addition to α,β-unsaturated carbonyl system:* Michael reaction, Stetter reaction, Robinson annulation.

Module III: Chemistry of s and p Block Elements-II (8 Lectures)
Interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens. Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF2, XeF4 and XeF6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2). Molecular shapes of noble gas compounds (VSEPR theory).

Module IV: Molecular Spectroscopy (8 lectures)
Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation.
Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: Classical equation of vibration, force constant; anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies.
Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.
Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Module V: Coordination Chemistry-I (8 Lectures)
Werner's theory, IUPAC nomenclature, Chelate effect, polynuclear complexes, valence bond theory (inner and outer orbital complexes), Molecular Orbital Theory, electro neutrality principle and back bonding.

Text books:

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Douglas, B. E. and McDaniel, D. H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
3. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Kapoor, K. L. A Textbook of Physical Chemistry, Volume 4, Mcmillan Publishers India Ltd, 2004.
6. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
7. Prasad, R.K. Quantum Chemistry, 3rd edition, New Age International, 2006.
8. Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).
9. I L Finar, Organic chemistry vol 1 &2

Reference books:

1. Atkins, P. W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.
2. House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004).
3. Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
4. Kakkar, R. Atomic & Molecular Spectroscopy: Concepts & Applications, Cambridge University Press (2015).
5. Huheey, J. E., Inorganic Chemistry, Prentice Hall, 1993.
6. Cotton, F. A. & Wilkinson, G, Advanced Inorganic Chemistry Wiley-VCH, 1999

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Teacher's Assessment	**5**

Mid Sem	**25**
Two Quizzes	**10+10**
End Sem Examination Marks	**50**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Sem	√	√			
Quiz –I	√				
Quiz II			√	√	
End Sem Examination Marks	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty

2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Course Outcome #	**Program Outcomes**			
	PO1	**PO2**	**PO3**	**PO4**
CO1	**H**	**H**	**L**	**L**
CO2	**M**	**H**	**H**	**L**
CO3	**H**	**H**	**M**	**L**
CO4	**H**	**H**	**M**	**M**
CO5	**M**	**H**	**H**	**M**

Mapping Between COs and Course Delivery (CD) methods

CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4, 5	CD1
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1,CD2
CD3	Seminars	CO 2, 3	CD3
CD4	Mini projects/Projects	CO3, 4	CD4

CD5	Laboratory experiments/teaching aids	CO 3, 5	CD5
CD6	Self- learning such as use of NPTEL materials and internets	CO1, 2, 3, 4	CD6
CD7	Simulation	CO2, 4	CD7

Lecture wise Lesson planning Details.

Week No.	**Lect. No.**	**Ch.No.**	**Topics to be covered**	**Text Book /References**	**COs mapped**	**Methodology used**
1-3	**L1-8**	**1**	**Quantum Chemistry**	**T1, R2, R3**	**1**	**PPT DigiClass /Chalk-Board**
4-6	**L 9-16**	**2**	**Carbonyl and related compounds**	**T1, R2**	**2**	**-do-**
7-9	**L17-24**	**3**	**Chemistry of s and p Block Elements-II**	**T1, R6**	**3**	**-do-**
10-13	**L25-32**	**4**	**Molecular Spectroscopy**	**T1, R2, R3**	**4**	**-do-**
14-15	**L33-40**	**5**	**Coordination Chemistry-I**	**T2, R5**	**5**	**-do-**

Course Code and Name: CH223 (Basic Chemistry Lab-III);
Credits: 2 L: 0 T: 0 P: 4
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04;
Class: B. Sc.
Level: I;
Branch: Chemistry

Organic

(i) Detection of special elements (N, S, Cl, Br) by Lassaigne's test for known compounds

(ii) Detection of the following functional groups by systematic chemical tests: aromatic amino ($-NH_2$), aromatic nitro ($-NO_2$), amido ($-CONH_2$, including imide), phenolic –OH, acid groups, carbonyl (distinguish between -CHO and >C=O) for known compounds

Inorganic

1. Iodo/Iodimetric Titrations

(i) Estimation of Cu(II) and K2Cr2O7 using sodium thiosulphate solution (Iodimetrically).

(ii) Estimation of available chlorine in bleaching powder iodometrically.

2. Inorganic preparations

(i) Cuprous Chloride, Cu2Cl2

(ii) Preparation of Manganese(III) phosphate, MnPO4.H2O

(iii) Preparation of Aluminium potassium sulphate KAl(SO4)2.12H2O (Potash alum) or Chrome alum.

(iv) Tetraamminecopper(II) sulphate, [Cu(NH3)4]SO4.H2O

(v) *Cis* and *trans* K[Cr(C2O4)2.(H2O)2] Potassium dioxalatodiaquachromate(III)

(vi) Tetraamminecarbonatocobalt(III) ion

(vii) Potassium tris(oxalate)ferrate(III)

Reference book:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
2. Mann, F. G. & Saunders, B. C. Practical Organic Chemistry, Pearson Education (2009).
3. Furniss, B. S.; Hannaford, A. J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).

Assessment Tool	**% Contribution**
Progressive Evaluation	**60 (Day to day performance: 30, Quiz: 10, Viva: 20)**
End Sem Examination	**40 (Experiment Performance: 30, Quiz: 10)**

Course Code and Name: CH224 (Basic Chemistry Lab-IV);
Credits: 2 L: 0 T: 0 P: 4
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04;
Class: B. Sc.
Level: I;
Branch: Chemistry

Colorimetry

(i) Verify Lambert-Beer's law and determine the concentration of $CuSO_4/KMnO_4/K_2Cr_2O_7$ in a solution of unknown concentration.
(ii). Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.
(iii). Study the kinetics of iodination of propanone in acidic medium.
(iv). Determine the amount of iron present in a sample using 1,10-phenathroline.

UV/Visible spectroscopy

(v) Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J $molecule^{-1}$, kJ mol^{-1}, cm^{-1}, eV).
(vi). Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$.
(vii). Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

Organic

Complete qualitative analysis of unknown organic compounds and identification by derivative preparation.

Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).
4. Mann, F. G. & Saunders, B. C. Practical Organic Chemistry, Pearson Education (2009).
5. Furniss, B. S.; Hannaford, A. J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).

Assessment Tool	% Contribution
Progressive Evaluation	**60 (Day to day performance: 30, Quiz: 10, Viva: 20)**
End Sem Examination	**40 (Experiment Performance: 30, Quiz: 10)**

Course Code and Name: CH225 (Basic Chemistry-V);
Credits: 3 L: 3 T: 0 P: 0
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 03;
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives

This course enables the students:

A.	To understand the basic concept of conductivity and related phenomenon in electrolytic medium
B.	To develop knowledge on different substitution reactions
C.	To understand the structure and physicochemical properties of Coordination Complexes
D.	To develop knowledge on different elimination reactions
E	To study the reactions of transition metals

Course Outcomes

After the completion of this course, students will be:

1.	Able to calculate equivalent conductivity, ionic mobility, transference numbers of electrolyte and able to measure the cell potential in a galvanic cell with half-cell equations
2.	Able to explain S_N1, S_N2 type substitution reactions
3.	Apply the concept of coordination chemistry to interpret different physicochemical properties of inorganic complexes
4.	Able to explain E1, E2, E1cB and Ei type elimination reactions
5.	Able to interpret the observations in the chemical reactions of transition metals

Syllabus

Module I: Electrochemistry (8 lectures)

Conductivity: equivalent and molar conductivity, Kohlrausch law of independent migration of ions, Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells.

Module II: Substitution reactions (8 lectures)

Free-radical substitution reaction: Halogentaion of alkanes, mechanism (with evidence) and stereochemical features; reactivity-selectivity principle in the light of Hammond's postulate. *Nucleophilic substitution reactions:* Substitution at sp^3 centre[systems: alkyl halides, allyl halides, benzyl halides, alcohols, ethers, epoxides, *a*-halocarbonyls]:mechanisms (with evidence),relative rates& stereochemical features: S_N1, S_N2 (Mitsunobu reaction), S_N2', S_N1' (allylic rearrangement) and S_Ni; effects of solvent, substrate structure, leaving group and nucleophiles (including ambident nucleophiles, cyanide & nitrite); substitutions involving NGP (with hetero atoms and aryl groups); role of crown ethers and phase transfer catalysts.

Module III: Coordination Chemistry-II (8 Lectures)

Crystal field theory, CFSE in weak and strong fields, Octahedral vs. tetrahedral coordination, Jahn-Teller theorem, square planar geometry. other geometries, Stereochemistry of complexes with 4 and 6 coordination numbers. Color and magnetism of the coordination complexes

Module IV: Elimination reactions and aromatic substitution **(8 lectures)**

(i)*Elimination reactions***:** E1, E2, E1cB and Ei (pyrolytic *syn* eliminations); formation of alkenes and alkynes; mechanisms (with evidence), reactivity, regioselectivity (Saytzeff/Hofmann) and stereoselectivity; comparison between substitution and elimination. (ii) *Electrophilic aromatic substitution:* Mechanisms and evidences in favour of it; orientation and reactivity; reactions: nitration, nitrosation, sulfonation, halogenation, Friedel-Crafts reaction; one-carbon electrophiles (reactions: chloromethylation, Gatterman-Koch, Gatterman, Houben-Hoesch, Vilsmeier-Haack, Reimer-Tiemann, Kolbe-Schmitt); Ipso substitution.(iii)Nucleophilic aromatic substitution: Addition-elimination mechanism and evidences in favour of it; SN1 mechanism; cine substitution (benzyne mechanism), structure of benzyne.

Module V: Transition Elements **(8 Lectures)**

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Difference between the first, second and third transition series. Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy).

Text books:

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Douglas, B. E. and McDaniel, D. H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
3. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
7. Kapoor, K. L. A Textbook of Physical Chemistry, Volume 3, Macmillan Publishers India Ltd, 2004
8. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).

Reference books:

1. Atkins, P. W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.
2. Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006).
3. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
4. Huheey, J. E., Inorganic Chemistry, Prentice Hall, 1993.
5. Cotton, F. A. & Wilkinson, G, Advanced Inorganic Chemistry Wiley-VCH, 1999
6. A guidebook to mechanism in organic chemistry, Peter sykes

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**

Teacher's Assessment	**5**
Mid Sem	**25**
Two Quizzes	**10+10**
End Sem Examination Marks	**50**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem	√	√			
Quiz –I	√	√			
Quiz II			√	√	√
End Sem Examination Marks	√	√	√	√	√

Indirect Assessment –

1. **Student Feedback on Faculty**
2. **Student Feedback on Course Outcome**

Mapping between Objectives and Outcomes

Course Outcome #	Program Outcomes			
	PO1	**PO2**	**PO3**	**PO4**
CO1	**H**	**H**	**L**	**L**
CO2	**M**	**H**	**H**	**L**
CO3	**H**	**H**	**M**	**L**
CO4	**H**	**H**	**M**	**M**
CO5	**H**	**H**	**M**	**M**

Mapping Between COs and Course Delivery (CD) methods

CD	Course Delivery methods	Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4, 5	CD1
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1,CD2
CD3	Seminars	CO 2, 3	CD3

CD4	Mini projects/Projects	CO3, 4	CD4
CD5	Laboratory experiments/teaching aids	CO 2	CD5
CD6	Self- learning such as use of NPTEL materials and internets	CO1, 2, 3, 4	CD6
CD7	Simulation	CO2, 4	CD7

Lecture wise Lesson planning Details.

Week No.	Lect. No.	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Methodology used
1-3	**L1-8**	**1**	**Electrochemistry**	**T1, R3**	**1**	**PPT DigiClass/ Chalk-Board**
4-6	**L 9-16**	**2**	**Substitution reactions**	**T1, R2,R3**	**2**	**-do-**
7-9	**L17-24**	**3**	**Coordination Chemistry-II**	**T2, R4**	**3**	**-do-**
10-13	**L25-32**	**4**	**Elimination reactions and aromatic substitution**	**T1, R2,R3**	**4**	**-do-**
14-15	**L33-40**	**5**	**Transition Elements**	**T1, R5**	**5**	**-do-**

Course Code and Name: CH226 (Basic Chemistry-VI);
Credits: 3 L: 3 T: 0 P: 0
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 03;
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To develop the concept of equilibrium in chemical reactions using the concept of thermodynamics
B.	To grow the basic knowledge in Organometallic chemistry
C.	To learn the electronic structure, and reactivities of inner transition metals.
D.	To understand the basics knowledge in Exploitation of acidity of α-H of C=O based on different name reaction.
E.	To develop the concepts of phase equilibrium in multi-component systems

Course Outcomes
After the completion of this course, students will be:

1.	Able to measure the equilibrium constants of chemical reactions and derive relationship between different equilibrium constants
2.	Able to apply the knowledge on organometallic chemistry in predicting structure and reactivities of the reactions
3.	Able to apply the knowledge in predicting the reactions of inner transition metals.
4.	Able to explain the organic reaction mechanism
5.	Able to draw phase diagram in one and multi-component systems

Syllabus
Module I: Chemical Equilibrium (8 lectures)
Criteria of thermodynamic equilibrium, degree of reaction advancement, the concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p, K_c and K_x. Le Chatelier principle (quantitative treatment); the equilibrium between ideal gases and a pure condensed phase.

Module II: Organometallics (8 lectures)
Grignard reagent, Organolithium, Gilman cuprates: Preparation and reactions (mechanism with evidence); addition of Grignard and organolithium to carbonyl compounds; substitution on -COX; directed ortho metalation of arenes using organolithiums, Shapiro reaction, conjugate addition by Gilman cuprates; Corey-House synthesis; abnormal behavior of Grignard reagents; comparison of reactivity among Grignard, organolithiums and organocopper reagents; Reformatsky reaction; Blaise reaction; concept of umpolung.

Module III: Inner Transition Element (8 Lectures)
Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

Module IV: Exploitation of acidity of α-H of C=O (8 lectures)
Exploitation of acidity of α-H of C=O: Hell-Volhard-Zelinsky (H. V. Z.) reaction, nitrosation, SeO2 (Riley) oxidation; condensations (mechanism with evidence): Aldol,Tollens', Knoevenagel, Claisen-Schmidt, Claisen ester including Dieckmann, Stobbe; Mannich reaction, Perkin reaction, Favorskii rearrangement; alkylation of active methylene compounds; preparation and synthetic applications of diethyl malonate and ethyl acetoacetate; specific enol equivalents (lithium enolates, enamines and silyl enol ethers) in connection with alkylation, acylation and aldol type reaction.

Module V: Phase Equilibrium: **(8 lectures)**
Concept of phases, components and degrees of freedom, derivation of Gibbs phase rule; Clausius-Clapeyron equation and its applications in phase equilibria, phase diagram for one component systems with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Three component systems: water-chloroform-acetic acid system, triangular plots.

Text books:

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Huheey, J. E., Inorganic Chemistry, Prentice Hall, 1993.
3. Powell, P. Principles of Organometallic Chemistry, Chapman and Hall, 1988.
4. Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.
5. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Kapoor, K. L. A Textbook of Physical Chemistry, Volume 2, Mcmillan Publishers India Ltd, 2004.
8. Kapoor, K. L. A Textbook of Physical Chemistry, Volume 3, Mcmillan Publishers India Ltd, 2004.
9. Peter, A. & Paula, J. de. Physical Chemistry 10th Ed., Oxford University Press (2014).
10. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).

Reference books:

1. Atkins, P. W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.
2. McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).
3. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
4. Levine, I. N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010).
5. Crabtree, R. H. The Organometallic Chemistry of the Transition Metals. New York, NY: John Wiley, 2000.
6. Spessard, G. O. & Miessler, G.L. Organometallic Chemistry. Upper Saddle River, NJ: Prentice-Hall, 1996.

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Teacher's Assessment	5
Mid Sem	25
Two Quizzes	10+10
End Sem Examination Marks	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem	√	√			
Quiz –I	√	√			
Quiz II			√	√	√
End Sem Examination Marks	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Course Outcome #	Program Outcomes			
	PO1	PO2	PO3	PO4
CO1	H	H	L	L
CO2	M	H	M	L
CO3	H	H	M	L
CO4	L	H	H	M
CO5	H	H	M	M

Mapping Between COs and Course Delivery (CD) methods

CD	Course Delivery methods	Course Outcome	Course Delivery Method

CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4, 5	CD1
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1, CD2
CD3	Seminars	CO 2, 3	CD3
CD4	Mini projects/Projects	CO3, 4	CD4
CD5	Laboratory experiments/teaching aids	CO 2	CD5
CD6	Self- learning such as use of NPTEL materials and internets	CO 2, 3, 4	CD6
CD7	Simulation	CO2, 3	CD7

Lecture wise Lesson planning Details.

Week No.	Lect. No.	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Methodology used
1-3	**L1-8**	**1**	**Chemical Equilibrium**	**T1, R1, R3**	**1**	**PPT DigiClass/ Chalk-Board**
4-6	**L 9-16**	**2**	**Organometallics**	**T2, T3, R5, R6**	**2**	**-do-**
7-9	**L17-24**	**3**	**Inner Transition Element**	**T1, R2**	**3**	**-do-**
10-13	**L25-32**	**4**	**Exploitation of acidity of α-H of C=O**	**T1, R2, R3**	**4**	**-do-**
14-15	**L33-40**	**5**	**Phase Equilibrium**	**T3, R2, R3**	**5**	**-do-**

Course Code and Name: CH227 (Basic Chemistry Lab-V);
Credits: 2 L: 0 T: 0 P: 4
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04;
Class: B. Sc.
Level: I;
Branch: Chemistry

Organic

Derivative preparation using various known functional groups (acetylation/benzoylation of amine, hydroxyl, amide preparation, ester preparation, anhydride preparation, SBT derivative etc.) and purification of product, crystallization etc.

Inorganic

1. Gravimetric Estimation (Any two)

(a) Estimation of nickel(II) using Dimethylglyoxime (DMG).
(b) Estimation of copper as CuSCN
(c) Estimation of iron as Fe2O3 by precipitating iron as Fe(OH)3.
(d) Estimation of Al(III) by precipitating with oxine and weighing as Al(oxine)3 (aluminium oxinate).

2. Measurement of 10 Dq by spectrophotometric method
3. Verification of spectrochemical series.
4. Controlled synthesis of two copper oxalate hydrate complexes: kinetic vs thermodynamic factors.
5. Preparation of acetylacetanato complexes of Cu2+/Fe3+. Find the λmax of the complex.

Reference book:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
2. Mann, F. G. & Saunders, B. C. Practical Organic Chemistry, Pearson Education (2009).
3. Furniss, B. S.; Hannaford, A. J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).

Assessment Tool	% Contribution
Progressive Evaluation	**60 (Day to day performance: 30, Quiz: 10, Viva: 20)**
End Sem Examination	**40 (Experiment Performance: 30, Quiz: 10)**

Course Code and Name: CH228 (Basic Chemistry Lab-VI);
Credits: 2 L: 0 T: 0 P: 4
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04;
Class: B. Sc.
Level: I;
Branch: Chemistry

Physical Chemistry

(i). Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.
(ii). Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:
a. simple eutectic and
b. congruently melting systems.
(iii). Distribution of acetic/ benzoic acid between water and cyclohexane.
IV). Study the equilibrium of at least one of the following reactions by the distribution method:
(i) $I_2(aq) + I^- \rightarrow I_3^-(aq)$
(ii) $Cu^{2+}(aq) + nNH_3 \rightarrow [Cu(NH_3)_n]^{2+}$

Inorganic

Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

$CO3^{2-}$, NO2 -, S2-, SO3 2-,S2O3 2-, CH3COO-, F-,Cl-, Br-, I-, NO3-, BO33-, C2O42-, PO43-, NH4+, K+, Pb2+,Cu2+, Cd2+, Bi3+, Sn2+, Sb3+, Fe3+, Al3+, Cr3+, Zn2+, Mn2+, Co2+, Ni2+, Ba2+,Sr2+, Ca2+, Mg2+. Mixtures should preferably contain one interfering anion, or insoluble component (BaSO4, SrSO4, PbSO4, CaF2 or Al2O3) or combination of anions e.g. CO32- and SO32-, NO2- and NO3-, Cl- and Br-, Cl and I-, Br- and I-, NO3- and Br-, NO3- and I-

Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).
4. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

Assessment Tool	% Contribution
Progressive Evaluation	60 (Day to day performance: 30, Quiz: 10, Viva: 20)
End Sem Examination	40 (Experiment Performance: 30, Quiz: 10)

Course Code and Name: CH331 (Physical Chemistry-I);
Credits: 4 L: 3 T: 1 P: 0
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04;
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To understand the theories of equilibrium in ionic medium
B.	To analyze the thermodynamic parameters in systems with variable compositions
C.	To familiarize with the concept of colligative properties of solution
D.	To understand the symmetry properties, present in the solid lattice
E.	To understand the concept of adsorption phenomena

Course Outcomes
After the completion of this course, students will be:

1.	Able to calculate pH/pKa, degree of ionization, dissociation constant, solubility product of electrolytes
2.	Able to explain the partial molar properties of different thermodynamic parameters due to variable compositions of matter in a mixture
3.	Able to determine the decrease in vapour pressure, increase in boiling point, depression of freezing point and osmotic pressure of solutions
4.	Able to use Bragg's law to index cubic powder XRD pattern, determine unit cell parameter
5.	Able to explain the adsorption phenomenon based on the Langmuir adsorption isotherm

Syllabus

Module I: Ionic Equilibria **(9 lectures)**
Strong and weak electrolytes, ionization of weak acids and bases, degree of ionization, ionic product of water, pH scale, common ion effect; dissociation constants of monoprotic acids and bases (exact treatment). Buffer action; buffer capacity derivation of Henderson equation; Salt hydrolysis- degree of hydrolysis and pH for different salts. Qualitative treatment of acid–base titration curves. Theory of acid–base indicators. Solubility and solubility product of sparingly soluble salts.

Module II: Systems of Variable Composition **(9 lectures)**
Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

Module III: Solutions and Colligative Properties **(9 lectures)**
Gibbs-Duhem-Margules equation: its derivation and applications, azeotropes, lever rule, partial miscibility of liquids, CST, steam distillation. Nernst distribution law: its derivation and applications. Lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Thermodynamic derivation using chemical potential (i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) depression of freezing point, (iv) osmotic pressure. Applications of colligative properties in calculating molar masses of normal, dissociated and associated solutes in solution.

Module IV: Symmetry and Solid State **(9 lectures)**
Elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point groups, seven crystal systems and fourteen Bravais lattices. Nature of the solid state, law of rational indices, Miller indices. Crystal packing, crystal defects. X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Band theory, metals and semiconductors, Different structures of AX, AX_2, ABX_3 compounds.

Module V: Surface Chemistry **(9 lectures)**

Physical adsorption, chemisorption, adsorption isotherms (Freundlich and Langmuir), nature of adsorbed state.

Text books:

1. Kapoor, K. L. A Textbook of Physical Chemistry, Volume 1, Mcmillan Publishers India Ltd, 2004.
2. Kapoor, K. L. A Textbook of Physical Chemistry, Volume 2, Mcmillan Publishers India Ltd, 2004.
3. Kapoor, K. L. A Textbook of Physical Chemistry, Volume 5, Mcmillan Publishers India Ltd, 2004.
4. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
5. McQuarrie, D. A. & Simon, J. D., Molecular Thermodynamics, Viva Books Pvt. Ltd.: New Delhi (2004).

Reference books:

1. Atkins, P. W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.
2. Ball, D. W. Physical Chemistry Cengage India (2012).
3. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
4. Levine, I. N. Physical Chemistry 6th Ed., Tata McGraw-Hill (2011).
5. Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Teacher’s Assessment	**5**
Mid Sem	**25**
Two Quizzes	**10+10**
End Sem Examination Marks	**50**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem	√	√			
Quiz –I	√	√			
Quiz II			√	√	√
End Sem Examination Marks	√	√	√	√	√

Indirect Assessment –

1. **Student Feedback on Faculty**
2. **Student Feedback on Course Outcome**

Mapping between Objectives and Outcomes

Course Outcome #	Program Outcomes			
	PO1	PO2	PO3	PO4
CO1	H	H	L	L
CO2	M	H	M	L
CO3	H	H	M	L
CO4	L	H	H	M
CO5	H	H	M	M

Mapping Between COs and Course Delivery (CD) methods

CD	Course Delivery methods	Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4, 5	CD1
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1, CD2
CD3	Seminars	CO 2, 3	CD3
CD4	Mini projects/Projects	CO3, 4	CD4
CD5	Laboratory experiments/teaching aids	CO 2	CD5
CD6	Self- learning such as use of NPTEL materials and internets	CO 2, 3, 4	CD6
CD7	Simulation	CO2, 3	CD7

Lecture wise Lesson planning Details.

WeekNo.	Lect. No.	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Methodology used
1-3	L1-9	1	Ionic Equilibria	T1, R2, R3	1	PPT DigiClass/ Chalk-Board
4-5	L 10-18	2	Systems of Variable Composition	T2, T3, R5, R6	2	-do-
6-9	L19-27	3	Solutions and Colligative Properties	T1, R3	3	-do-
10-13	L28-35	4	Symmetry and Solid State	T1, R2, R3	4	-do-
14-16	L36-45	5	Surface chemistry	T3, R2, R3	5	-do-

Course Code and Name: CH332 (Organic Chemistry-I);
Credits: 4 L: 3 T: 1 P: 0
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04;
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To understand the basics of Organic Spectroscopy
B.	To understand the synthesis of various nitrogen contain compounds
C.	To understand the basics of pericyclic reactions
D.	To understand different rearrangement reactions
E.	To understand the different heterocyclic reactions

Course Outcomes
After the completion of this course, students will be:

1.	Able to explain basics of Organic Spectroscopy
2.	Able to explain synthesis of various nitrogen contain compounds
3.	Able to explain basics of pericyclic reactions
4.	Able to explain different rearrangement reactions
5.	Able to explain different heterocyclic reactions

Syllabus

Module-I: Organic Spectroscopy **(9 lectures)**
(i) Basic introduction of UV, IR, NMR Spectroscopy, (ii) UV: Types of electronic transitions, end absorption; Bathochromic and Hypsochromic shifts; λmax for the conjugated diene, α,β-unsaturated aldehydes and ketones(alicyclic, homoannular and heteroannular); extended conjugated systems (dienes, aldehydes and ketones); conjugative effect, steric effect, solvent effect, effect of pH; effective chromophore concentration: keto-enol systems; benzenoid transitions.(iii) IR: Modes of molecular vibrations (fundamental); characteristic and diagnostic stretching frequencies of C-H, N-H, O-H, C-O, C-N, C-X, C=C (including skeletal vibrations of aromatic compounds), C=O, C=N, N=O, C≡C, C≡N; characteristic/diagnostic application in functional group analysis. (i) NMR: basic principles of Proton NMR; choice of solvent and internal standard; equivalent and non-equivalent protons; chemical shift and factors influencing it; ring current effect; significance of the terms: up-/downfield, shielded and deshielded protons; spin coupling and coupling constant (1st order spectra); relative intensities of first-order multiplets: Pascal's triangle; chemical and magnetic equivalence in NMR ; anisotropic effects in alkene, alkyne, aldehydes and aromatics; NMR peak area, integration; relative peak positions with coupling patterns of common organic compounds; rapid proton exchange.

Module-II: Nitrogen compounds **(9 lectures)**
(i). Nitro compounds: Preparation and reaction (with mechanism): reduction under different conditions; Nef carbonyl synthesis, Henry reaction and conjugate addition of nitroalkane anion. (ii). Amines: Preparation amines; reaction (with mechanism): Eschweiler–Clarke methylation, diazo coupling reaction, formation and reactions of phenylenediamines, diazomethane and diazoacetic ester. Diazonium salts and their reactions: Gomberg, Japp-Klingermann. (iii). Alkylnitrile and isonitrile: Preparation and reaction (with mechanism): Thorpe nitrile condensation, von Richter reaction.

Module-III: Pericyclic reactions **(9 lectures)**
(I) Mechanism, stereochemistry, regioselectivity in case of (ii)Electrocyclic reactions: FMO approach involving 4π- and 6π-electrons (thermal and photochemical) and corresponding cycloreversion reactions. (iii) *Cycloaddition reactions:*FMOapproach, Diels-Alder reaction, photochemical [2+2] cycloadditions.(iv) *Sigmatropic reactions:* FMO approach,sigmatropic shifts and their order; [1,3] and [1,5] H shifts and [3,3] shifts with reference to Claisen and Cope rearrangements.

Module IV: Rearrangements: **(9 lectures)**

(i). Rearrangement to electron-deficient carbon: Wagner-Meerwein rearrangement, pinacol rearrangement, dienone-phenol; Wolff rearrangement in Arndt-Eistert synthesis, benzil-benzilic acid rearrangement, Demjanov rearrangement. *(ii). Rearrangement to electron-deficient nitrogen:* rearrangements: Hofmann, Curtius, Lossen, Schmidt and Beckmann. *(iii). Rearrangement to electron-deficient oxygen:* Baeyer-Villiger oxidation, cumene hydroperoxide-phenol rearrangement and Dakin reaction. *(iv). Aromatic rearrangements:* Fries rearrangement and Claisen rearrangement. *(v). Migration from nitrogen to ring carbon*: Hofmann-Martius rearrangement,Orton rearrangement and benzidine rearrangement.

Module-V: Heterocycles **(9 lectures)**

Heterocyclic compounds: 5- and 6-membered rings with one heteroatom; reactivity, orientation and important reactions (with mechanism) of furan, pyrrole,thiophene and pyridine; synthesis (including retrosynthetic approach and mechanistic details): pyrrole: Knorr synthesis, Paal-Knorr synthesis, Hantzsch; furan: Paal-Knorr synthesis, Feist-Benary synthesis and its variation; thiophenes: Paal-Knorr synthesis, Hinsberg synthesis; pyridine: Hantzschsynthesis;benzo-fused 5-and 6-membered rings with one heteroatom: reactivity, orientation and important reactions (with mechanistic details) of indole, quinoline and isoquinoline; synthesis (including retrosynthetic approachand mechanistic details): indole: Fischer,quinoline: Skraup, isoquinoline: Bischler-Napieralski synthesis.

Text books:

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Willy & Sons (1976).

Reference books:

1. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
2. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem	**25**
Assignment	**05**
Two Quiz	**20**
End Sem Examination Marks	**50**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem	√	√			
Assignment	√	√	√		
Quiz -1	√				
Quiz II			√	√	
End Sem Examination Marks	√	√	√	√	√

Indirect Assessment –

1. **Student Feedback on Faculty**
2. **Student Feedback on Course Outcome**

Mapping between Objectives and Outcomes

Course Outcome #	Program Outcomes				
	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	M
CO2	H	H	M	L	H
CO3	H	H	H	M	H
CO4	H	H	L	M	H

Mapping Between COs and Course Delivery (CD) methods

CD	Course Delivery methods	Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4	CD1
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1,CD2
CD3	Seminars	CO 2, 3	CD3
CD4	Mini projects/Projects	CO3, 4	CD4
CD5	Laboratory experiments/teaching aids	CO 1, 2, 3	CD5
CD6	Self- learning such as use of NPTEL materials and internets	CO1, 2, 3, 4	CD6
CD7	Simulation	CO2, 4	CD7

Lecture wise Lesson planning Details.

Week No.	**Lect. No.**	**Ch. No**	**Topics to be covered**	**Text Book / References**	**COs mapped**	**Methodology used**
1-4	**L01-L9**	**1**	Organic spectroscopy	**T1, T2, R1, R2, R4**	**4**	**PPT DigiClass /Chalk-Board**
5-6	**L10-L18**	**2**	Nitrogen compounds	**T1, T4, R1**	**5**	**-do-**
7-10	**L19-L27**	**3**	Pericyclic reactions	**T1, T4, R1, R2, R3**	**3**	**-do-**
11-13	**L28-L36**	**4**	Rearrangement reactions	**T3, T5, R3**	**1**	**-do-**
14-15	**L37-L45**	**5**	Heterocyclic Compounds	**T3, T5, R3**	**2**	**-do-**

Course Code and Name: CH333 (Inorganic Chemistry-I);
Credits: 4 L: 3 T: 1 P: 0
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04;
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To understand the basic concept of organometallic complexes
B.	To develop knowledge on the formation of metal-ligand bonds
C.	To create concept of magnetic properties
D.	To understand the basics of inorganic reaction mechanism
E	To development knowledge on the general principles of metallurgy

Course Outcomes
After the completion of this course, students will be:

1.	Able to explain the properties of organometallic complexes
2.	Able to predict the formation of metal-ligand bonds
3.	Able to understand magnetochemistry
4.	Able to explain the mechanism of inorganic reactions
5	Able to explain the general principles of metallurgy

Syllabus

Module I: Introduction to Organometallic complexes (9 Lectures)
Introduction, Concept of hapticity of organic ligands. 18 electron rule in Organometallic complexes- Ionic and Covalent Model; Metal Alkyls: structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds, Aryls, and Hydrides and Related σ-Bonded Ligands: Metal Hydride Complexes, σ Complexes, Grignard reagent and their structures, Schlenk equilibrium. Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene. MO diagram of metallocene

Module II: Metal–Ligand Multiple Bonds (9 Lectures)
Carbenes: Fischer Versus Schrock Carbenes - conditions, synthesis examples reactivity and structure, Carbynes- synthesis, examples and reactivity, structure, Bridging Carbenes and Carbynes, N-Heterocyclic Carbenes- synthesis examples reactivity and structure, General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. π-acceptor behaviour of CO, MO diagram of CO, synergic effect and use of IR data to explain extent of back bonding. Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

Module III: Introduction to Magnetochemistry (9 Lectures)
Definition of magnetic properties, Types of magnetic bodies, Experimental arrangements for the determination of magnetic susceptibility: Guoy method, Faraday method, Vibrating sample magnetometer, SQUID, NMR method; Diamagnetism in atoms and polynuclear systems, Pascals constant, Two sources of paramagnetism.

Module IV: Reaction Mechanism of Transition Metal Complexes (9 Lectures)

Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valency bond and crystal field theory, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, substitution reaction in square complexes, trans effect, redox reactions, electron transfer reactions, mechanism of one electron transfer reaction, outer sphere type reactions, inner sphere type reactions.

Module V: General Principles of Metallurgy (9 Lectures)

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining. Metallurgy of selected metals

Text books:

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Huheey, J. E.; Keiter, E. A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson
3. Basic Organometallic Chemistry: Concepts, Synthesis and applications, B. D. Gupta, A. J. Elias
4. Crabtree, R. H. The Organometallic Chemistry of the Transition Metals. New York, NY: John Wiley
5. R. L. Dutta, A. Syamal, Elements of Magnetochemistry, East-West Press.
6. Basolo, F. & Pearson, R. Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed., John Wiley & Sons Inc; NY

Reference books:

1. Collman, J. P. et al. Principles and Applications of Organotransition Metal Chemistry. Mill Valley, CA: University Science Books.
2. B- M. Bochmann, Organometallic Chemistry: (Oxford series).
3. F. E. Mabbs and D. J. Machin, Magnetism and Transition Metal complexes, Dover Publications.

Lecture plan

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Assessment Tool	% Contribution during CO Assessment
Teacher's Assessment	5
Mid Sem	25
Two Quizzes	10+10

End Sem Examination Marks	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem	√	√	√		
Quiz –I	√				
Quiz II		√	√		
End Sem Examination Marks	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty

2. Student Feedback on Course Outcome

<u>Mapping between Objectives and Outcomes</u>

Course Outcome #	Program Outcomes			
	PO1	PO2	PO3	PO4
CO1	H	H	L	L
CO2	M	H	H	L
CO3	H	H	M	L
CO4	H	H	M	M
CO5	H	H	H	H

Mapping between COs and Course Delivery (CD) methods

CD	Course Delivery methods	Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4	CD1
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1, CD2
CD3	Seminars	CO 2, 3	CD3
CD4	Mini projects/Projects	CO3, 4, 5	CD4
CD5	Laboratory experiments/teaching aids	CO 1, 2, 3	CD5
CD6	Self- learning such as use of NPTEL materials and internets	CO1, 2, 3, 4 5	CD6
CD7	Simulation	CO2, 4	CD7

Lecture wise Lesson planning Details.

Week No.	**Lect. No.**	**Ch. No.**	**Topics to be covered**	**Text Book / References**	**COs mapped**	**Methodology used**
1-4	L1-L09	**1**	Introduction to Organometallic complexes	**T1, T2 T3,R1**	**1**	**PPT DigiClass/ Chalk-Board**
5-6	L10-L18	**2**	Metal–Ligand Multiple Bonds	**T1,T3 R1,R2**	**2**	**-do-**
7-9	L19-L27	**3**	Introduction to Magnetochemistry	**T5, R2**	**3**	**-do-**
9-13	L28-L36	**4**	Reaction Mechanism of Transition Metal Complexes	**T2, T7**	**4**	**-do-**
14-16	L37-L45	**5**	General Principles of Metallurgy	**T1**	**5**	**-do-**

Course Code and Name: CH334 (Inorganic Chemistry Lab-I);
Credits: 2 L: 0 T: 0 P: 4
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04;
Class: B. Sc.
Level: I; **Branch: Chemistry**

1. Chemical Analysis of Alloy samples: Dissolution, sample preparation & Analysis. (any one)

a) Analysis of brass: Estimation of copper by gravimetry and zinc by EDTA titration.

b) Analysis of bronze: Estimation of copper by volumetry and tin by gravimetry

2. a) Ligand synthesis for multimetal complex: Preparation of *bis*-(*N,N*-disalicylidene ethylenediamine)

b) Preparation of *bis*-(N, N'-disalicylalethylene-diamine)-μ-aquadicobalt(II)

3. Kinetics of Hg(II) catalysed reaction of [FeCN6]4- with 1,10-*ortho* phenonthroline and its application in the determination of trace quantity of Hg(II).

4. Study of the conductance of H[Co(DMGH)2Cl2] in freshly prepared aqueous solution and its change with time for studying the rate of aquation.

5. pH metric determination of Proton- Ligand and Metal-Ligand stability constants.

6. Colorimetric study of the kinetics of the reduction of azidopentaminecobalt(III) chloride by aqueous Fe(II) ion.

7. Semi micro qualitative analysis of mixtures containing two anions, two common cations and one rare earth elements: W, Mo, Ce, Th, Zr, V, U and Li.

Assessment Tool	% Contribution
Progressive Evaluation	**60 (Day to day performance: 30, Quiz: 10, Viva: 20)**
End Sem Examination	**40 (Experiment Performance: 30, Quiz: 10)**

Course Code and Name: CH335 (Physical Chemistry-II);
Credits: 4 L: 3 T: 1 P: 0
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04;
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To understand quantum mechanical treatment of quantization of energy in hydrogen atom and hydrogen like ions
B.	To develop knowledge on the molecular orbital formation from the concept of linear combination of atomic orbitals
C.	To acquire knowledge of electromagnetic radiation, laws and principles of photochemistry, their applications in chemical processes
D.	To understand the basic principles of spin resonance spectroscopies like NMR and EPR
E.	To develop the concept on electrical and magnetic properties of matter

Course Outcomes
After the completion of this course, students will be:

1.	Able to apply the Schrodinger equation to qualitatively describe the quantization of energy levels of hydrogen atoms and hydrogen like ions
2.	Able to explain the formation of molecular orbitals (MOs) of homonuclear and heteronuclear diatomic molecules from the linear combination of atomic orbitals (LCAO) model
3.	Able to apply the knowledge of photochemistry in spectrophotometry and derive rate equation for photochemical reactions and photosensitised reactions
4.	Able to analyse and interpret the spectra of organic compounds and radicals by NMR and EPR spectroscopy respectively
5.	Able to explain electrical and magnetic phenomenon in matter with molecular level interpretations

Syllabus

Module I: Advanced Quantum Chemistry **(9 lectures)**
Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus. Setting up of Schrödinger equation for many-electron atoms (He, Li).

Module II: Chemical Bonding **(9 lectures)**
Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wavefunctions, detailed solution not required) and their limitations. Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Qualitative MO theory and its application to AH_2 type molecules.

Module III: Photochemistry **(9 lectures)**
Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.
Laws of photochemistry, quantum yield, actinometry, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. photostationary states, chemiluminescence.

Module IV: Magnetic resonance spectroscopy **(9 lectures)**
Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift, spin-spin coupling, interpretation of PNMR spectra of organic molecules.
Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.

Module V: Electrical & Magnetic Properties of Atoms and Molecules **(9 lectures)**
Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mossotti equation, Lorentz-Lorentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation.

Text books:

1. Kapoor, K. L. A Textbook of Physical Chemistry, Volume 4, Mcmillan Publishers India Ltd, 2004.
2. Kapoor, K. L. A Textbook of Physical Chemistry, Volume 5, Mcmillan Publishers India Ltd, 2004.
3. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
4. McQuarrie, D. A. & Simon, J. D., Molecular Thermodynamics, Viva Books Pvt. Ltd.: New Delhi (2004).
5. Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).
6. Rohatgi-Mukherjee, K. K. Fundamentals of Photochemistry, New Age International Pvt. Ltd.; 3rd edition, New Delhi, 2014.

Reference books:

1. Atkins, P. W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.
2. House, J. E. Fundamentals of Quantum Chemistry 2^{nd} Ed. Elsevier: USA (2004).
3. Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
4. Kakkar, R. Atomic & Molecular Spectroscopy: Concepts & Applications, Cambridge University Press (2015).
5. Levine, I. N. Physical Chemistry 6th Ed., Tata McGraw-Hill (2011).

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Teacher's Assessment	**5**
Mid Sem	**25**
Two Quizzes	**10+10**
End Sem Examination Marks	**50**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem	√	√			
Quiz –I	√	√			
Quiz II			√	√	√
End Sem Examination Marks	√	√	√	√	√

Indirect Assessment –

1. **Student Feedback on Faculty**
2. **Student Feedback on Course Outcome**

Mapping between Objectives and Outcomes

Course Outcome #	Program Outcomes			
	PO1	PO2	PO3	PO4
CO1	H	H	L	L
CO2	M	H	M	L
CO3	H	H	M	L
CO4	L	H	H	M
CO5	H	H	M	M

Mapping Between COs and Course Delivery (CD) methods

CD	Course Delivery methods	Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4, 5	CD1
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1, CD2
CD3	Seminars	CO 2, 3	CD3
CD4	Mini projects/Projects	CO3, 4	CD4
CD5	Laboratory experiments/teaching aids	CO 2	CD5
CD6	Self- learning such as use of NPTEL materials and internets	CO 2, 3, 4	CD6
CD7	Simulation	CO2, 3	CD7

Lecture wise Lesson planning Details.

WeekNo.	Lect. No.	Ch. No.	Topics to be covered	Text Book / References	COs mapped	Methodology used
1-3	L1-9	1	Advanced Quantum Chemistry	T1, R2, R3	1	PPT DigiClass/ Chalk-Board
4-5	L 10-18	2	Chemical Bonding	T2, T3, R5, R6	2	-do-
6-9	L19-27	3	Photochemistry	T1, R3	3	-do-
10-13	L28-35	4	Magnetic resonance spectroscopy	T1, R2, R3	4	-do-
14-16	L36-45	5	Electrical & Magnetic Properties of Atoms and Molecules	T3, R2, R3	5	-do-

Course Code and Name: CH336 (Organic Chemistry-II);
Credits: 4 L: 3 T: 1 P: 0
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04;
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To understand the Logic of Organic Synthesis, *Retrosynthetic analysis*
B.	To understand the synthesis of various Biomolecules.
C.	To understand the synthesis of Terpenoids, Steroids, Polyketide and Alkaloids.
D.	To understand the synthesis of different carbohydrates
E.	To understand the different Polynuclear hydrocarbon and their derivatives, Lipids and Flavonoids.

Course Outcomes
After the completion of this course, students will be:

1.	Able to explain Logic of Organic Synthesis, *Retrosynthetic analysis*
2.	Able to explain synthesis of various Biomolecules.
3.	Able to explain synthesis of Terpenoids, Steroids, Polyketide and Alkaloids.
4.	Able to explain synthesis of different carbohydrates
5.	Able to explain different Polynuclear hydrocarbon and their derivatives, Lipids and Flavonoid

Syllabus
Module-1: The Logic of Organic Synthesis (9 lectures)
(i)*Retrosynthetic analysis***:** Disconnections; synthons, donor and acceptor synthons; natural reactivity and *umpolung*; latent polarity in bifunctional compounds: illogical electrophiles and nucleophiles; synthetic equivalents; functional group interconversion and addition (FGI and FGA). (ii)*Strategy of ring synthesis:* Thermodynamic and kinetic factors; synthesis of large rings, application of high dilution technique. (iii) *Asymmetric synthesis***:** Stereoselective and stereospecific reactions; diastereoselectivity and enantioselectivity Felkin-Anh model.
Module-2: Biomolecules (9 lectures)
(i) *Aminoacids:* Synthesis with mechanistic details: Strecker, Gabriel; acetamido malonic ester, azlactone, Bücherer hydantoin synthesis, synthesis involving diketopiperizine, isoelectric point, zwitterions; electrophoresis, reaction (with mechanism): ninhydrin reaction, Dakin-West reaction; resolution of racemic amino acids. (ii) *Protein:* Peptide linkage and its geometry; syntheses (with mechanistic details) of peptides using N-protection & C-protection, solid-phase (Merrifield) synthesis; peptide sequence: *C*-terminal and *N*-terminal Module- determination (Edman, Sanger and 'dansyl'methods); partial hydrolysis; specific cleavage of peptides; use of CNBr. Primary, secondary, tertiary and quaternary structure of proteins. Classification of proteins; Denaturation of proteins.(iii) *Nucleic acids:* Pyrimidine and purine bases (only structure & nomenclature); nucleosides and nucleotides corresponding to DNA and RNA; mechanism for acid catalysed hydrolysis of nucleosides; comparison of alkaline hydrolysis of DNA and RNA; complimentary base–pairing in DNA.
Module 3: Terpenoids, Steroids, Polyketide and Alkaloids. (9 lectures)
(I)Metabolites and classification of natural products; natural occurrence, general structural features, classification and importance of: (i) *Terpenoids* (geraniol, menthol and camphor), (ii) *Steroids* (Cholesterol, bile acids, androsterone, testosterone, estone, progesterone and aldosterone) (ii) Introduction to alkaloids, natural occurrence, general structural features and classification; Medicinal importance of Coniine, Nicotine, Atropine, Cocaine, Quinine, Chloroquine, Papaverine, Lysergic acid, Reserpine and Morphine. Synthesis of Nicotine, Quinine, Papaverine, Reserpine and Morphine

Module-4: Carbohydrates **(9 lectures)**

(i)Monosaccharides: Aldoses up to 6 carbons; structure of D-glucose & D-fructose (configuration & conformation); ring structure of monosaccharides (furanose and pyranose forms): Haworth representations and non-planar conformations; anomeric effect (including stereoelectronic explanation); mutarotation; epimerization; reactions (mechanisms in relevant cases): Fischer glycosidation, osazone formation, bromine-water oxidation, HNO_3 oxidation, selective oxidation of terminal $–CH_2OH$ of aldoses, reduction to alditols, (ii) Lobry de Bruyn-van Ekenstein rearrangement; stepping–up (Kiliani-Fischer method) and stepping–down (Ruff's &Wohl's methods) of aldoses; end-group-interchange of aldoses; acetonide (isopropylidene and benzylidene protections; ring size determination; Fischer's proof of configuration of (+)-glucose. (iii) *Disaccharides:* Glycosidic linkages, concept of glycosidic bond formation by glycosyl donor-acceptor, structure of sucrose, inversion of cane sugar.

Module-5: Polynuclear hydrocarbon and their derivatives, Lipids and Flavonoids. **(9 lectures)**

(I) Synthetic methods include Haworth, Bardhan-Sengupta, Bogert-Cook and other useful syntheses (with mechanistic details); fixation of double bonds and Fries rule; reactions (with mechanism) of naphthalene, anthracene and phenanthrene and their derivatives.

(II) *Lipids*: Introduction and classification of lipids. Oils and fats: Common and naturally occurring fatty acids with structural features present in oils and fats, Omega fatty acids. Biological importance of triglycerides, phospholipids and glyco-lipids.

(III) *Flavonoids*: Introduction, structural features, classification and importance of flavonoids.

Text books:

1. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Reference books:

1. Berg, J. M., Tymoczko, J. L. & Stryer, L. Biochemistry. 6th Ed. W.H. Freeman and Co. (2006).
2. Nelson, D. L., Cox, M. M. & Lehninger, A.L. Principles of Biochemistry. IV Edition. W.H. Freeman and Co. (2009).
3. Murray, R. K., Granner, D. K., Mayes, P. A. & Rodwell, V. W. Harper's Illustrated Biochemistry. XXVIII edition. Lange Medical Books/ McGraw-Hill. (2009).

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
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Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem	25
Assignment	05
Two Quiz	20
End Sem Examination Marks	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem	√	√			
Assignment	√	√	√		
Quiz -1	√				
Quiz II			√	√	
End Sem Examination Marks	√	√	√	√	√

Indirect Assessment –

1. **Student Feedback on Faculty**
2. **Student Feedback on Course Outcome**

Mapping between Objectives and Outcomes

Course Outcome #	Program Outcomes				
	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	M
CO2	H	H	M	L	H
CO3	H	H	H	M	H
CO4	H	H	L	M	H

Mapping Between COs and Course Delivery (CD) methods

CD	Course Delivery methods	Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4	CD1
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1,CD2
CD3	Seminars	CO 2, 3	CD3
CD4	Mini projects/Projects	CO3, 4	CD4
CD5	Laboratory experiments/teaching aids	CO 1, 2, 3	CD5
CD6	Self- learning such as use of NPTEL materials and internets	CO1, 2, 3, 4	CD6
CD7	Simulation	CO2, 4	CD7

Lecture wise Lesson planning Details.

Wee No.	Lect No.	Ch. No	Topics to be covered	Text Book / References	COs mapped	Methodology used
1-3	**L01-L9**	**1**	Logic of organic synthesis	**T1, T2, R1, R2, R4**	**2**	**PPT Digi Class/Chalk -Board**
4-6	**L10-L18**	**2**	Biomolecules	**T1, T4, R1**	**1**	**-do-**
6-9	**L19-L27**	**3**	Terpenoids, Steroids, Polyketide and Alkaloids	**T1, T4, R1, R2, R3**	**4**	**-do-**
10-13	**L28-L36**	**4**	Carbohydrates	**T3, T5, R3**	**3**	**-do-**
13-15	**L37-L45**	**5**	Polynuclear hydrocarbons	**T3, T5, R3**	**5**	**-do-**

Course Code and Name: CH 337 (Inorganic Chemistry-II);
Credits: 4 L: 3 T: 1 P: 0
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04;
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives

This course enables the students:

A.	To understand the basic of bioinorganic chemistry
B.	To develop knowledge on the oxygen management and transport in biological systems
C.	To create concept of metalloenzymes
D.	To understand the basics of nuclear chemistry
E	To create concept of nuclear reactions

Course Outcomes

After the completion of this course, students will be:

1.	Able to explain the basics of bioinorganic chemistry and the importance of inorganic elements in biological systems
2.	Able to explain the concept of oxygen management and transport in biological systems
3.	Able to predict the function of hydrolase and oxido-reductase enzymes
4.	Able to understand the basic concept of nuclear chemistry
5	Able to explain the nuclear reactions

Syllabus

Module I Basic Bio-inorganic Chemistry **(9 Lectures)**

Elements of life, the natural selection of elements, metallo-biomolecules– enzymes and proteins, their differences, Metal ion storage and transport: Ferritin, metallothioneins, cerruloplasmin; Siderophores–enterobactin, transferin;. Na^+, K^+ pump, Ca^{2+} transport.

Module II Oxygen management and oxygen transport **(9 Lectures)**

Kinetics of biological and non-biological oxygenation, Reactive Oxygen Species (ROS): Occurance, types, active site structure and mechanism Super oxide dismutase, Catalase, Peroxidase.

Natural Oxygen carriers: Heme Type: Myoglobins and Hemoglobins, Mechanism of dioxygen binding and model systems. Di-iron Type: Hemerythrins and Myohemerythrins : Protein structure, The di-iron site and formulation of the O2 binding reaction, Mechanism of dioxygen binding, Autoxidation, Cooperative hemerythrins, Dicopper Type: Hemocyanins: Protein structure, Mechanism of dioxygen binding.

Module III Hydrolase and Oxido-Reductase Enzymes **(9 Lectures)**

Zn Carbonic Anhydrase, Zn Carboxy peptidase, Fe Acid Phosphatase, Ni Urease, Alcohol dehydrogenase-Occurance, types, active site structure and mechanism and model system. catalytic activity of Cu proteins for biological oxidation: Tyrosinase, Galactose oxidase, Catecholase, phenoxazinone synthase.

Module-V: Basic Nuclear Chemistry **(9 Lectures)**

Systematic of alpha, beta and gamma decays, spectra of alpha particles, Geiger-Nuttal law, theory of alpha decay, penetration of potential barrier, beta decay, beta spectrum, Fermi theory of beta decay, allowed and forbidden transitions, curie plots, gamma decay, Nuclear energy levels, selection rule, isomeric transitions, Internal conversion, Auger effect. Nuclear Potential, Binding energy, empirical mass equation, The Nuclear Models: Shell model, Liquid drop model, Fermi gas model.

Module II: Nuclear reactions **(9 Lectures)**

Nuclear cross section, nuclear dynamics, threshold energy of nuclear reaction, direct nuclear reactions, heavy ion induced nuclear reactions, photonuclear reactions. Fission and Fusion reactions: Fission barrier and threshold, fission cross section, mass energy and charge distribution of fission products, symmetric and Asymmetric fission, decay chains and delayed neutrons.

Text books:

1. Bertini, H. B. Gray, S. J. Lippard, J. S. Valentine,Bioinorganic Chemistry, University Science Books, Mill Valley, CA.
2. W. Kaim, B. Schwederski, A. Klein, Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life: An Introduction and Guide, Wiley.
3. Lippard, S. J. & Berg, J. M. Principles of Bioinorganic Chemistry Panima Publishing Company.
4. H. J. Arnikar, Essentials of Nuclear Chemistry, 4th ed. Wiley Eastern.

Reference books:

1. R. R. Crichton, Biological Inorganic Chemistry, 2nd ed., Elsvier.
2. R. M. Roat-Malone, Bioinorganic Chemistry: A Short Course, Wiley.
3. G. Friedlander, T. W. Kennedy, E. S.Macias and J. M. Miller, Introduction of Nuclear and Radiochemistry, 3rd ed., John Wiley.

Lecture plan

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Assessment Tool	% Contribution during CO Assessment
Teacher's Assessment	**5**
Mid Sem	**25**
Two Quizzes	**10+10**
End Sem Examination Marks	**50**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem	√	√	√		
Quiz –I	√	√			
Quiz II			√	√	
End Sem Examination Marks	√	√	√	√	√

Indirect Assessment –

1. **Student Feedback on Faculty**
2. **Student Feedback on Course Outcome**

Mapping between Objectives and Outcomes

Course Outcome #	**Program Outcomes**			
	PO1	**PO2**	**PO3**	**PO4**
CO1	**H**	**H**	**L**	**L**
CO2	**M**	**H**	**H**	**L**
CO3	**H**	**H**	**M**	**L**
CO4	**H**	**H**	**M**	**M**
CO5	**H**	**H**	**H**	**H**

Mapping between COs and Course Delivery (CD) methods

CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO 1, 2, 3, 4, 5	CD1
CD2	Tutorials/Assignments	CO 1, 2, 3, 4, 5	CD1,CD2
CD3	Seminars	CO 2, 3, 5	CD3
CD4	Mini projects/Projects	CO 3, 4, 5	CD4
CD5	Laboratory experiments/teaching aids	CO 1, 2, 3	CD5
CD6	Self- learning such as use of NPTEL materials and internets	CO 1, 2, 3, 4 5	CD6
CD7	Simulation	CO2, 4	CD7

Lecture wise Lesson planning Details.

Week No.	**Lect. No.**	**Ch. No**	**Topics to be covered**	**Text Book / References**	**COs mapped**	**Methodology used**
1-4	L1-L09	**1**	Basic Bio-inorganic Chemistry	**T1, T2, R1**	**1**	**PPT DigiClass/ Chalk-Board**
5-6	L10-L18	**2**	Oxygen management and oxygen transport	**T1, T3 R1, R2**	**2**	**-do-**
7-9	L19-L27	**3**	Hydrolase and Oxido-Reductase Enzymes	**T1, T3, R2**	**3**	**-do-**
9-13	L28-L36	**4**	Basic Nuclear Chemistry	**T4, R3**	**4**	**-do-**
14-16	L37-L45	**5**	Nuclear reactions	**T4, R3**	**5**	**-do-**

Course Code and Name: CH338 (Physical Chemistry Lab-I);
Credits: 2 L: 0 T: 0 P: 4
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04; Class: B. Sc.
Level: I; Branch: Chemistry

Kinetics

Study the kinetics of the following reactions.

1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:

(i) Acid hydrolysis of methyl acetate with hydrochloric acid.
(ii) Saponification of ethyl acetate.

pH metry

1. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
2. Preparation of buffer solutions of different pH

(i) Sodium acetate-acetic acid
(ii) Ammonium chloride-ammonium hydroxide

3. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
4. Determination of dissociation constant of a weak acid.
5. Indexing of a given powder diffraction pattern of a cubic crystalline system.
6. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Conductometry

1. Determination of cell constant
2. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
3. Perform the following conductometric titrations: (any two)

(i) Strong acid vs. strong base
(ii) Weak acid vs. strong base
(iii) Mixture of strong acid and weak acid vs. strong base
(iv) Strong acid vs. weak base

Potentiometry

1. Perform the following potentiometric titrations: (any two)

(i) Strong acid vs. strong base
(ii) Weak acid vs. strong base
(iii) Dibasic acid vs. strong base
(iv) Potassium dichromate vs. Mohr's salt

Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

Assessment Tool	% Contribution
Progressive Evaluation	60 (Day to day performance: 30, Quiz: 10, Viva: 20)
End Sem Examination	40 (Experiment Performance: 30, Quiz: 10)

Course Code and Name: CH339 (Organic Chemistry Lab-I);
Credits: 2 L: 0 T: 0 P: 4
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04;
Class: B. Sc.
Level: I;
Branch: Chemistry

Isolation of the organic compounds from binary mixture and identification of functional groups through qualitative analysis, derivative preparation and characterization by FTIR, UV-VIS & NMR.

Assessment Tool	% Contribution
Progressive Evaluation	**60 (Day to day performance: 30, Quiz: 10, Viva: 20)**
End Sem Examination	**40 (Experiment Performance: 30, Quiz: 10)**

Course Code and Name: CH421 (Advanced Physical Chemistry-I);
Credits: 3 L: 3 T: 0 P: 0
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 03;
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To understand the basic principles and applications of equilibrium thermodynamics
B.	To develop the idea about how thermodynamic functions are linked with molecular properties
C.	To create concept of molecular partition functions to explain the accessible energy levels available for translational, rotational, vibrational and electronic energy states
D.	To understand the concept of heat capacity and fermi energy levels in solids
E.	To understand the basic principles of non-equilibrium thermodynamics

Course Outcomes
After the completion of this course, students will be:

1.	Able to calculate change in thermodynamic properties, equilibrium constants, partial molar quantities, chemical potential
2.	Able to calculate population distribution in various energy states possible in molecules
3.	Able to measure the partition function of ideal and real gases
4.	Able to explain the thermodynamic functions like internal energy, entropy, heat capacity using molecular distribution function
5.	Able to solve numerical problems based on non-ideal solutions, chemical potentials, thermodynamic properties

Syllabus

Module I: Equilibrium Thermodynamics **(08 lectures)**
Basics of Thermodynamics: 1st law and 2nd law; Derivation of Clapeyron-Clausius equation and its applications, fugacity & activity of gas and liquid. Third law of thermodynamics: Determination of absolute entropy of solids, liquids & gases, Boltzmann entropy equation.

Module II: Basics of Statistical Thermodynamics **(08 lectures)**
Concept of distribution, Thermodynamic probability and most probable distribution, Maxwell-Boltzmann statistics, Bose-Einstein statistics, Fermi-Dirac statistics. Ensemble averaging, Canonical, Grand canonical and micro canonical ensembles.

Module III: Applications of Statistical Thermodynamics I **(08 lectures)**
Ideal Gases: Partition functions: Translational, rotational, Vibrational and electronic partition functions and calculation of thermodynamic properties in terms of partition functions for ideal monatomic and diatomic gas. Equilibrium constant of an ideal gas reaction in terms of partition function. *Real gases:* intermolecular potential and virial coefficients.

Module IV: Applications of Statistical Thermodynamics II **(08 lectures)**
Debye and Einstein theory of heat capacity of solids. Structure and thermal properties of liquids, Pair correlation functions. *Solids:* Thermodynamics of solids - Einstein and Debye models. T^3 dependence of heat capacity of solids at low temperatures (universal feature). *Metals:* Fermi function, Fermi energy, free electron model and density of states, chemical potential of conduction electrons.

Module V: Non-equilibrium thermodynamics **(08 lectures)**
Thermodynamic criteria for non-equilibrium state, Phenomenological laws and Onsager reciprocal relations, Conservation of mass and energy in closed and open system. Entropy production: Due to heat flow, involving chemical reactions. Entropy production and entropy flow in open system. Transformation properties of fluxes

and forces. Electrokinetic phenomena. Stationary non-equilibrium state: Prigogine's principle. Irreversible thermodynamics for biological systems.

Text books:

1. D. A. McQuarrie and J. D. Simon, Molecular Thermodynamics, Viva Books Private Limited, 1st Indian edition, 2004.
2. D. A. McQuarrie and J. D. Simon, Physical Chemistry: A molecular Approach, Viva, 1998.
3. C. Kalidas and M. V. Sangaranarayan, Non-Equilibrium Thermodynamics: Principles and Applications, McMillan India Ltd., 2002.
4. R. P. Rastogi and R. R. Misra, An Introduction to Chemical Thermodynamics, Vikas Publishing House Pvt. Ltd., 6th ed., 2000.
5. S. Glasstone, Thermodynamics for Chemists, East-West Press Pvt. Ltd. 2008.

Reference books:

1. P. W. Atkins, Physical Chemistry, 7thed., Oxford University Press, New York, 2002.
2. I. N. Levine, Physical Chemistry, 5th ed., Tata McGraw Hill Pub. Co. Ltd., New Delhi. 2002.
3. F. W. Sears & G. L. Salinger, Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Narosa, 1986.
4. I. Prigogine, Introduction to Thermodynamics of Irreversible Processes. 3rd ed., Interscience, New York, 1978.

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

<u>Course Outcome (CO) Attainment Assessment tools & Evaluation procedure</u>

<u>Direct Assessment</u>

Assessment Tool	**% Contribution during CO Assessment**
Mid Sem	**25**
Assignment	**05**
Two Quiz	**20**
End Sem Examination Marks	**50**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Sem	√	√			

Assignment	√	√	√		
Quiz -1	√				
Quiz II			√	√	
End Sem Examination Marks	√	√	√	√	√

Indirect Assessment –

1. **Student Feedback on Faculty**
2. **Student Feedback on Course Outcome**

Mapping between Objectives and Outcomes

Course Outcome #	**Program Outcomes**			
	PO1	**PO2**	**PO3**	**PO4**
CO1	**H**	**H**	**M**	**L**
CO2	**M**	**H**	**H**	**L**
CO3	**H**	**H**	**M**	**L**
CO4	**H**	**H**	**L**	**M**
CO5	**H**	**H**	**M**	**L**

Mapping Between COs and Course Delivery (CD) methods

CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4, 5	CD1
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1,CD2
CD3	Seminars	CO 2, 3	CD3
CD4	Mini projects/Projects	CO3, 4	CD4
CD5	Laboratory experiments/teaching aids	CO 2	CD5
CD6	Self- learning such as use of NPTEL materials and internets	CO1, 2, 3, 4	CD6
CD7	Simulation	CO2, 4	CD7

Lecture wise Lesson planning Details.

Week No.	**Lect. No.**	**Ch.No.**	**Topics to be covered**	**Text Book / References**	**COs mapped**	**Methodology used**

1-2	**L1-8**	**1**	Equilibrium Thermodynamics	**T1, R2,R3**	**1**	**PPT Digi Class/Chalk -Board**
3-4	**L 9-16**	**2**	Basics of Statistical Thermodynamics	**T1, R2,R3**	**2**	**-do-**
5-6	**L17-24**	**3**	Applications of Statistical Thermodynamics I	**T1, T2**	**3**	**-do-**
7-8	**L25-32**	**4**	Applications of Statistical Thermodynamics II	**T1, R2,R3**	**4**	**-do-**
9-10	**L33-40**	**5**	Non-equilibrium thermodynamics	**T1, R1,R3**	**5**	**-do-**

Course code: CH422
Course title: Advanced Organic Chemistry-I
Pre-requisite(s): Intermediate Level Chemistry
Co- requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To understand the conformation and reactivity of cyclohexane
B.	To understand the principles of organic reaction
C.	To understand the principles of reaction mechanism
D.	To understand the various asymmetric synthesis techniques
E.	To understand the principles of retrosynthesis

Course Outcomes
After the completion of this course, students will be:

1.	Able to explain conformation and reactivity of cyclohexane
2.	Able to explain principles of organic reaction
3.	Able to explain Principles of reaction mechanism.
4.	Able to explain various asymmetric synthesis techniques
5.	Able to explain principles of retrosynthesis

Module I: Conformation and Reactivity [8 Lectures]
Conformation around sp^3-sp^2 and sp^2-sp^2 bond, conformation around carbon hetero atom bond, conformations of cyclic system (cyclopentane, cyclohexane with mono and di substituted cyclohexanes, cycloheptane, cyclooctane and decalins),, Conformation of cyclohexane, monosubsituted, disubstituted, etc. Reactivity of cyclohexane and substituted system (substitution, addition, elimination, rearrangement etc.).

Module II: Principles of Organic Reaction [8 Lectures]
Reagent type and reaction type, Investigation of reaction mechanism (nature of products, kinetic data, use of isotope, study of intermediate, stereochemical criteria.Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, free energy relationships, kinetic and thermodynamic control, Nature of reaction energy, Potential energy diagrams, transition states and intermediates, methods of determing mechanisms, nonkinetic methods of determining reaction mechanism, isotope effects, solvent effect.

Module III: Principles of Reaction Mechanism [8 Lectures]
Hammond's postulate, Curtin-Hammett principle, Hammett energy diagrams and reaction rate laws, Hammett's σ_x and ρ values and their physical significance through-conjugation, deviations from straight line plots; steric effects: Taft equation, Softness (Hardness) Scales, HSAB principle, HSAB application for organic reactions: Reaction Selectivity, Alkylation vs. Acylation, C- vs. O-Alkylation, Reactions of Organosulfur Compounds, Reactions of Organophosphorus Compounds, Elimination and Substitution, Addition to Double Bonds, Addition to Carbonyl Compounds.

Module IV: Asymmetric synthesis (8 Lectures)
Stereoisomerism, methods of resolution, optical purity, prochirality, enantiotopic and diastereotopic atoms, groups and faces, optical activity Cram's rule, Felkin's rule, Prelog's rule, Karabatso's rule

and their application in organic synthesis (stereoselectivity in hydride reduction), Homogenous and heterogenous asymmetric catalysis.

Module V: Principles of Retrosynthesis **(8 Lectures)**
Methodologies in organic synthesis-basic ideas on synthons and synthetic equivalents, disconnection approach, functional group transformations and inter-conversions of simple functionalities, Disconnection Approaches, Functional Group Interconversions (FGI). Concept of synthetic efficiency: one pot, multi-component and atom economical reactions. linear and convergent synthesis. One group disconnections, Reactions examples One group C-C and C-X disconnection, Umpolung of reactivity and protecting groups. Two group C-C disconnections, Diels-Alder reaction,

Text books:

1. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
2. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Gowariker, V. R.; Viswanathan, N. V. & Sreedhar, J. Polymer Science, New Age International (P) Ltd. Pub.
4. Solomons, G. T.W. Organic Chemistry, John Wiley & Sons, Inc.
5. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Prajati Prakashan (2010).
6. Kemp, W. Organic Spectroscopy, Palgrave.

Reference books:

1. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
3. Billmeyer, F. W. Textbook of Polymer Science, John Wiley & Sons, Inc.
4. Pavia, D. L. et al. Introduction to Spectroscopy 5th Ed. Cengage Learning India Ed., 2015.
5. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem	**25**
Assignment	**05**
Two Quiz	**20**

End Sem Examination Marks	**50**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Sem	√	√			
Assignment	√	√	√		
Quiz -1	√				
Quiz II			√	√	
End Sem Examination Marks	√	√	√	√	√

Indirect Assessment –

1. **Student Feedback on Faculty**
2. **Student Feedback on Course Outcome**

Mapping between Objectives and Outcomes

Course Outcome #	**Program Outcomes**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**H**	**H**	**L**	**L**	**M**
CO2	**H**	**H**	**M**	**L**	**H**
CO3	**H**	**H**	**H**	**M**	**H**
CO4	**H**	**H**	**L**	**M**	**H**

Mapping Between COs and Course Delivery (CD) methods

CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4	CD1
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1,CD2
CD3	Seminars	CO 2, 3	CD3
CD4	Mini projects/Projects	CO3, 4	CD4
CD5	Laboratory experiments/teaching aids	CO 1, 2, 3	CD5

CD6	Self- learning such as use of NPTEL materials and internets	CO1, 2, 3, 4	CD6
CD7	Simulation	CO2, 4	CD7

Lecture wise Lesson planning Details.

Week No.	**Lect No.**	**Ch. No**	**Topics to be covered**	**Text Book / References**	**COs mapped**	**Methodology used**
1-4	**L01-L08**	**1**	Conformation and Reactivity	**T1, T2, R1, R2, R4**	**1**	**PPT Digi Class/Chalk -Board**
5-6	**L09-L16**	**2**	Principles of organic reactions	**T1, T4, R1**	**2**	**-do-**
7-10	**L17-L24**	**3**	Principlesof recation mechanism	**T1, T4, R1, R2, R3**	**3**	**-do-**
11-13	**L25-L32**	**4**	Asymmetric synthesis	**T3, T5, R3**	**4**	**-do-**
14-15	**L33-L40**	**5**	Retrosynthesis	**T3, T5, R3**	**5**	**-do-**

Course Code and Name: CH423 (Advanced Inorganic Chemistry-I);
Credits: 3 L: 3 T: 0 P: 0
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 03;
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To know about the chemical bonding quantum mechanically
B.	To understand the electronic spectra of coordination complexes
C.	To understand the principle of electronic spectra of transition metal complexes
D.	To study the metal complexes in biological systems
E.	To study the medicinal systems containing metal atoms

Course Outcomes
After the completion of this course, students will be:

1.	Able to explain quantum mechanical interpretation of chemical bonding
2.	Able to interpret electronic spectra of transition metal complexes
3.	Able to explain theoretical principle of the nature of the electronic spectra of transition metal complexes
4.	Able to explain the structure-property relationships in bioinorganic molecules
5.	Able to interpret the role of metals in medicines

Syllabus

Module I: Chemical Bonding: Valency Theories- Quantum Chemical Approach (8 Lectures)
Huckel approximation applied to H2+ and H2 type systems, comparative study of the application of VB and MO methods to diatomic (homo and hetero) species; MO of polyatomic molecules; Walsh diagram, configuration interaction, orbital construction for Hn type systems, localized and delocalized M.O., σ, π, δ bonds, polyatomic molecules, electron deficient and hypervalent molecules.

Module II: Introduction to electronic Spectra of transition metal complexes (8 Lectures)
Important features of transition metal electronic spectra- band intensities, band energies, band width and sets; characteristic spectra of complexes of fast row transition metal ions, Octahedral, tetrahedral and square planar complexes of first row transition metal ions; Effect of temperature on electronic bands, Spectrochemical & Nephelauxetic series.

Module III: Theoretical basis of Electronic Spectra of transition metal complexes (8 Lectures)
Spectroscopic ground state, Orgel and Tanabe–Sugano diagrams for transition metal complexes, calculations of Dq, B and beta parameters, Charge transfer spectra: Intraligand charge transfer spectra, Metal to ligand charge transfer spectra, Ligand to metal charge transfer spectra Absorption spectra of *f*-block elements.

Module IV: Model Systems in Bioinorganic Chemistry (8 Lectures)
Chemistry of Vitamin B12, Iron– Sulphur proteins, Cytochrome c Oxidase, Cytochrome P– 450, Nitrogenase- biological nitrogen fixation, molybdenum nitrogenase, Nitrogenase model systems, Hydrogenase and model systems, Metal complexes in transmission of energy- Chlorophylls & Photosynthetic Water Oxidation.

Module V: Metals in Medicine (8 Lectures)
Metal Toxicity and Homeostasis, Chelation Therapy, Vanadium-Based Diabetes Drugs, Pt based Anti-Cancer Drugs, Mechanism of cisDDP Antitumor Activity, Anti-arthritis drugs, Imaging Agents: Technetium Imaging Agents, Gadolinium MRI Imaging Agents, Gold containing drugs used in the therapy of Rheumatoid Arthritis, Lithium in psychopharmacological drugs.

Text books:
1. G. Wulfsberg, Inorganic Chemistry, University Science Books, 2000.
2. C. J. Ballhausen & H. B. Gray, Molecular Orbital Theory, W.A. Benjamin, 1978.
3. A. B. P. Lever, Inorganic Electronic Spectroscopy, Elsevier, 1984.
4. A. K. Das, M. Das, Fundamental Concepts of Inorganic Chemistry; Volume-1-5; CBS Publishers, 2012.
5. I. Bertini, H. B. Gray, S. J. Lippard, J. S. Valentine, Bioinorganic Chemistry, University Science Books, Mill Valley, CA, 1994.
6. W. Kaim, B. Schwederski, A. Klein, Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life: An Introduction and Guide, Wiley, 1994.
7. L. Stryer, J. M. Berg, J. L. Tymoczko, 5th ed.,W. H. Freeman & Co Ltd, 2002.

Reference books:
1. B. N. Figgis and M. A. Hitchman, Ligand Field Theory and its Applications, Wiley–VCH, New York, 2000.
2. I. B. Bersuker, Electronic Structure and Properties of transition metal compounds, 2nd ed., Wiley, 2010.
3. C. J. Ballhausen, Introduction to Ligand Field Theory, McGraw-Hill Inc., 1962.
4. D. N. Sathyanarayana, Electronic Absorption Spectroscopy, Universities Press, 2001.
5. R Sarkar, General and Inorganic Chemistry- Volume-I and Volume-II, 3rd revised ed., New Central Book Agency, 2011.
6. R. R. Crichton, Biological Inorganic Chemistry, 2nd ed., Elsvier, 2012.
7. R. M. Roat-Malone, Bioinorganic Chemistry: A Short Course, Wiley, 2002.

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem	**25**
Assignment	**05**
Two Quiz	**20**
End Sem Examination Marks	**50**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem	√	√			

Assignment	√	√	√		
Quiz -1	√				
Quiz II			√	√	
End Sem Examination Marks	√	√	√	√	√

Indirect Assessment –

1. **Student Feedback on Faculty**
2. **Student Feedback on Course Outcome**

<u>Mapping between Objectives and Outcomes</u>

Course Outcome #	Program Outcomes				
	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	M
CO2	H	H	M	L	H
CO3	H	H	H	M	H
CO4	H	H	L	M	H

Mapping Between COs and Course Delivery (CD) methods

CD	Course Delivery methods	Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4	CD1
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1,CD2
CD3	Seminars	CO 2, 3	CD3
CD4	Mini projects/Projects	CO3, 4	CD4
CD5	Laboratory experiments/teaching aids	CO 1, 2, 3	CD5
CD6	Self- learning such as use of NPTEL materials and internets	CO1, 2, 3, 4	CD6
CD7	Simulation	CO2, 4	CD7

Lecture wise Lesson planning Details.

Week No.	Lect. No.	Ch. No	Topics to be covered	Textbook/ Reference	COs mapped	Methodology used
1-4	**L01-L09**	**1**	Chemical Bonding: Valency Theories- Quantum Chemical Approach	**T1, T2, R1, R2, R4**	**1**	**PPT Digi Class/Chalk -Board**
5-6	**L10-L18**	**2**	Introduction to electronic Spectra of transition metal complexes	**T1, T4, R1**	**2**	**-do-**
7-10	**L25 -L40**	**3**	Theoretical basis of Electronic Spectra of transition metal complexes	**T1, T4, R1, R2, R3**	**3**	**-do-**
11-13	**L41-L52**	**4**	Model Systems in Bioinorganic Chemistry	**T3, T5, R3**	**4**	**-do-**
14-15	**L53-L60**	**5**	Metals in Medicine	**T3, T5, R3**	**5**	**-do-**

Course Code and Name: CH424 (Theoretical and Computational Chemistry Lab);
Credits: 2 L: 0 T: 0 P: 4
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04;
Class: B. Sc.
Level: I;
Branch: Chemistry

Syllabus

1. A) Draw and clean the 2D chemical structure for given molecules (e.g.; Barbituric Acid,N-acetylneuraminic acid, Cholesterol) as per ACS format using ChemDraw Software. B) Perform the analysis of the drawn structure to report IUPAC name, molecular weight, exact mass and elemental analysis. C) Convert the 2D chemical structure into 3D structure using Chem3D software and demonstrate the various molecular models.
2. Draw the suitable conformers of 2,3-dibromobutane and demonstrate in Sawhorse, Newmann, and Fisher projection. Minimize the eclipsed and staggered conformor and evaluate the energies by molecular mechanics (MM) for both conformers.
3. Compute the physico-chemical properties such as log p, solubility, molar refractivity and NMR for a given molecule.
4. Draw the reaction mechanism for a given name reaction using ChemDraw tools in ACS (American Chemical Society) format.
5. Compute the partial atomic charges (extended Huckel) in phenol and display by color gradient.
6. Draw and demonstrate the HOMO-LUMO diagram using ethylene molecule. Minimize the energy of the given molecule and calculate HUMO-LUMO energy gap using Gaussian Software.
7. (a) Introduction about the computational chemistry software Schrodinger, understanding and use of its Graphical interface "Maestro" to prepare the molecular system for computer simulation. (b) Draw the 3D structure of a given chiral molecule (tamiflu) in Maestro workspace, clean the structure by short minimization using MM.
8. Generate the all stereochemical structure of a given molecules (tamiflu or zanamavir) using maestro interface of Schrodinger.
9. Conduct the molecular docking experiment for a given ligands with a large protein structure. Report the docking score and binding mode of ligands within the protein active site. Compare the docking result to conclude the remarks for its bindingaffinity.
10. Determine the single point energy of benzene (assume: singlet and uncharged) by density-function calculation with the B3LYP functional and a 6-31G** basis set. Optimize the geometry of the output structure form experiment-9 using BLYP/6-31G** level.
11. Run the calculation to demonstrate the electrostatic potential (ESP) of vinyl alcohol. Label atoms in the workspace with atomic properties derived from the ESP and examine the electrostatic potential (ESP) on the molecular surface.
12. Predict and describe the pKa values of organic bases such as methylamine, dimethyl amine and trimethyl amine usingChemOffice.
13. Draw and describe the 3D conformational features of *trans*-1,3-demthyl cyclohexane. Draw, demonstrate and compare the electrostatic potential map of CH_3-Cl and CH_3-Li. Explain the significance of this experiment.

Reference books:

1. F. Jensen, Introduction to Computational Chemistry, Wiley, New York, 1999.
2. A. Szabo and N. S. Ostlund, Modern Quantum Chemistry, Introduction to Advanced Electronic Structure Theory, 1st ed., revised Dover, 1989. More mathematical detail for many of the ab initio electronic structure methods.

Assessment Tool	**% Contribution**
Progressive Evaluation	**60 (Day to day performance: 30, Quiz: 10, Viva: 20)**
End Sem Examination	**40 (Experiment Performance: 30, Quiz: 10)**

Course Code and Name: CH 426 (Advanced Physical Chemistry-II);
Credits: 4 L: 3 T: 1 P: 0
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04; Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To understand the theories of reaction kinetics and techniques to study and analyse reaction dynamics
B.	To develop the concept of interfacial phenomena related to electrochemistry of electrode kinetics, colloids and gas adsorption over solid surfaces
C.	To use techniques of approximations to solve the quantum mechanical problems
D.	To understand the complex atomic spectra of single and many-electron systems
E	To understand the concepts molecular symmetry to determine the point groups and to develop the associated irreducible representations to form character table

Course Outcomes
After the completion of this course, students will be:

1.	Able to solve problems on rate/rate constants/efficiency for complex reactions and explain the electronically excited state dynamics using the Stern-Volmer constants determined from quenching of fluorescence
2.	Able to calculate electrochemical cell parameters, current and overpotential under given condition, amount of corrosion and its rate and plot potential vs current, surface coverage vs. potential, potential vs. pH, concentration profile vs. distance from the electrode
3.	Able to solve the model problems in quantum mechanics for which exact analytical methods and solutions are available which forms the foundations for advanced study of the subject.
4.	Able to explain the concept of spin-orbit coupling and determine the term symbols of atomic energy states
5.	Able to determine the symmetry elements and corresponding point groups of molecules and how to use character table of corresponding point groups to predict the properties

Syllabus

Module I: Kinetics and Reaction Dynamics (09 lectures)
Introduction to reaction kinetics, Theories of unimolecular gaseous reactions: Lindemann-Hinshelwood, RRK and RRKM theories, Kinetics of reactions in solution. Kinetics of fast reactions: Relaxation method, Flow methods, Pulse methods, flash photolysis. Molecular reaction dynamics, potential energy surfaces. Heterogeneous catalysis: Kinetics of surface reactions (unimolecular and bimolecular).
Kinetics in the excited state: Jablonski diagram, Kinetics of Unimolecular and bimolecular photophysical and photochemical processes, Kinetics of collisional quenching: Stern-Volmer equation, Resonance energy transfer rates (RET), Dynamics of electron transfer, Marcus theory of electron transfer.

Module II: Colloid and Interface Chemistry (09 lectures)
Derivation of Debye-Hückel theory of ion-ion interaction and activity coefficient, Applicability and limitations of Debye-Hückel limiting law, Introduction to electrical double layer, a brief introduction to electrode kinetics: Butler-Volmer equation, polarography, cyclic voltammetry, corrosion.
Electrical and electrokinetic properties of colloidal states, Micelles, CMC, factors affecting the CMC, Thermodynamics of micellization-phase separation, solubilization, Micro-emulsion, Reverse micelles
Adsorption of gases by solids: BET theory of multilayer adsorption.

Module III: Approximation Methods in Quantum Chemistry (09 lectures)
Operators in quantum mechanics: Linear and Hermitian operators, operator algebra, eigenvalues and eigenfunctions, commutation relations. Perturbation (Time-independent & Time-dependent) and Variation methods: Examples of Variation methods: (i) Hydrogen atom, Hydrogen atom in an electric field, (ii) Helium atom. Examples of Perturbation method: (i) perturbed particle in a box, (ii) perturbed harmonic oscillator (iii) Hydrogen atom in electric field.

Module IV: Atomic Spectra and Atomic Structure **(09 lectures)**

The spectrum of atomic hydrogen: Electronic configuration of atoms, addition of angular momenta, spectroscopic term symbols, spin-orbit coupling, selection rules for atomic spectra; The structure of helium; Many-electron atoms: Antisymmetric wave functions of many electron atoms, Slater determinants, Hartree and Hartree-Fock self-consistent field model for atoms.

Module V: Basic Concept of Symmetry & Group Theory **(09 lectures)**

Definition and theorem of group theory, Molecular symmetry & the symmetry group, Symmetry operations & symmetry elements, multiplication tables. Representation of molecular point groups, character, reducible and irreducible representations. The Great Orthogonality Theorem (GOT, without proof), use of GOT to construct character table, character table for point groups & their uses.

Text books:

1. P.W. Atkins and R.S. Friedman, Molecular Quantum Mechanics, 4th edition, Oxford University Press. Oxford, 2005.
2. D. A. McQuarrie, Quantum Chemistry, University Science Books, 1983.
3. R. K. Prasad, Quantum Chemistry, 3rd ed., New Age International, 2006.
4. A. K. Chandra, Introductory Quantum Chemistry, Tata Mcgraw-Hill, New Delhi, 1988.
5. F. A. Cotton, Chemical Applications of Group Theory, Wiley, 1996.
6. K. J. Laidler, Chemical Kinetics, 3rd ed., Harper & Row, New York, 1998.
7. J. O'M. Bockris and A. K. N. Reddy, Modern Electrochemistry, Vol. 2, 2nd ed., Plenum Press, New York, 1998.
8. K. K. Rohatgi-Mukherjee, Fundamentals of Photochemistry, New Age International Pvt. Ltd.; 3rd ed., New Delhi, 2014.
9. A. W. Adamson and A. P. Gast, Physical Chemistry of Surfaces, 5th ed., Wiley, 1997.

Reference books:

1. M. R. Wright, An Introduction to Chemical Kinetics, 1st ed., Wiley, 2005.
2. H. Eyring, J.Walter and G. E. Kimball, Quantum Chemistry, John Wiley, New York, 1944.
3. I. N. Levine, Quantum Chemistry, 5th ed., Pearson Educ., Inc., New Delhi, 2000.
4. D. J. Griffiths, Introduction to Quantum Mechanics, Pearson Education, 2005.
5. J. P. Lowe and K. A. Peterson, Quantum Chemistry, 3rd ed., Academic Press, 2005.
6. D. M. Bishop, Group theory and Chemistry, Dover, 1993.
7. M. J. Pilling and A. P.W, Seakins, Reaction Kinetics, Oxford Science Publication, New York, 1998.
8. J. G. Calvert and J. N. Pitts, Jr., Photochemistry, John Wiley & Sons, New York, 1966.
9. R. P. Wayne, Principles and Applications of Photochemistry, Oxford University Press, Oxford, 1988.
10. M. Satake, S. A. Iqbal, Colloidal & Surface Chemistry, Discovery Publishing Pvt. Ltd, 2003.

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem	25
Assignment	05
Two Quiz	20
End Sem Examination Marks	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem	√	√			
Assignment	√	√	√		
Quiz -1	√				
Quiz II			√	√	
End Sem Examination Marks	√	√	√	√	√

Indirect Assessment –

1. **Student Feedback on Faculty**
2. **Student Feedback on Course Outcome**

Mapping between Objectives and Outcomes

Course Outcome #	Program Outcomes				
	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	M
CO2	H	H	M	L	H
CO3	H	H	H	M	H
CO4	H	H	L	M	H

Mapping Between COs and Course Delivery (CD) methods

CD	Course Delivery methods	Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4	CD1
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1, CD2
CD3	Seminars	CO 2, 3	CD3
CD4	Mini projects/Projects	CO3, 4	CD4
CD5	Laboratory experiments/teaching aids	CO 1, 2, 3	CD5
CD6	Self- learning such as use of NPTEL materials and internets	CO1, 2, 3, 4	CD6
CD7	Simulation	CO2, 4	CD7

Lecture wise Lesson planning Details.

Week No.	Lect. No.	Ch. No	Topics to be covered	Text Book / References	COs mapped	Methodology used
1-4	**L01-L09**	**1**	Kinetics and Reaction Dynamics	**T1, T2, R1, R2, R4**	**1**	**PPT DigiClass/ Chalk-Board**
5-6	**L10-L18**	**2**	Colloid and Interface Chemistry	**T1, T4, R1**	**2**	**-do-**
7-10	**L19-L27**	**3**	Approximation Methods in Quantum Chemistry	**T1, T4, R1, R2, R3**	**3**	**-do-**
11-13	**L28-L36**	**4**	Atomic Spectra and Atomic Structure	**T3, T5, R3**	**4**	**-do-**
14-15	**L37-L45**	**5**	Basic Concept of Symmetry & Group Theory	**T3, T5, R3**	**5**	**-do-**

Course code: CH 427
Course title: Advanced Organic Chemistry-II
Pre-requisite(s): Intermediate Level Chemistry
Co- requisite(s):
Credits: 4 L: 3 T: 1 P: 0
Class schedule per week: 04
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To understand the principle of protection and deprotection of alcohol, amine, carbonyl and carboxyl groups
B.	To understand the Organic Photochemistry
C.	To understand the Free Radical Reaction
D.	To understand the Neighboring Group Participation
E.	To understand the Organometallic reagents

Course Outcomes
After the completion of this course, students will be:

1.	Able to explain principle of protection and deprotection of alcohol, amine, carbonyl and carboxyl groups
2.	Able to explain Organic Photochemistry
3.	Able to explain Free Radical Reaction
4.	Able to explain various Neighboring Group Participation
5.	Able to explain Organometallic reagents

Module I: Protection and deprotection **(9 Lectures)**
Principle of protection and deprotection of alcohol, amine, carbonyl and carboxyl groups

Module II: Organic Photochemistry **(9 Lectures)**
Singlet and triplet excited state, radiative and non-radiative transitions, potential energy surfaces, photoreduction, photoaddition, photorearrangement, photooxidation, aromatic substitution, Norrish Type I, Norrish Type II, excimers and exciplexes, photochemistry of alkenes, carbonyl, aromatic compounds.

Module III: Free Radical Reaction **(9 Lectures)**
Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighboring group assistance, Reactivity for aliphatic and aromatic substrates, Reactivity in the attacking radicals, the effect of solvents on reactivity, Allylic halogenation, Oxidation of aldehydes to carboxylic acids, auto-oxidation, Sandmeyer reaction, free radical rearrangement, Hunsdiecker reaction.

Module IV: Neighboring Group Participation **(9 Lectures)**
Concept of neighboring group participation with mechanism, neighboring group participation by π & σ bonds, classical and non-classical carbocations, Intramolecular displacement by hydrogen, Oxygen, nitrogen, Sulphur and halogen. Anchimeric assistance using Alkyl, cycloalkyl, Aryl participation, participation in bicyclic system, migratory aptitude, intimate and solvent separated ion-pair, transannular, pinacol and carbocation rearrangements and related rearrangements in neighboring group participation, NGP in elimination and addition.

Module V: Organometallic reagents **(9 Lectures)**
Principle, preparations, properties and applications of the following reagents in organic synthesis with Mechanistic details: Zn , Cu, Pd, Ni, Fe, Co, Ru, Rh, Cr & Ti . Coupling reactions (Suzuki, Miyara, Stille, Heck, Negeshi, Sonagashira, Kumada) catalytic cycles, Roles of Sovent, catalyst, base, ligand in organic synthesis. Wilkinson, Grubs-1st, 2nd generation catalyst, TON, TOF.

Text books:

1. I. L. Finar, Organic Chemistry, Vol. I and II, 5th ed., Longman Ltd., New Delhi, 2011.
2. P. Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th ed., John Wiley & Sons, New York, 1985.
3. T. W. G. Solomons, Fundamentals of Organic Chemistry, 4th ed., John Wiley, 1994.
4. R. N. Morrison & R. N. Boyd, Organic Chemistry, 7th ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 2010.

Reference books:

1. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, 2nd ed., Oxford Press, 2012,
2. J. March, Organic reaction and mechanism-structure and reactivity, 7th ed., John Wiley, 2015.
3. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure and Mechanisms, Springer, New York, 2006.

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem	**25**
Assignment	**05**
Two Quiz	**20**
End Sem Examination Marks	**50**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem	√	√			
Assignment	√	√	√		
Quiz -1	√				
Quiz II			√	√	

End Sem Examination Marks	√	√	√	√	√

Indirect Assessment –

1. **Student Feedback on Faculty**
2. **Student Feedback on Course Outcome**

Mapping between Objectives and Outcomes

Course Outcome #	Program Outcomes				
	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	M
CO2	H	H	M	L	H
CO3	H	H	H	M	H
CO4	H	H	L	M	H

Mapping Between COs and Course Delivery (CD) methods

CD	Course Delivery methods	Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4	CD1
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1,CD2
CD3	Seminars	CO 2, 3	CD3
CD4	Mini projects/Projects	CO3, 4	CD4
CD5	Laboratory experiments/teaching aids	CO 1, 2, 3	CD5
CD6	Self- learning such as use of NPTEL materials and internets	CO1, 2, 3, 4	CD6
CD7	Simulation	CO2, 4	CD7

Lecture wise Lesson planning Details.

Week No.	Lect. No.	Ch. No	Topics to be covered	Text Book / References	COs mapped	Methodology used

1-4	**L01-L09**	**1**	Protection deprotection	**T1, T2, R1, R2, R4**	**1**	**PPT Digi Class/Chalk -Board**
5-6	**L10-L18**	**2**	Organic photochemistry	**T1, T4, R1**	**2**	**-do-**
7-10	**L25 -L40**	**3**	Free radical reactions	**T1, T4, R1, R2, R3**	**3**	**-do-**
11-13	**L41-L52**	**4**	Neighboring group participation	**T3, T5, R3**	**4**	**-do-**
14-15	**L53-L60**	**5**	Organometallic regents	**T3, T5, R3**	**5**	**-do-**

Course Code and Name: CH428 (Advanced Inorganic Chemistry-II);
Credits: 4 L: 3 T: 1 P: 0
Pre-requisite(s): Intermediate Level Chemistry; Co- requisite(s):
Class schedule per week: 04;
Class: B. Sc.
Level: I;
Branch: Chemistry

Course Objectives
This course enables the students:

A.	To understand how the thermal energy affect the magnetochemistry
B.	To develop knowledge on the anomalous magnetic moment in coordination complexes
C.	To create concept of Inorganic Rings, Cages and clusters
D.	To understand the reactivity of organometallic complexes
E.	To study different types of organometallic catalytic reactions

Course Outcomes
After the completion of this course, students will be:

1.	Able to explain the changes in magnetic properties on changing temperature
2.	Able to predict the anomalous magnetic moment in coordination complexes
3.	Able to explain the structure and properties of inorganic Rings, Cages and Clusters
4.	Able to predict organometallic reactions.
5.	To draw the catalytic cycle and explain the organometallic reactions

Syllabus

Module I: Thermal energy and magnetic properties **(9 Lectures)**
Spin & Orbital effects, Spin orbit coupling, Lande interval rule, Energies of J levels, Multiplet width and temperature; Curie equation, Curie & Curie–Weiss law, 2nd order Zeeman Effect, Temperature independent paramagnetism, Van Vleck susceptibility equation, Thermal Equilibrium between High Spin and Low spin state in Spin Cross over region, Magnetic behavior of lanthanides & actinides, Anomalous magnetic moments, magnetic properties of binuclear and polynuclear complexes— ferromagnetism and anti-ferromagnetism.

Module II: Anomalous Magnetic Moments in Coordination Complexes **(9 Lectures)**
Superexchange interaction in terms of Goodenough-Kanamori-Anderson Rules (GKA Rules), Interpretation of magnetic exchange by GKA Rule in terms of Molecular Orbital Theory, Antiferromagnetism in magnetically concentrated system, Cooperative magnetic interactions in binuclear Cu(II) complexes, Antiferromagnetic coupling in other metal complexes: Dimers of oxidovanadium(IV) and oxidomolybdenum(V) complexes, Dinuclear complexes of Ti(III), Dimeric Cr(II) acetate- monohydrate, Mn2(CO)10

Module III: Inorganic Rings, Cages and clusters **(9 Lectures)**
Rings: Homocyclic rings of S, Se and Te. Heterocyclic rings of S, N, P and O;
Cages: Higher boron hydrides: structures and reactions, equation of balance, Lipscomb topological diagrams, polyhedral skeletal electron pair theory (PSEPT), carboranes, metalloboranes and heteroboranes, metallocarboranes.
Clusters: Classification, Low nuclearity (M3 – M4) and high nuclearity cluster (M5 – M10), Metal-metal bonding (MOT), Carbonyl clusters, skeletal electron counting, Wade-Mingos-Luber rule, application of isolobal and isoelectronic analogy, capping rules, Zintl ions, chevrel compounds, infinite metal chains, application of cluster compounds in catalysis.

Module IV: Reactivity of Organometallic Complexes **(9 Lectures)**
Oxidative Addition and Reductive Elimination: Concerted Additions, SN2 Reactions, Radical Mechanisms, Ionic Mechanisms, σ-Bond Metathesis, Oxidative Coupling and Reductive Cleavage.
Insertion and Elimination Reactions Involving CO and Alkenes, Other Insertions, α, β, γ, and δ Elimination. Mechanism, Type and commercial application of Alkene Metathesis and C-H activation

Module V: Catalysis by Organometallic Compounds **(9 Lectures)**

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinsons Catalyst)
2. Hydroformylation (Co salts)
3. Wacker Process
4. Synthetic gasoline (Fischer Tropsch reaction)
5. Olefin Polymerisation (Ziegler–Natta Catalyst)
6. Monsanto acetic acid process

Text books:

1. F. A. Cotton, G. Willkinson, Advanced Inorganic Chemistry, Wiley, 6th ed., 2007.
2. J. E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 4th ed. 2006.
3. R. L. Dutta, A. Syamal, Elements of Magnetochemistry, East-West Press, 1993.
4. A. K. Das, M. Das, Fundamental Concepts of Inorganic Chemistry; Volume-6; CBS Publishers, 2012.
5. R. H. Crabtree, The Organometallic Chemistry of the Transition Metals, Wiley-Interscience; 4th ed., 2005.

Reference books:

1. G. Wilkinson, R. D. Gillars & J. A. Mccleverty, Comprehensive Co-ordination Chemistry, 2nd ed., Elsvier, 2003.
2. J. D. Lee, Concise Inorganic Chemistry, 5th ed., Oxford, 2008.
3. F. E. Mabbs and D. J. Machin, Magnetism and Transition Metal complexes, Dover Publications; 2008.
4. N. N. Greenwood and E. A. Earnshaw; Chemistry of elements, 2nd ed., Butterworth- Heinemann, 1997.
5. B- M. Bochmann, Organometallic Chemistry: (Oxford series), 1994.
6. R. C. Mehrotra & A. Singh, Organometallic Chemistry, New Age Int. Publishers, 2nd ed., 1991.
7. M. Gielen, R. Willem, B. Wrackmeyer, Fluxanol Organometallic and Coordination compounds, Wiley, 1st ed., 2008.
8. F. A. Cotton, G. Willkinson, Advanced Inorganic Chemistry,Wiley, 6th ed., 2007.
9. J. E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 4th ed. 2006.

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem	**25**

Assignment	**05**
Two Quiz	**20**
End Sem Examination Marks	**50**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Sem	√	√			
Assignment	√	√	√		
Quiz -1	√				
Quiz II			√	√	
End Sem Examination Marks	√	√	√	√	√

Indirect Assessment –

1. **Student Feedback on Faculty**
2. **Student Feedback on Course Outcome**

<u>Mapping between Objectives and Outcomes</u>

Course Outcome #	**Program Outcomes**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**H**	**H**	**L**	**L**	**M**
CO2	**H**	**H**	**M**	**L**	**H**
CO3	**H**	**H**	**H**	**M**	**H**
CO4	**H**	**H**	**L**	**M**	**H**

Mapping Between COs and Course Delivery (CD) methods

CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4	CD1
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1,CD2

CD3	Seminars	CO 2, 3	CD3
CD4	Mini projects/Projects	CO3, 4	CD4
CD5	Laboratory experiments/teaching aids	CO 1, 2, 3	CD5
CD6	Self- learning such as use of NPTEL materials and internets	CO1, 2, 3, 4	CD6
CD7	Simulation	CO2, 4	CD7

Lecture wise Lesson planning Details.

Week No.	Lect. No.	Ch. No	Topics to be covered	Text Book / References	COs mapped	Methodology used
1-4	**L01-L09**	**1**	Thermal energy and magnetic properties	**T1, T2, R1, R2, R4**	**1**	**PPT Digi Class/Chalk -Board**
5-6	**L10-L18**	**2**	Anomalous Magnetic Moments in Coordination Complexes	**T1, T4, R1**	**2**	**-do-**
7-10	**L25 -L40**	**3**	Inorganic Rings, Cages and clusters	**T1, T4, R1, R2, R3**	**3**	**-do-**
11-13	**L41-L52**	**4**	Reactivity of Organometallic Complexes	**T3, T5, R3**	**4**	**-do-**
14-15	**L53-L60**	**5**	Catalysis by Organometallic Compounds	**T3, T5, R3**	**5**	**-do-**