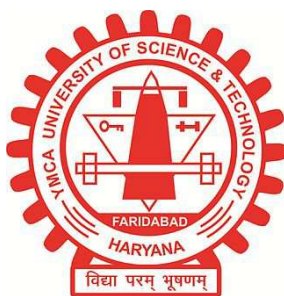


**DEPARTMENT OF  
HUMANITIES AND SCIENCES**

**M.Sc. (CHEMISTRY)  
ACADEMIC SESSION 2017-2018**



**YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY**



## **YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY**

### **VISION**

YMCA University of Science and Technology aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres which transforms the life of students through integration of teaching, research and character building.

### **MISSION**

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the art technological exposure to its scholars.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities



## **HUMANITIES AND SCIENCES DEPARTMENT**

### **VISION**

A department that can effectively harness its multidisciplinary strengths to create an academically stimulating atmosphere; evolving into a well-integrated system that synergizes the efforts of its competent faculty towards imparting intellectual confidence that aids comprehension and complements the spirit of inquiry.

### **MISSION**

- To create well-rounded individuals ready to comprehend scientific and technical challenges offered in the area of specialization.
- To counsel the students so that the roadmap becomes clearer to them and they have the zest to turn the blueprint of their careers into a material reality.
- To encourage critical thinking and develop their research acumen by aiding the nascent spirit for scientific exploration.
- Help them take economic, social, legal and political considerations when visualizing the role of technology in improving quality of life.
- To infuse intellectual audacity that makes them take bold initiatives to venture into alternative methods and modes to achieve technological breakthroughs.

## **M.Sc. Chemistry**

Chemistry is a fundamental science and has contributed immensely to the improvement of the life of human beings by providing many of human requirements and essentialities. The developments in Chemistry during last few decades are phenomenal. New branches of chemistry are emerging and gaining importance, such as bioorganic chemistry, materials chemistry, computational chemistry, etc. The practice of Chemistry at industrial scale also is undergoing radical changes and is more or more based on deep understanding the chemical phenomena. The emerging Chemical Technologies are highly science based. The aid of computers has not only accelerated growth in the practice of Chemistry, but revolutionized the entire field. A Chemist cannot isolate himself from other disciplines. Thus, after a long span of more and more specialization in graduate and post-graduate syllabi, a symbiotic interdisciplinary approach now seems to be more relevant.

### **PROGRAM EDUCATIONAL OBJECTIVES**

- To impart training in Chemistry at advanced level in a more wholistic way and enthuse the students for the subject;
- To make students confident and capable of accepting any challenge in Chemistry,
- To give a flavour of research in Chemistry and train the students for research career,
- To abreast the students about the current status and new developments in Chemistry,
- To make the students aware of the impact of Chemistry on environment and imbibe the concept of sustainable developments,
- To educate the students with respect to skills and knowledge to practice chemistry in ways that are benign to health and environment,
- To provide flexibility in selecting some of the courses as per the interest and also to provide space for fast learners,
- To make the students aware of resources and make them capable of mining the data.

### **PROGRAM OUTCOMES**

After the successful completion of the course, the student would:

- Have fundamental knowledge of Chemistry.
- Develop global outlook possessing state of the art skills.
- Become capable of taking challenging responsibilities in the field of research in Chemical Sciences.

**YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD  
DEPARTMENT OF HUMANITIES AND SCIENCES**

**SCHEME OF M. Sc. CHEMISTRY**

**SEMESTER I**

Subject Code	Title	Teaching Hours per week			Maximum Marks			Credits	Category Code
		L	T	P	Sessional Marks	End-semester Examination	Total Marks		
CH-101A	Inorganic Chemistry (General-I)	4			25	75	100	4	DCC
CH-102A	Organic Chemistry (General-I)	4			25	75	100	4	DCC
CH-103A	Physical Chemistry (General-I)	4			25	75	100	4	DCC
CH-104A-X*	Mathematics for Chemists	3			25	75	100	3	FC
CH-104A-Y*	Chemistry of life processes	3			25	75	100	3	FC
CH-105A	Inorganic Chemistry Lab-I			6	30	70	100	3	DCC
CH-106A	Organic Chemistry Lab-I			6	30	70	100	3	DCC
CH-107A	Physical Chemistry Lab-I			6	30	70	100	3	DCC
XXX	MOOC**								
					<b>Total</b>		<b>700</b>	<b>24</b>	

DCC – Discipline Core Course; FC – Foundation Course; MOOC – Massive Open Online Course

L – Lecture; T - Tutorial; P - Practical

\*Candidates with Biology background will appear for CH-104 A-X\* and Candidates with Mathematical background will appear for CH-104A-Y\*

\*\*The students have to pass at least one mandatory MOOC course with 4-6 credits (12-16 weeks) from the list given on the Swayam portal or the list given by the department/ university from 1<sup>st</sup> semester to 3<sup>rd</sup> semester as notified by the university.

### **Instructions to the students regarding MOOC**

1. Two types of courses will be circulated: branch specific and general courses from the website <https://swayam.gov.in> in the month of June and November every year for the forthcoming semester.
2. The department coordinators will be the course coordinators of their respective departments.
3. Every student has to pass a selected MOOC course within the duration as specified below:

<b>Programme</b>	<b>Duration</b>
B. Tech.	Sem. I to Sem. VII
M.Sc./M.Tech./MA/MBA	Sem. I to Sem. III
B.Sc./MCA	Sem. I to Sem. V

The passing of a MOOC course is mandatory for the fulfilment of the award of the degree of concerned programme.

4. A student has to register for the course for which he is interested and eligible which is approved by the department with the help of course coordinator of the concerned department.
5. A student may register in the MOOC course of any programme. However, a UG student will register only in UG MOOC courses and a PG student will register in only PG MOOC courses.
6. The students must read all the instructions for the selected course on the website, get updated with all key dates of the concerned course and must inform his/her progress to their course coordinator.
7. The student has to pass the exam (online or pen-paper mode as the case may be) with at least 40% marks.
8. The students should note that there will be a weightage of Assessment/quiz etc. and final examination appropriately as mentioned in the instructions for a particular course.
9. A student must claim the credits earned in the MOOC course in his/her marksheet in the examination branch by forwarding his/her application through course coordinator and chairperson.

**YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD  
DEPARTMENT OF HUMANITIES AND SCIENCES**

**SCHEME OF M. Sc. CHEMISTRY**

**SEMESTER II**

Subject Code	Title	Teaching Hours per week			Maximum Marks			Credits	Category Code
		L	T	P	Internal Assessment	End-semester Examination	Total Marks		
CH-201A	Inorganic Chemistry (General-II)	4			25	75	100	4	DCC
CH-202A	Organic Chemistry (General-II)	4			25	75	100	4	DCC
CH-203A	Physical Chemistry (General-II)	4			25	75	100	4	DCC
CH-204A	Computational Techniques	3			25	75	100	3	FC
CH-205A	Inorganic Chemistry Lab-II			6	30	70	100	3	DCC
CH-206A	Organic Chemistry Lab-II			6	30	70	100	3	DCC
CH-207A	Physical Chemistry Lab-II			6	30	70	100	3	DCC
XXX	Audit Course*	2	0	0	40	60	100	0	AUD
<b>Total</b>							<b>700</b>	<b>24</b>	

DCC – Discipline Core Course; FC – Foundation Course ; AUD-Audit Course

L – Lecture; T - Tutorial; P - Practical

\*The students have to choose one Audit course from the list provided by the department/university. Only passing of the Audit course is mandatory.

**YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD  
DEPARTMENT OF HUMANITIES AND SCIENCES**

**SCHEME OF M. Sc. CHEMISTRY**

**SEMESTER III**

Subject Code	Title	Teaching Hours per week			Maximum Marks			Credits	Category Code	
		L	T	P	Internal Assessment	End-semester Examination	Total			
CH-301A	Spectroscopy-I	4			25	75	100	4	DCC	
CH-302A	Spectroscopy-II	4			25	75	100	4	DCC	
CH-303A	Analytical Techniques	4			25	75	100	4	DCC	
CH-304/314/324A	Inorganic / Organic / Physical Chemistry Lab-Special-I			6	30	70	100	3	DEC	
CH-305/315/325A	Inorganic / Organic / Physical Chemistry Lab -Special-II			6	30	70	100	3	DEC	
CH-306/316/326A	Inorganic / Organic / Physical Chemistry Lab -Special-III			6	30	70	100	3	DEC	
XXX	Open Elective Course*	3			25	75	100	3	OEC	
							<b>Total</b>	<b>700</b>	<b>24</b>	

DCC – Discipline Core Course; DEC – Discipline Elective Course; OEC – Open Elective Course  
L – Lecture; T - Tutorial; P - Practical

\* The students have to choose one open elective course related to other branch of Science/ Engg./ other discipline offered by other departments within the same faculty required for enhancing professional performance as provided by the department/ university.



**YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD  
DEPARTMENT OF HUMANITIES AND SCIENCES**

**SCHEME OF M. Sc. CHEMISTRY**

**SEMESTER IV**

Subject Code	Title	Teaching Hours per week			Maximum Marks			Credits	Category Code	
		L	T	P	Internal Assessment	End-semester Examination	Total			
CH-401/411/421A	Inorganic / Organic / Physical Chemistry Special-I	4			25	75	100	4	DEC	
CH-402/412/422A	Inorganic / Organic / Physical Chemistry Special-II	4			25	75	100	4	DEC	
CH-403/413/423A	Inorganic / Organic / Physical Chemistry Special-III	4			25	75	100	4	DEC	
CH-404/414/424A	Inorganic / Organic / Physical Chemistry Special-IV	4			25	75	100	4	DEC	
CH-431A	Project			16	50	150	200	8	DCC	
							<b>Total</b>	<b>600</b>	<b>24</b>	

DCC – Discipline Core Course; DEC – Discipline Elective Course

L – Lecture; T - Tutorial; P - Practical

**YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD**  
**DEPARTMENT OF HUMANITIES AND SCIENCES**

The Audit course and Open elective courses offered by PG Department in Chemistry:

Course	Subject	Subject Code
Audit Course	1. Green Chemistry	ACH-204A
Open Elective Course	1. Chemistry for sustainable development	OCH-307A
	2. Applied Chemistry	OCH-308A

**M Sc CHEMISTRY, SEMESTER I**

**CODE: CH-101A**

**SUBJECT NAME: Inorganic Chemistry (General-I)**

**NO OF CREDITS: 4**

L	P	SESSIONAL:	25
4	0	THEORY EXAM:	75
		TOTAL:	100

**Course Objectives:** To learn about the group theory and VSEPR theory, concepts of coordination Chemistry, stability of the complexes and stereochemistry of complexes. To study about structure and bonding in coordination compounds.

**UNIT: I**

**Symmetry and Group Theory in Chemistry**

Definitions of group, subgroup, relation between orders of a finite group and its subgroup. Conjugacy relation and classes. Symmetry elements and symmetry operation, Point symmetry group. Schönflies symbols, representations of groups by matrices (representation for the  $C_n$ ,  $C_n v$ ,  $C_n h$ ,  $D_n h$  etc. groups to be worked out explicitly). Character of a representation, reducible and irreducible representations, The great orthogonality theorem (without proof) and its importance, Derivation of character tables of  $C_{2v}$ ,  $C_{3v}$  and  $D_{2h}$  Character tables and their use. Molecular asymmetry, dissymmetry and optical activity.

**UNIT: II**

**Stereochemistry and Bonding in Main Group compounds:** VSEPR theory,  $d\pi - p\pi$  bonds, Bent rule and energetic of hybridization. Huckel theory with reference to ethylene and butadiene. Some simple substitution reactions of covalently bonded molecules of boron, silicon and nitrogen.

**UNIT: III**

**Metal-Ligand Equilibria in solution**

Stepwise and overall formation constants and their interactions, trends in stepwise constants, factors affecting stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry. Substitution reactions in octahedral complexes, theories of trans effect with respect to Pt(II) complexes, brief account of electron transfer reactions, inert and labile complexes.

**UNIT: IV**

**Metal-Ligand Bonding**

Limitation of crystal field theory, crystal field effects, Jahn Teller distortion, nephelauxetic series, spin-orbital coupling, molecular orbital theory of octahedral, tetrahedral and square planar complexes (with and without  $\pi$ -bonding).

**Course Outcomes:**

After the successful completion of the course the learner would be able to

- i. understand the bonding concepts involved in Coordination compounds
- ii. and can utilize this knowledge for complex formation of research interest.

**Referenc Books**

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harper & Row.
3. Chemical Applications of Group Theory; F.A. Cotton, Wiley, New York.
4. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
5. The Chemical bond; J.N.Murrell, SFA Kettle and J.M. Tedder; Wiley, New York.
6. Modern Aspects of Inorganic Chemistry; H.J. Emeléus and Sharpe.
7. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J.J.Alexander; John Wiley and Sons.
8. Inorganic Chemistry, A Modern Introduction; T Moeller, John Wiley and Sons.

**M Sc CHEMISTRY, SEMESTER I**

**CODE: CH-102A**

**SUBJECT NAME: Organic Chemistry (General-I)**

**NO OF CREDITS: 4**

L	P	SESSIONAL:	25
4	0	THEORY EXAM:	75
		TOTAL:	100

**Course Objectives:**

To understand the bonding, basics of reaction mechanism, reaction intermediates and mechanism of nucleophilic substitution reactions. To learn the concepts of stereochemistry, conformational analysis and their Application in the determination of reaction mechanism.

**UNIT: I**

**Nature of Bonding in Organic molecules:** Delocalized chemical bonding –conjugation, cross conjugation, resonance, hyperconjugation, tautomerism. Aromaticity in benzenoid and non-benzenoid compounds, alternante and non-alternante hydrocarbons, Huckel's rule,

**Reaction Mechanism: Structure and Reactivity:** Types of mechanisms, types of reactions, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Effect of structure on reactivity. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft equation. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Hard and soft acids and bases. Generation, structure, stability and reactivity of carbocations, carbanions, carbenes and nitrenes.

**UNIT: II**

**Aliphatic Nucleophilic Substitution:** The SN2, SN1, mixed SN1 and SN2, SNi, SN1', SN2', SNI' and SET mechanisms. Reactivity- effects of substrate structure, attacking nucleophile, leaving group and reaction medium. Ambident nucleophile, regioselectivity. The neighbouring group mechanisms, neighbouring group participation by n electrons,  $\pi$  and  $\sigma$  bonds, anchimeric assistance. Classical and nonclassical carbocations, phenonium ions, common carbocation rearrangements.

**UNIT: III**

**Stereochemistry-I:** Symmetry elements, D-L, R-S, E-Z and threo-erythro nomenclature, interconversion of Fischer, Newman, Sawhorse and flying wedge formulae. conformational analysis, enantiomerism and diastereomerism of simple, cyclic (chair and boat configuration) and acyclic systems. Axial and planer chirality, optical somerism in allenes, biphenyls (atropoisomerism), spiranes, hemispiranes. elementary ideas about stereochemistry o f tertiary amines, quaternary salts, sulphur and phosphorous compounds.

#### **UNIT: IV**

**Stereochemistry – II:** Topicity of ligands and faces, their nomenclature and prostereoisomerism, stereogeneity, chirogenicity, pseudoasymmetry and prochiral centre. stereospecific and stereoselective reaction.

Elementary idea of principle categories of asymmetric synthesis, Cram's rule and its modification, Prelog rule and horeaus rule.

**Stereochemistry of sugars-** C<sub>1</sub> and 1C conformations of hexoses, c<sub>2</sub>'-endo and c<sub>3</sub>'-endo conformation of pentoses, homomorphous sugars, abnormal mutarotation and Δ-2 instability factor. Stereochemistry of decalins,

Chemical correlation of configuration -determination of relative configuration of 2-butanol, isoserine, alanine, malic acid, lactic acid and mandelic acid.

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i. understand the principles involved in an organic reaction
- ii. and their relation with stereochemistry of compounds.

#### **Reference Books:**

1. Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice -Hall.
6. Modern Synthetic Reactions, H. O. House, Benjamin.
7. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional.
8. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.
9. Organic Chemistry, J. Clayden, N. Greeves, S. Warren, P. Wothers, Oxford Press.

**M Sc CHEMISTRY, SEMESTER I**

**CODE: CH-103A**

**SUBJECT NAME: Physical Chemistry (General-I)**

**NO OF CREDITS: 4**

L	P	SESSIONAL:	25
4	0	THEORY EXAM:	75
		TOTAL:	100

**Course Objectives:**

To study the thermodynamic properties associated with chemical processes and partial molar quantities. To understand theories and basic concepts of Chemical kinetics, ion-ion interactions and catalysis reactions.

**UNIT: I**

**Thermodynamics:** Brief recapitulation of first and second Law of thermodynamics. Entropy changes in reversible and irreversible processes; variation of entropy with temperature, pressure and volume, entropy concept as a measure of unavailable energy and criteria for the spontaneity of reaction; free energy functions and their significance, criteria for spontaneity of a process; partial molar quantities (free energy, volume, heat concept), Gibb's-Duhem equation.

**UNIT: II**

**Chemical Kinetics:** Collision theory of reaction rates, the steric requirement, Arrhenius equation and activated complex theory (ACT), comparison of collision and activation complex theory, Potential energy surfaces (Only basic Idea), thermodynamic formulation of activated complex theory, chain reactions (hydrogen-halogen reaction), unimolecular reactions, Lindemann – Hinshelwood mechanism of unimolecular reactions.

**UNIT: III**

**Electrochemistry: Ion - Ion Interactions:** The Debye -Huckel theory of ion- ion interactions: potential and excess charge density as a function of distance from the central ion, Debye Huckel reciprocal length, ionic cloud and its contribution to the total potential, Debye – Huckel limiting law of activity coefficients and its limitations, ion - size effect on potential, ion - size parameter and the theoretical mean - activity coefficient in the case of ionic clouds with finite - sized ions. Debye - Huckel -Onsager treatment for aqueous solutions and its limitations Debye- Huckel-Onsager theory for non-aqueous solutions,

**UNIT: IV**

**Surface Chemistry and Catalysis:** Gibbs adsorption equation, Langmuir adsorption isotherm and its kinetic derivation for non- dissociative and dissociative adsorption, BET adsorption

isotherm, its kinetic derivation and applications. Study of surfaces by SEM & TEM (brief idea). Heterogeneous catalysis, surface heterogeneity, surface catalyzed unimolecular and bimolecular reactions, temporary and permanent catalytic poisons, activation energy for surface reactions. Comparison of homogeneous and heterogeneous reaction rates.

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i. Handle the thermodynamics of a chemical process.
- ii. Understand the rate of a reaction and its associated kinetics which help in designing a new reaction.
- iii. Solve the peculiar behaviour of ions based on electrochemistry
- iv. Explore surface characteristics of compounds.

### **Reference Books**

1. An Introduction to Chemical Thermodynamics, R.P. Rastogi and R.R. Misra, Vikas Pub.
2. Physical Chemistry, P.W. Atkins, Oxford University Press.
3. Thermodynamics for Chemists, S. Glasstone, Affiliated East -West Press.
4. Thermodynamics, I.M. Klotz and R.M. Rosenbers, Benzamin.
5. Chemical Kinetics, K.J. Laidler, McGraw Hill.
6. Kinetics and Mechanism, A. A. Frost and R.G. Pearson, John Wiley and Sons.
7. Electrochemistry, S. Glasstone, Affiliated East -West Press.
8. Physical Chemistry, G.W. Castellan, Narosa.
9. Heterogeneous Catalysis: Fundamentals and Applications, Julian R.H. Ross, Wiley-VCH; 2nd, Revised and Enlarged Edition, edition (October 1, 2007)
10. Concepts of Modern Catalysis and Kinetics, I. Chorkendorff and J. W. Niemantsverdriet



**M Sc CHEMISTRY, SEMESTER I**

**CODE: CH-104A-X**

**SUBJECT NAME: Mathematics for Chemists**

**NO OF CREDITS: 3**

L	P	SESSIONAL:	25
3	0	THEORY EXAM:	75
		TOTAL:	100

**Course Objectives:** To impart knowledge of basic mathematics, which is necessary for a chemist.

**UNIT: I**

**Vectors:** Examples of scalar and vectors, definitions of vectors in two, three spaces, representation and simple properties of vectors, addition and subtraction of vectors, vector addition by the method of triangles, resolution of vectors into rectangular components, addition of vectors by components, multiplication and differentiation of vectors. Scalar product of vectors, vector product

**Matrices and Determinants:** Definition of matrix, types of matrices, viz. row matrix, column matrix, null matrix, square matrix, diagonal matrix, addition, subtraction and multiplication by a number, matrix multiplication. Transpose and adjoint of matrix, elementary transformation, representation and applications (without development of theory) to solution of linear equations. Definition, properties and evaluation of determinants.

**UNIT: II**

**Logarithm:** definition of logarithm, common logarithms, natural logarithms, laws of logarithm, expressing the logarithm of a number, simplifying expressions using laws of logarithm, change of base, calculating antilogs.

**Graphical Representation of Equations:** Rectangular coordinates, straight lines, slope and intercept of the equation, slope and point equation, two point equation, parallel lines, points of intersection, distance between two points, change of origin. Curve fitting for least squares method.

**Differential Calculus:** Theory, rules of differentiation, powers, added and subtracted functions, constants, products, quotients, functions of a function, logarithmic differentiation, and parametric functions. Algebraic simplification, differentiation of implicit functions, graphical significance of differentiation, rate of change of slope, successive differentiation.

**UNIT: III**

**Partial Differentiation:** The fundamental theorem, geometrical significance of partial differentiation, special cases of fundamental theorem, successive partial differentiation. Integral

transforms (Fourier and Laplace). Reduction formulae. Methods of Lagrangian multipliers, Sterling's approximation, probability and errors.

**Integral Calculus:** Integral theory, rules of integration between limits, significance of 'e' exponential equations, methods of integration, viz. algebraic simplifications, substitution, integration by parts, integration by partial fractions, coordinate transformation (e.g., cartesian to spherical polar), curve sketching, integral as area

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i. solve numerical problems of chemistry.
- ii. explain derivations of theories and principles.
- iii. handle concepts of computational chemistry and modelling.

### **Reference Books**

1. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill.
2. Mathematical Preparation for General Physics, J.B. Marian, R.C. Davidson Saunder Company.
3. Mathematical Methods for Science Students, G. Stephemen, ELBS.
4. Chemical Thermodynamics, R.C. Reid.

**M Sc CHEMISTRY, SEMESTER I**

**CODE: CH-104A-Y**

**SUBJECT NAME: Chemistry of Life Processes**

**NO OF CREDITS: 3**

L    P  
3    0

SESSIONAL:        25  
THEORY EXAM:    75  
TOTAL:             100

**Course Objectives:**

To introduce the basic chemistry of life processes and compounds of life. To understand the chemistry behind genetics.

**UNIT: I**

**Introduction to metabolic processes:** Catabolism and anabolism, ATP, currency of biological energy, energy rich and energy poor phosphates, role of NADH, NADPH, FADH<sub>2</sub>, TPP, coenzyme A, lipoic acid and biotin.

Introduction to photosynthesis.

**UNIT: II**

**Lipids:** Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Lipoproteins - composition and function, role in atherosclerosis

Lipid metabolism -  $\beta$ -oxidation of fatty acids.

**Proteins:** Primary, secondary, tertiary and quaternary structures, enzymes, active sites, allosteric sites and mechanism of their action, e.g. Chymotrypsin

**UNIT: III**

**Nucleic Acids and Genetic Code:** Structure of nucleotides, nucleosides, DNA (Watson-Crick mode I) RNA structure and conformation, Replication of DNA (semi-conservative, conservative and dispersive replication Meselson-Stahl experiment) , transcription, translation of genetic material, genetic code, universality of the code, codon, anticodon pairing, RNA.

**Course Outcomes:** After the successful completion of the course the learner would be able to

- Understand the metabolism and energy cycle of living beings.
- Correlate the metabolism of a body and chemical reactions responsible for it.
- Predict biochemistry of any metabolism
- Solve problems of genetic engineering.

**Reference Books**

1. Principles of Biochemistry, A. L. Lehninger, Worth Publishers.
2. Biochemistry, L.Stryer, W.H.Freeman.
3. Biochemistry, J. David Rawn, Neil Patterson.
4. Biochemistry, Voet and Voet, John Wiley.
5. Outlines of Biochemistry, E. E.Conn and P. K. Stumpf, John Wiley.

**M Sc CHEMISTRY, SEMESTER I**

**CODE: CH-105A**

**SUBJECT NAME: Inorganic Chemistry Lab-I**

**NO OF CREDITS: 3**

L	P	SESSIONAL:	30
0	6	FINAL EXAM:	70
		TOTAL:	100

**Course Objectives:**

To analyse a given mixture of salts qualitatively in laboratory.

**Qualitative Analysis:**

Less common metal ions- W,Tl,Mo,Se,Ti,Zr,Th,V,U,Ce ,Be.(two metal ions in cationic/anionic forms)

Insolubles- Oxides( $\text{Al}_2\text{O}_3$  , $\text{Cr}_2\text{O}_3$ , $\text{SnO}_2$  ,  $\text{TiO}_2$  ,  $\text{SiO}_2$   $\text{WO}_3$ ,); Sulphates( Lead Sulphate, Barium Sulphate Strontium Sulphate and Calcium Sulphate); Halides(Calcium fluoride and silver halides)

(2 less common metal ions and 1 insoluble to be given)

**Experiment: 45 marks**

**Lab Record: 15 marks**

**Viva-voce: 10 marks**

**Course Outcomes:** After the successful completion of the course the learner would be able to

- identify a given mixture of inorganic salts qualitatively by experiments.
- to learn comprehensive laboratory techniques

**Reference Books**

1. A Text Book of Macro and Semi-micro Quantitative Analysis, A.I.Vogel, Orient Longman.
2. A Vogel's Text Book of Quantitative Inorganic Analysis , J. Bassett, R.C. Denney, G.B. Jaffery and J. Menaham, Longman, London.
3. Synthesis and Characterization of Inorganic Compounds, W.B. Jolly, Prentice Hall, Englewood.
4. Synthesis and Physical Studies of Inorganic Compounds, C.F. Bell, Pergamon Press
5. Inorganic Preparations; W.G. Palmer.

**M Sc CHEMISTRY, SEMESTER I**

**CODE: CH-106A**

**SUBJECT NAME: Organic Chemistry Lab-I**

**NO OF CREDITS: 3**

L	P	SESSIONAL:	30
0	6	FINAL EXAM:	70
		TOTAL:	100

**Course Objectives:**

To analyse a given mixture of compounds qualitatively in laboratory. To synthesise various organic compounds in laboratory

**Experiments**

- Qualitative analysis of mono and bifunctional compounds.
- Synthesis of organic compounds involving some of the following reactions: acylation reaction, Oxidation and reductions, Coupling reactions, Diels-Alder reaction, Nucleophilic substitution reaction, Condensation reaction, Diazotization reactions.

**Experiment: 45 marks**

**Lab Record: 15 marks**

**Viva-voce: 10 marks**

**Course Outcomes:** After the successful completion of the course the learner would be able to

- analyse a given mixture of compounds qualitatively by experiments
- synthesise various organic compounds.
- propose different synthetic routes for a compound.

**Reference Books**

1. A Hand book of Organic Analysis -Qualitative and Quantitative by H.T. Clarke, and revised by B.Haynee, Edward Arnold, London 1975.
2. Vogel's Text Book of Practical Organic Chemistry by B.S. Furhen et. al, Longman-Group Ltd.
3. Systematic Qualitative Organic Analysis by H. Middleton, Edward Arnold (Publishers) Limited, London 1959.
4. Elementary Practical Organic Chemistry by Arthur I. Vogel, Ex CBS Publishers and Distributors.

5. Experiments in Organic Chemistry by Louis, F.Fieser, D.C. Heath and Company Boston, 1955.

## M Sc CHEMISTRY, SEMESTER I

CODE: CH-107A

SUBJECT NAME: Physical Chemistry Lab-I

NO OF CREDITS: 3

L	P	SESSIONAL:	30
0	6	FINAL EXAM:	70
		TOTAL:	100

### Course Objectives:

To determine the strength of given acid / base by conductometric titration. To determine the strength of given acid / base by pH-metric titration. To study the chemical kinetics of some simple reactions. To determine the viscosity of liquids and variation of viscosity. To determine molar mass of a polymer.

### EXPERIMENTS

#### 1. Conductometry

- Determine the strength of strong acid by conductometric titration with strong base.
- Determine the strength of weak acid by conductometric titration with strong base.
- Determine the strength of strong acid and weak acid in a mixture by conductometric titration with strong base.
- Study precipitation titration between KCl and AgNO<sub>3</sub> conductometrically.
- Determine the basicity of mono-, di- and tri-basic acids conductometrically.
- Determine solubility and solubility product of sparingly soluble salts like PbSO<sub>4</sub>, BaSO<sub>4</sub>.

#### 2. pH-metry

- Determine the strength of strong acid by pH-metric titration with strong base.
- Determine the strength of weak acid by pH-metric titration with strong base.
- Determine the dissociation constant of acetic acid using pH-meter.

#### 3. Chemical Kinetics

- Study the hydrolysis of methyl acetate in presence of hydrochloric acid.
- Study saponification of ethyl acetate by sodium hydroxide solution taking the initial concentration of ester and base to be different.

#### 4. Viscosity

- Determine the viscosity of liquids (environment friendly) using Ostwald viscometer.
- Study the variation of viscosity with concentration for a glycerol solution using Ostwald viscometer and thereafter determine the concentration of unknown solution of glycerol.
- Determination of molar mass of a polymer.



**Experiment: 45 marks**  
**Lab Record: 15 marks**  
**Viva-voce: 10 marks**

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i. solve problems related to strength of a given acid / base by conductometric and ph-metric titration.
- ii. handle chemical kinetics and other related problems of some simple reactions.
- iii. determine the viscosity of a given liquid.
- iv. find out the molar mass of a given polymer.

#### **Reference Books**

1. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman.
3. Practical Physical Chemistry, S.R. Palit and S.K. De, Science.
4. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.
5. Experiments in Physical Chemistry, D.P. Shoemaker
6. Experiments in Physical Chemistry, D.V. Jahagirdhar.
7. Senior Practical Physical Chemistry by B.D. Khosla, V. Garg and A. Gulati.
8. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing House.

## M Sc CHEMISTRY, SEMESTER II

CODE: CH-201A

SUBJECT NAME: Inorganic Chemistry (General-II)

NO OF CREDITS: 4

L	P	SESSIONAL:	25
4	0	THEORY EXAM:	75
		TOTAL:	100

### Course Objectives:

To study about properties of metal complexes especially magnetic properties and spectral behaviour. To learn about structure and bonding in metal compounds.

### UNIT: I

#### Electronic Spectra and Magnetic Properties of Transition Metal Complexes -I

Electronic arrangements of microstates, calculation of the number of microstates in various electronic arrangements, spectroscopic term symbols, vector diagrams to indicate coupling of orbital angular momenta in  $p^2$ ,  $p^3$ ,  $d^2$  configurations and spin orbit coupling for  $p^2$  arrangement, spectroscopic terms, spectral terms of  $d^2$  to  $d^8$  metal ions, determining the ground state terms - Hund's rules, derivation of the term symbol for a closed subshell.

### UNIT: II

#### Electronic Spectra and Magnetic Properties of Transition Metal Complexes -II

Interpretation of electronic spectra, Orgel diagrams, Tanabe-Sugano diagrams for transition metal complexes ( $d^1$  -  $d^9$  states), calculations of  $Dq$ ,  $B$  and  $\beta$  parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

#### Circular Dichroism and Optical Rotatory Dispersion

Polarized light, fundamental symmetry requirements, for optical activity, interaction of polarized light with optically active matter, optical rotation, Cotton effect, configuration of Tris -chelated complexes.

### UNIT: III

#### Metal $\pi$ -Complexes

Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding, structure and

important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand.

#### **UNIT: IV**

##### **Metal Clusters**

Higher boranes, carboranes, metallocboranes and metallocarboranes. Metal carbonyl and halide clusters, compounds with metal-metal multiple bonds.

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i. correlate structure of a metal compound and its magnetic properties.
- ii. design a complex with required magnetic properties.
- iii. explore more about complexes like boranes, carboranes, metal carbonyles etc and their applications.

##### **Reference Books**

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harper & Row.
3. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
4. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
5. Introduction to Ligand fields; B.N. Figgis, Wiley, New York.
6. Modern Aspects of Inorganic Chemistry; H.J. Emeleus and Sharpe.
7. Introduction to Ligand Field Theory; C.J. Ballahyen, McGraw Hill, New York.
8. Organometallic Chemistry; R.C.Mehrotra and A.Singh, New Age International.
9. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H.McDaniel and J.J.Alexander; John Wiley.
10. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.

**M Sc CHEMISTRY, SEMESTER II**

**CODE: CH-202A**

**SUBJECT NAME: Organic Chemistry (General-II)**

**NO OF CREDITS: 4**

L	P	SESSIONAL:	25
4	0	THEORY EXAM:	75
		TOTAL:	100

**Course Objectives:** To study about various types of aliphatic and aromatic reactions, rearrangements and their synthetic utility.

**UNIT: I**

**Aromatic Electrophilic Substitution:** The arenium ion, mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Vilsmeier reaction, Gattermann-Koch reaction.

**Aromatic Nucleophilic Substitution:** The ArSN1, ArSN2, and Benzyne mechanisms. Generation, structure and reaction of arynes. Reactivity – effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.

**UNIT: II**

**Aliphatic Electrophilic Substitution:** Bimolecular mechanisms - SE2 and SEi. The SE1 mechanism, Electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

**Elimination Reactions:** The E2, E1 and E1cB mechanisms. Orientation of the double bond. Reactivity – effects of substrate structures, attacking base, the leaving group and the medium. Stereochemistry of E2 Elimination, Reaction and Eclipsing Effects in E2 Eliminations. Dehydration of Alcohols, Elimination not involving C-H Bonds, Mechanism and orientation in pyrolytic eliminations.

**Carbocation Rearrangements:** Wagner Meerwein rearrangement, Pinacol-pinacolone rearrangements, Aldehyde-Ketones, Demjanov ring expansion & contraction and Transannular rearrangement.

**UNIT: III**

**Addition to Carbon-Carbon Multiple Bonds:** Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio – and chemo-selectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.

**Free Radicals:** General aspects of generation, structure, stability and reactivity of free radicals, types of free radical reactions, halogenation including allylic halogenation (NBS), autooxidation, decomposition of azo compounds and peroxides, coupling of alkynes, homolytic aromatic substitution, Sandmeyer reaction and Hunsdiecker reaction.

#### **UNIT: IV**

**Addition to Carbon-Hetero Multiple Bonds:** Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction. Mechanism of condensation reactions involving enolates – Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters, Reformatsky reaction, Dieckman reaction, Cannizzaro reaction, Robinson-Mannich reaction

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i. solve problems related to reaction mechanism.
- ii. propose mechanism for any reaction in research.
- iii. propose synthetic routes for a compound of interest.

#### **Reference Books**

1. Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.
6. Modern Organic Reactions, H. O. House, Benjamin.
7. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional.
8. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.
9. Organic Chemistry, J. Clayden, N. Greeves, S. Warren, P. Wothers, Oxford Press.

**M Sc CHEMISTRY, SEMESTER II**

**CODE: CH-203A**

**SUBJECT NAME: Physical Chemistry (General-II)**

**NO OF CREDITS: 4**

L	P	SESSIONAL:	25
4	0	THEORY EXAM:	75
		TOTAL:	100

**Course Objectives:**

To study about the various aspects and details of quantum mechanics. To understand the chemistry and kinetics of chain reactions.

**UNIT: I**

**Quantum Mechanics-I:** The postulates of quantum mechanics, Linear and Hermitian operators. Commutation of operators and Uncertainty Principle. Schrodinger equation, eigen function and eigen values, free particle, Schrodinger equation for a particle in a box, the degeneracy, particle in a box with a finite barrier, Schrodinger equation for linear harmonic oscillator and its solution, zero point energy, Tunneling Problem: Tunneling through a rectangular barrier.

**UNIT: II**

**Quantum Mechanics-II:** Energy levels and wave-functions of Rigid rotator. Hydrogen atom: Complete solution (separation of variables in spherical polar coordinates and its solution). Radial distributions. Angular momentum and its directional quantization, Angular momentum operators, commutation relation, shape of atomic orbitals upto d - level and their discussion.

**UNIT: III**

**Chain reactions:** Photochemical and thermolytic reactions. General treatment of chain reactions (ortho -para hydrogen conversion and hydrogen - halogen reactions), apparent activation energy of chain reactions, chain length, Branching chain reactions leading to explosions; explosion limits, H<sub>2</sub> - O<sub>2</sub> reaction. Kinetics of (one intermediate) enzymatic reaction: Michaelis - Menton treatment, evaluation of Michaelis's constant for enzyme - substrate binding by Lineweaver - Burk plot, by Dixon and by Eadie- Hofstae methods. Competitive and non-competitive inhibition.

**UNIT: IV**

**Ion Transport in solutions:** Ionic movement under the influence of an electric field, mobility of ions, ionic drift velocity and its relation with current density, Einstein relation between the absolute mobility and diffusion coefficient, the Stokes- Einstein relation, the Nernst -Einstein equation, Waldens rule, the Rate- Process approach to ionic migration, the Rate process equation for equivalent conductivity, total driving force for ionic transport, Nernst - Planck Flux equation, ionic drift and diffusion potential, the Onsager phenomenological equations. The basic equation for the diffusion, Planck- Henderson equation for the diffusion potential.

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i. solve problems related to quantum mechanics.
- ii. explain enzyme catalysis and kinetics of complex chain reactions.
- iii. handle problems of ionic mobility in solutions.

### **Reference Books**

1. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
2. Quantum Chemistry, I.M. Levine, Prentice Hall.
3. Physical Chemistry, Peter Atkins, Julio de Paula, Oxford University Press.
4. Quantum Chemistry, B. K. Sen, Kalyani Publishers
5. Quantum Chemistry, R. Prasad, New Age International.
6. Chemical Kinetics, K.J. Laidler, McGraw Hill.

**M Sc CHEMISTRY, SEMESTER II**

**CODE: CH-204A**

**SUBJECT NAME: Computational Techniques**

**NO OF CREDITS: 3**

L    P  
3    0

SESSIONAL:        25  
THEORY EXAM:    75  
TOTAL:             100

**Course Objectives:**

To study the basic computational technique. To learn about basic statistics required for data handling in chemistry.

**UNIT: I**

**Introduction to C:**

**Operators and Expressions:** operators, Arithmetic Operators, relational and logical operators

**Flow of control:** introduction, compound statement, selective execution, repetitive execution, Nested loops, the GOTO statement

**Arrays:** introduction, one dimensional arrays, strings, multi dimensional arrays

**Structures:** Introduction, Nested structures, Enumerated data types, unions

**UNIT: II**

**Pointers:** introduction, pointer variables, pointer and arrays

**Functions:** Function prototypes, parameter passing in functions, returning values from functions, recursion

File handling in C, command line arguments.

**UNIT: III**

**Basic Statistics:** Mean, Median, Mode, Variance, Standard deviation, Moments, Properties and effect of change of origin and scale.

**Probability:** rules of probability, conditional probability, independent events, Bays theorem, Random variable, Discrete and continuous random variable

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i. perform computational analysis in chemistry.
- ii. perform modelling work in chemistry.
- iii. solve problems related to data handling in chemistry



### **Reference Books**

1. C problem solving and programming, Kenneth, A., Prentice Hall.
2. Theory and problems of Programming in C, Gottfried, B., Schaum Series.
3. The Programming Language, Kerningham & Ritchie, PHI.
4. Fundamentals of Data Structures, E. Horowitz and S. Sahani, Galgotia Book source Pvt. Ltd, 2003

**M Sc CHEMISTRY, SEMESTER II**

**CODE: CH-205A**

**SUBJECT NAME: Inorganic Chemistry Lab-II**

**NO OF CREDITS: 3**

L P  
0 6

SESSIONAL: 30  
FINAL EXAM: 70  
TOTAL: 100

**Course Objectives:**

To analyse a given salt quantitatively in laboratory. To prepare various inorganic complexes in laboratory

**EXPERIMENTS**

**Quantitative Analysis**

Separation of the metal ions and determination of any one of them using volumetric/gravimetric methods.

Cu-Ni, Cu-Zn, Cu-Al, Ca-Ba, Fe -Mg, Fe-Ni etc.

**Preparations:**

Preparation of selected inorganic compounds and their spectroscopic studies.

1.  $\text{Hg}[\text{Co}(\text{SCN})_4]$
2.  $\text{Ni}(\text{dmg})_2$
3.  $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4 \cdot \text{H}_2\text{O}$
4. Prussian Blue and Turnbull's Blue.
5.  $\text{Na}[\text{Cr}(\text{NH}_3)_2(\text{SCN})_4]$
6.  $\text{Mn}(\text{acac})_3$
7.  $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2$
8.  $\text{VO}(\text{acac})_2$

**Experiment: 45 marks**

**Lab Record: 15 marks**

**Viva-voce: 10 marks**

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i. analyse a given salt quantitatively

- ii. synthesise an inorganic complex on his own
- iii. design and synthesize a complex of interest

### Reference Books

1. A Text Book of Macro and Semi-micro Quantitative Analysis, A.I.Vogel, Orient Longman.
2. A Vogel's Text Book of Quantitative Inorganic Analysis , J. Bassett, R.C. Denney, G.B. Jaffery and J. Menaham, Longman, London.
3. Synthesis and Characterization of Inorganic Compounds, W.B. Jolly, Prentice Hall, Englewood.
4. Synthesis and Physical Studies of Inorganic Compounds, C.F. Bell, Pergamon Press
5. Inorganic Preparations; W.G. Palmer.

**M Sc CHEMISTRY, SEMESTER II**

**CODE: CH-206A**

**SUBJECT NAME: Organic Chemistry Lab-II**

**NO OF CREDITS: 3**

L P  
0 6

SESSIONAL: 30  
FINAL EXAM: 70  
TOTAL: 100

**Course Objectives:**

To analyse a given mixture of salts qualitatively in laboratory. To purify various organic compounds using different techniques in laboratory. This course aims to study about UV and IR spectra of simple compounds.

**Experiments**

1. Qualitative analysis of mixture of organic compounds
2. Purification of organic compounds involving fractional crystallization, fractional distillation, steam distillation, sublimation and extraction.
3. UV and IR spectra of simple compounds (for functional group identification)

**Experiment: 45 marks**

**Lab Record: 15 marks**

**Viva-voce: 10 marks**

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i. Analyse a given mixture of salts qualitatively and give composition of mixture.
- ii. Purify various organic compounds from a mixture using different techniques.
- iii. Interpret UV and IR spectra of simple organic compounds.

## Reference Books

1. A Hand book of Organic Analysis -Qualitative and Quantitative by H.T. Clarke, and revised by B.Haynee, Edward Arnold, London 1975.
2. Vogel's Text Book of Practical Organic Chemistry by B.S. Furhen et. al, Longman-Group Ltd.
3. Systematic Qualitative Organic Analysis by H. Middleton, Edward Arnold (Publishers) Limited, London 1959.
4. Elementary Practical Organic Chemistry by Arthur I. Vogel, Ex CBS Publishers and Distributors.
5. Experiments in Organic Chemistry by Louis, F.Fieser, D.C. Heath and Company Boston, 1955.

**M Sc CHEMISTRY, SEMESTER II**

**CODE: CH-207A**

**SUBJECT NAME: Physical Chemistry Lab-II**

**NO OF CREDITS: 3**

L	P	SESSIONAL:	30
0	6	FINAL EXAM:	70
		TOTAL:	100

**Course Objectives:**

To determine the refractive index, refraction and molar refraction of some organic liquids. To study about angle of optical rotation, specific & molecular rotation and the kinetics of inversion of cane sugar. To study about standard electrode potential, determination of the strength of a given solution. To determine distribution coefficient of a substance between two liquids.

**1. Refractometry**

- Determine the refractive index of simple organic liquids (environment friendly)
- Determine the refractivity and molar refraction of some organic liquids so as to determine the molar refractions for  $\text{CH}_2$ , C, H and Cl.
- Study the variation of refractive index with concentration for KCl solution and thereafter determine the unknown concentration of given KCl solution.

**2. Polarimetry**

- Study the variation of angle of optical rotation with the concentration of any optically active substance (sucrose or glucose) and determine the unknown concentration of given solution.
- Determine the specific and molecular rotation of sucrose or glucose at number of concentrations.
- Study the kinetics of inversion of cane sugar (sucrose) in presence of an acid.

**3. Potentiometry**

- Determine the standard electrode potential of Cu and Zn.
- Determine the strength of a given solution of ferrous ammonium sulphate by potentiometric titration with  $\text{K}_2\text{Cr}_2\text{O}_7$  solution.
- Study the precipitation titration between KCl and  $\text{AgNO}_3$  potentiometrically.
- Determine the strength of iodide, bromide and chloride in a mixture by potentiometric titration with silver nitrate.

**4. Distribution Law**

- i. Determine distribution coefficient of ammonia between chloroform and water.
- ii. Determine the formula of the complex formed between copper (II) ion and ammonia using distribution method.

**Experiment: 45 marks**

**Lab Record: 15 marks**

**Viva-voce: 10 marks**

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i. find out the refractive index, refractivity and molar refractivity of organic liquids.
- ii. find out angle of optical rotation, specific & molecular rotation of sugars
- iii. solve problems related to kinetics of inversion of cane sugar
- iv. determine standard electrode potential, and strength of a given solution.
- v. calculate distribution coefficient of a substance between two liquids.

### **Reference Books**

1. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman.
3. Practical Physical Chemistry, S.R. Palit and S.K. De, Science.
4. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.
5. Experiments in Physical Chemistry, D.P. Shoemaker
6. Experiments in Physical Chemistry, D.V. Jahagirdhar.
7. Senior Practical Physical Chemistry by B.D. Khosla, V. Garg and A. Gulati.
8. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing House.

**M Sc CHEMISTRY, SEMESTER II**

**CODE: ACH-204A**

**SUBJECT NAME: Green Chemistry (Audit Course)**

**NO OF CREDITS: 0**

L    P  
2    0

SESSIONAL:        25  
THEORY EXAM:    75  
TOTAL:             100

**Course Objectives:**

To know eco-friendly methods of synthesis. This helps in planning the synthesis of any type of organic compounds with the revolution of Green Chemistry.

**UNIT I**

**PRINCIPLES & CONCEPT OF GREEN CHEMISTRY**

Introduction –Concept and Principles-development of Green Chemistry- Atom economy reactions – rearrangement reactions , addition reactions- atom uneconomic-sublimation-elimination-Wittig reactions-toxicity measures- Need of Green Chemistry in our day to day life.

**UNIT II**

**EMERGING GREEN TECHNOLOGY AND ALTERNATIVE ENERGY SOURCES**

Design for Energy efficiency-Photochemical reactions- Advantages-Challenge faced by photochemical process. Microwave technology on Chemistry- Microwave heating –Microwave assisted reactions-Sono chemistry and Green Chemistry –Electrochemical Synthesis-Examples of Electrochemical synthesis.

**UNIT III**

**RENEWABLE RESOURCES**

Biomass , Renewable energy, Fossil fuels, Energy from Biomass, Solar Power, Other forms of renewable energy, Fuel Cells, Alternative economics, Syngas economy, hydrogen economy, Some other natural chemical resources.



#### **UNIT IV: INDUSTRIAL CASE STUDIES**

Methyl Methacrylate (MMA), Greening of Acetic acid manufacture, Dyeing, Application, Polyethylene, Ziegler-Natta Catalysis, Metallocene Catalysis, Eco friendly Pesticides-Insecticides.

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i understand the meaning and concept of green chemistry
- ii design environment sustainable and economical route of a synthesis.
- iii appreciate renewable and alternate resources of energy and their utilization
- iv realize the importance of concept with respect to industrial processes

#### **Reference Books:**

1. Mike Lancaster , Green Chemistry and Introductory text, II Edition
2. P.T.Anastas and J.C Warner, Green Chemistry theory and Practice, Oxford University press, Oxford (1988).
3. P.Tundo *et. al.*, Green Chemistry, Wiley –Blackwell, London (2007).
4. Protti D.Dondi *et.al.*, Green Chemistry
5. T.E Graedel, Streamlined Life cycle Assessment, Prentice Hall, New Jersey (1998).
6. V.K. Ahluwalia, Methods and Reagents of Green Chemistry: An Introduction by Green Chemistry.
7. [www.clri.org](http://www.clri.org)

**M Sc CHEMISTRY, SEMESTER III**

**CODE: CH -301A**

**SUBJECT NAME: Spectroscopy-I**

**NO OF CREDITS: 4**

L P  
4 0

SESSIONAL: 25  
THEORY EXAM: 75  
TOTAL: 100

**Course Objectives:** To learn about the spectroscopic techniques being used as a tool for structural elucidation of organic compounds. To understand the basic concept of UV, IR, NMR and mass spectrometry.

**UNIT-I**

**Ultraviolet and Visible Spectroscopy:**

Introduction and understanding of UV phenomenon, Various electronic transitions (185-800 nm), Beer-Lambert law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser-Woodward rules for conjugated dienes and carbonyl compounds.

**Infrared Spectroscopy:**

Principle and Theory, Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance. FT-IR.

**UNIT -II**

**Nuclear Magnetic Resonance Spectroscopy-I**

General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, mechanism of measurement, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto), complex spin-spin interaction between two, three, four and five nuclei (first order spectra), spin system-Pople notation, virtual coupling.

**UNIT -III**

**Nuclear Magnetic Resonance Spectroscopy-II**

Stereochemistry, concept of topicity, effect of enantiomeric and diastereomeric protons, hindered rotation, Karplus curve - variation of coupling constant with

dihedral angle. Fourier transform technique and its advantages. Resonance of other nuclei-F, P. Tools for simplification of complex NMR spectrum (chemical and instrumental):-Deuteration, changing solvent, trifluoroacetylation, basification and acidification, lanthanide shift reagents, increased magnetic field strength, double resonance and nuclear overhauser effect (NOE), variable temperature probe. Concept of 2D-NMR spectroscopy.

### **Carbon-13 NMR Spectroscopy**

General considerations, Comparison of  $^1\text{H}$ -NMR and  $^{13}\text{C}$ -NMR, Proton coupled and proton decoupled  $^{13}\text{C}$ -NMR, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants. Nuclear Overhauser effect.

## **UNIT -IV**

### **Mass Spectrometry**

Introduction, ion production - EI, CI, FD and FAB, Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, Nitrogen rule, molecular weight determination molecular formula from isotopic ratio data, isotope profile of halogen compounds, fragmentation pattern - simple cleavage, retro-Diels Alder, Hydrogen transfer rearrangement like scrambling, ortho effect, McLafferty rearrangement, fragmentation patterns of hydrocarbons, alcohols, phenols, ethers, aldehydes, ketones, esters, carboxylic acids, amines, nitro, amides, nitriles.

### **Composite Problems**

Problems involving the application of the above spectroscopic techniques (UV/Visible, IR, NMR and Mass) for structural elucidation of organic molecules.

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i. understand the basic principle of all kinds of spectroscopic techniques used in organic chemistry for structural elucidation of organic compounds.
- ii. Would be able to predict structure of organic compounds on the basis of its spectral data.
- iii. Would be able to interpret various spectral data.

### **Reference Books**

1. Introduction to Spectroscopy- A Guide for Students of Organic Chemistry, 2<sup>nd</sup> Edn. By Donald L. Pavia, Gary M. Lampman and George S. Kriz. Saunders Golden Sunburst Series. Harcourt Brace College Publishers, New York.
2. Spectrometric Identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley.
3. Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall.
4. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming, Tata McGraw-Hill.
5. Spectroscopy of Organic Compounds by P.S. Kalsi, Wiley Eastern, New Delhi.
6. Organic Spectroscopy by William Kemp, John Wiley.

7. Organic Mass Spectrometry by K.G. Das & E.P. James, Oxford & IBH Publishing Co.
8. Organic Spectroscopy (Principles & Applications) by Jagmohan.

**M Sc CHEMISTRY, SEMESTER III**

**CODE: CH -302A**

**SUBJECT NAME: Spectroscopy-II**

**NO OF CREDITS: 4**

L P  
4 0

SESSIONAL: 25  
THEORY EXAM: 75  
TOTAL: 100

**Course Objectives:**

To study the various types of spectroscopy to understand the interaction of radiations with the matter to elucidate the molecular structure. To understand basic to advanced level concepts of X-ray crystallography

**UNIT: I**

**Microwave Spectroscopy**

The rotation of molecules, rotational spectra of rigid diatomic molecules, intensities of rotational spectral lines, isotopic effect, non-rigid rotator, spectra of polyatomic linear molecules and symmetric top molecules.

**Infrared Spectroscopy**

The vibrating diatomic molecule, force constant, zero point energy, simple harmonic vibrator, anharmonicity, Morse potential, overtones, hot bands, diatomic vibrating rotators, P, Q, R branches, vibration of polyatomic molecules, normal mode of vibrations. Fourier transform spectroscopy.

**UNIT: II**

**Nuclear Magnetic Resonance Spectroscopy**

Basic principles of NMR, theory of nuclear magnetic resonance, spin lattice relaxation, spin-spin relaxation, experimental techniques chemical shift, the  $\delta$ -scale of chemical shift, the origin of shielding constant, pattern of coupling, origin of spin-spin coupling, the nuclear overhauser effect.

**Nuclear Quadrupole Resonance Spectroscopy**

Introduction, energies of quadrupole transitions, effect of magnetic field on the spectra, relationship between electric field gradient and molecular structure, applications, interpretations of structural information from NQR spectra

**UNIT: III**

**Raman Spectroscopy**

Classical and quantum theories, pure rotational Raman spectra of linear molecules, vibrational Raman spectra, mutual exclusion principle, polarization of the light and Raman effect, depolarization of Raman lines, technique.

### **Electron Spin Resonance Spectroscopy**

Basic principles of ESR, experimental technique, the g-value hyperfine structure, Instrumentation of ESR and its applications to the study of free radicals and fast reactions, spin densities and McConnell relationship

### **UNIT: IV**

### **X-ray Crystallography**

Symmetry elements in crystals, stereographic projections, point groups (illustration of R, R-bar, Rm, R/m, R-bar/m point groups only), miller indices for planes and directions, criteria for determining unit cell of lattice, space lattices, space groups P1, Pbar1, P2, P2<sub>1</sub>, Pm, Pc, C2, Cm, Cc X-ray emission spectra, absorption edges, X-ray filters, Reciprocal lattice concept and its importance, Definition of Reciprocal lattice vector (derivation excluded). Interplanar spacing using reciprocal lattice concept for cubic, tetragonal, orthorhombic and hexagonal crystal systems, Equivalence of Bragg's and Laue condition, Structure factor calculations for primitive, base-centered, body-centered and face centered unit cells. Relation of structure factor to electron density and intensities (derivation excluded), Interpretation of powder photographs for cubic crystals, Data reduction, Phase problem – Patterson method and Heavy-atom method, refinement of structure by successive and difference fourier synthesis. Correctness of a structure (Discrepancy index), Characteristic difference between X-ray, electron and neutron diffraction techniques.

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i Illuminate the various structural parameters of molecules by using various spectroscopic technique.
- ii Explore the crystallographic structure and orientation of crystal plane in a molecule via XRD technique.

### **Books Suggested:**

1. Fundamentals of Molecular Spectroscopy, C.N. Banwell, Tata McGraw Hill.
2. Modern Spectroscopy, J.M. Hollas, John Wiley.
3. Basic Principles of Spectroscopy, R.Chang, McGraw Hill.
4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
5. Physical Method in Chemistry, R.S. Drago, Saunders College.
6. Elementary Crystallography, L. Azaroff.

7. Structure Determination by X-ray Crystallography, M. Ladd and R. Palmer
8. X-Ray Structure Determination: A Practical Guide, 2nd Edition by [George H. Stout](#) and Lyle H. Jensen.
9. *Essentials of Crystallography*, McKie & McKie, Blackwell Scientific Publications, 1986
10. Handbook of X-rays, Emmett and F. Kaelbse, McGraw Hill.

**M Sc CHEMISTRY, SEMESTER III**

**CODE: CH -303A**

**SUBJECT NAME: Analytical Techniques**

**NO OF CREDITS: 4**

L    P  
4    0

SESSIONAL:        25  
THEORY EXAM:    75  
TOTAL:             100

**Course Objectives:**

To study about different spectroscopic techniques. To elucidate structure and mode of bonding in inorganic compounds. To study about analytical techniques.

**UNIT: I**

**Vibrational Spectroscopy**

Symmetry, shapes and number of IR modes  $AB_2$ ,  $AB_3$ ,  $AB_4$ ,  $AB_5$  and  $AB_6$  (Group theoretical treatment) mode of bonding of ambidentate ligands and diketonato or complexes, application of resonance Raman spectroscopy particularly for the study of active- sites of metalloproteins.

**Atomic Absorption Spectroscopy**

General principles, resonance line, its natural width, Doppler effect, broadening due to pressure, Hollow cathode lamp. Application to alkali and alkaline earth metals.

**UNIT: II**

**Mossbauer Spectroscopy**

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

**Photoelectron Spectroscopy**

Basic principles; photo-electric effect, ionization process, Koopman's theorem. Photoelectron spectra of simple molecules, ESCA, chemical information from ESCA.

**UNIT: III**

**Flame photometry**



Theory of flame photometry, flame temperature, Emission Flame photometry - intensity of spectral lines, selection of optimum working conditions, application of flame photometry in trace metal analysis.

### **Spectrophotometry and Colorimetry**

Fundamental concepts, instrumentation for absorption measurements, interferences, application of absorption spectroscopy and Colorimetry to analysis of inorganic substance.

### **UNIT: IV**

#### **Nuclear Magnetic Resonance**

Basic Principle of NMR, Nuclear relaxation, Factors affecting nuclear relaxation, effect of chemical exchange on spectrum and evaluation of reaction rate of fast reactions, Double resonance, Lanthanide shift reagents, an overview of NMR of other nuclides with emphasis on  $^{31}\text{P}$ ,  $^{19}\text{F}$ ,  $^{195}\text{Pt}$  and  $^{119}\text{Sn}$  NMR. Application in inorganic chemistry

#### **Electron Spin Resonance Spectroscopy**

Hyperfine coupling, spin polarization for atoms and transition metal ions, spin-orbit coupling and significance of g-tensor, application to transition metal complexes (having one unpaired electron) and inorganic free radicals such as  $\text{PH}_4$ ,  $\text{F}_2^-$  and  $[\text{BH}_3]^-$ . Double resonance in EPR.

**Course Outcomes:** After the successful completion of the course the learner would be able to:

- i. Understand and interpret vibrational spectra and atomic absorption spectra
- ii. Solve problems related to mossbauer spectroscopy and photoelectron spectroscopy
- iii. Analyse inorganic substances the technique of flame photometry, spectrophotometry and colorimetry.
- iv. Solve problems based on NMR and ESR

#### **Books Suggested:**

1. A Textbook of Quantitative Inorganic Analysis, A.I. Vogel; ELBS, London.
2. Fundamentals of Analytical Chemistry; D.A. Skoog, O.M. West and F.J. Holler; W.B. Saunders.
3. Instrumental methods of Analysis; L.L. Merrit, R.H. Willard and J.A. Dean; Van Nostrand-Reinhold.
4. Physical methods in Chemistry; R.S. Drago; Saunders.
5. NMR, NQR, EPR and MB Spectroscopy in inorganic Chemistry, R.V. Parish, Ellis Horwood.
6. Introduction to Magnetic Resonance; McLachan and Carrington; Chapman and Hall.

**M Sc CHEMISTRY, SEMESTER III**

**CODE: CH-304A**

**SUBJECT NAME: Inorganic Chemistry Lab-Special-I**

**NO OF CREDITS: 3**

L P  
0 6

SESSIONAL: 30  
FINAL EXAM: 70  
TOTAL: 100

**Course Objectives:**

To synthesize inorganic compound in laboratory. To carry out elemental analysis of inorganic compounds. To do spectral studies of inorganic compounds.

**1. Preparations:**

Preparation of selected Inorganic Compounds and their Characterization by elemental analysis and spectroscopic methods (IR, NMR, EPR, Magnetic moment etc.)

- I** Chloropentaamminecobalt (III) Chloride
- II** Nitro/Nitritopentaamminecobalt (III) Chloride (Distinction between nitro and nitrito by IR)
- III** Potassium trioxalatoferrate (III)
- IV** Chromous acetate
- V** Cis and trans  $[\text{Co}(\text{en})_2\text{Cl}_2]$

**2** Preparation of some inorganic compounds and their spectral studies.

Tris(acetyl-acetonato) manganese (III)  
Tris(acetyl-acetonato) cobaltate (III)  
Preparation of Ferrocene  
Tris thiourea copper(I) sulfate  
Tris(acetylacetonato)chromium(III)

**Experiment: 45 marks**

**Lab Record: 15 marks**

**Viva-voce: 10 marks**

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i. analyse a given salt qualitatively
- ii. synthesise an inorganic complex on his own
- iii. design and synthesize a complex of interest

iv. do elemental and spectral analysis of a compound

**Referece Books:**

1. Synthesis and Characterization of Inorganic compounds. W. L. Jolly, Prentice Hall, Englowood.
2. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London.
3. Inorganic Preparations: W. G. Palmer.

**M Sc CHEMISTRY, SEMESTER III**

**CODE: CH-305A**

**SUBJECT NAME: Inorganic Chemistry Lab-Special-II**

**NO OF CREDITS: 3**

L P  
0 6

SESSIONAL: 30  
FINAL EXAM: 70  
TOTAL: 100

**Course Objectives:**

To synthesize inorganic compound in laboratory. To carry out elemental analysis of inorganic compounds. To do spectral studies of inorganic compounds.

**Instrumentation Techniques:**

- I** Spectrophotometric Determinations
- II** Conductometric Titrations
- III** Flame Photometry
- IV** Potentiometric/pH-analysis
- V** Electrogravimetric analysis
- VI** Polarographic analysis
- VII** Any other techniques introduced

**Experiment: 45 marks**

**Lab Record: 15 marks**

**Viva-voce: 10 marks**

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i. perform spectrophotometric analysis of compounds.
- ii. Analysis based on conductometric titrations
- iii. Do pH-metry based analysis of compounds and solutions
- iv. Handle different instruments for analytical studies

**Referece Books:**

1. Synthesis and Characterization of Inorganic compounds. W. L. Jolly, Prentice Hall, Englowood.

2. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London.
3. Inorganic Preparations: W. G. Palmer.

**M Sc CHEMISTRY, SEMESTER III**

**CODE: CH-306A**

**SUBJECT NAME: Inorganic Chemistry Lab-Special-III**

**NO OF CREDITS: 3**

L P  
0 6

SESSIONAL: 30  
FINAL EXAM: 70  
TOTAL: 100

**Course Objectives:**

To perform elemental analysis of a mixture of a complex compound in laboratory different methods of analysis including instrumentation techniques. To find out the presence of some specific metals by complexometric titrations

**Quantitative analysis:**

1. Determination of triple elements in the mixtures, ores, alloys etc. by available analytical techniques.
  - I Volumetrically
  - II Gravimetrically
  - III Instrumentation methods
2. Determination of any one metal ion by volumetric method (Complexometric titration).  
Ca<sup>2+</sup>, Mg<sup>2+</sup>, Zn<sup>2+</sup>, Cu<sup>2+</sup> etc.

**Experiment: 45 marks**

**Lab Record: 15 marks**

**Viva-voce: 10 marks**

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i. Perform elemental analysis by volumetric and gravimetric methods
- ii. Undertake instrumental techniques for analysis of inorganic compounds and solutions
- iii. Understand the concept and application of complexometric titrations
- iv. Handle different instruments for analytical studies

**Reference Books:**

1. Synthesis and Characterization of Inorganic compounds. W. L. Jolly, Prentice Hall, Englewood.
2. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London.
3. Inorganic Preparations: W. G. Palmer.

**M Sc CHEMISTRY, SEMESTER III**

**CODE: CH-314A**

**SUBJECT NAME: Organic Chemistry Lab-Special-I**

**NO OF CREDITS: 3**

L P  
0 6

SESSIONAL: 30  
FINAL EXAM: 70  
TOTAL: 100

**Course Objectives:**

To perform multistep synthesis in lab for important organic compounds and their precursors. Also to monitor the progress of reaction, checking purity of target compound using chromatographic technique.

**1. Preparations of Organic compounds involving two and three stages:**

Typical preparations from which the two and three stage preparations can be chosen are:

1. Toluene — p-nitrotoluene — p-nitrobenzoic acid — p-amino benzoic acid
2. Hydroquinone — Benzoquinone — 5- Hydroxy benzoxathiole-2-one —5-Acetoxy benzoxathiol-2-one
3. Benzene — Acetophenone — Acetophenone oxime — Acetanilide
4. Benzaldehyde — Benzoin — Benzil — Benzillic acid
5. Acetylacetone — 4,6-dimethylpyridine-2-mercaptopyrimidine — 4,6-dimethyl-2-hydrazinpyrimidine — 1-(4'-6'-dimethylpyridine-2'yl) 3,5-dimethylpyrazole
6. Nitrobenzene — m-dinitrobenzene — m-nitroaniline — m-nitrophenol
7. Phthalic acid — phthalic anhydride — phthalimide — Anthranilic acid
8. Acetophenone — Benzalacetophenone — epoxide
9. Cyclohexanone —Cyclohexanone oxime—caprolactam
10. Phthalic anhydride—o-benzoylbenzoic acid—anthraquinone.
11. O-Cholobenzoic acid —N-phenylanthranilic acid —acridone.
12. Cholobenzene—2,4-dinitrochlorobenzene —2,4-dinitrophenol
13. Bromobenzene—triphenylcarbinol-tritylchloride
14. Resorcinol—resacetophenone — 4-ethyl resorcinol
15. Resorcinol — 4-methyl-7-hydroxycoumarin — 6 and 8- nitro-4-methyl-7-hydroxycoumarin
16. Phenol — salicylaldehyde —coumarin
17. Aniline — 2,4,6-tribromaniline — 1,3,5-tribromobenzene
18. Resorcinol—resacetophenone — Chalcone
19. Any other multi step reaction as per requirement

**All the students must check the progress of reaction and purity of Final products for all the stages of preparation by Thin layer Chromatography.**

**Experiment: 45 marks**

**Lab Record: 15 marks**

**Viva-voce: 10 marks**

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i. To perform multistep synthesis of organic compounds
- ii. Purification of organic compounds by crystallization
- iii. propose different synthetic routes for a compound.
- iv. To monitor reaction and check purity of organic compounds through TLC.

**Reference Books:**

1. "Elementary Practical Organic Chemistry by Arthur I. Vogel Longmans, Green and Co. 1958.
2. "An Introduction to Practical Biochemistry", by David T. Plummer, Tata McGraw Hill Publishing Company, Ltd., N. Delhi, 1988.
3. 'Practical Organic Chemistry' by Mann and Saunders.
4. Text Book of Vogel's Practical Organic Chemistry by Longman Group, B.S. Furness et al., Ltd.
5. "Experiments in Organic Chemistry" Louis F. Fieser O.C. Heath and Company Boston, 1955.
6. "Organic Synthesis" Collective Vol. I.
7. Laboratory Manual in Organic Chemistry' by R.K. Bansal, Wiley Eastern Ltd., New Delhi-1980.
8. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B. Maynes, Edward Arnold (Pub.), Ltd. London, 1975).
9. "Systematic Qualitative Organic Analysis" by H. Middleton, Edward Arnold (Publishers) Ltd., London 1959.
10. "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966.
11. "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors.
12. "A Guide to spectroscopy in Organic Chemistry' by PAVY
13. "Spectrometric Identification of Organic Compounds", Fifth Ed., R.M. Silverstein, G.S. Bassler and T.C. Morrill, John Wiley and Sons, New York.
14. "Organic Spectroscopy', 3<sup>rd</sup> Ed., by William Kemp. John Wiley & Sons.
15. "Spectroscopic" Methods in Organic Chemistry, D.H. Williams & Ian Fleming.
16. Vogel's Text Book of Practical Organic Chemistry by B.S. Furness et. al., Longman Group Ltd. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B. Maynes, Edward Arnold (Pub.), Ltd. London, 1975).



17. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.

**M Sc CHEMISTRY, SEMESTER III**

**CODE: CH 315A**

**SUBJECT NAME: Organic Chemistry Lab-Special-II**

**NO OF CREDITS: 3**

L P  
0 6

SESSIONAL: 30  
FINAL EXAM: 70  
TOTAL: 100

**Course Objectives:**

To perform qualitative estimation of different functional groups in organic compounds.

- 1. Quantitative estimation of the followings:** Amino group, hydroxyl group, acetoxy group, carbonyl group, unsaturation, reducing and non-reducing sugars,
- 2.** Saponification value and iodine value of fats and oils, formalin and glycine, Determination of the molecular weight of an acid by titration and by the silver salt method.

**Experiment: 45 marks**

**Lab Record: 15 marks**

**Viva-voce: 10 marks**

**Course Outcomes:** After the successful completion of the course the learner would be able to

- To perform estimation of organic functional groups present in organic compounds.
- Understand the qualitative aspect of organic chemistry.

**Reference Books:**

- "Elementary Practical Organic Chemistry by Arthur I. Vogel Longmans, Green and Co. 1958.
- "An Introduction to Practical Biochemistry", by David T. Plummer, Tata McGraw Hill Publishing Company, Ltd., N. Delhi, 1988.
- Practical Organic Chemistry' by Mann and Saunders.
- Text Book of Vogel's Practical Organic Chemistry by Longman Group, B.S. Furness et al., Ltd.
- "Experiments in Organic Chemistry" Louis F. Fieser O.C. Heath and Company Boston, 1955.
- "Organic Synthesis" Collective Vol. I.
- Laboratory Manual in Organic Chemistry' by R.K. Bansal, Wiley Eastern Ltd., New Delhi-1980.

- 8 "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.), Ltd. London, 1975).
- 9 "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.
- 10 "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966.
- 11 "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors.
- 12 "A Guide to spectroscopy in Organic Chemistry' by PAVY
- 13 "Spectrometric Identification of Organic Compounds", Fifth Ed., R.M. Silverstein, G.S. Bassler and T.C.Morrile, John Wiley and Sons, New York.
- 14 "Organic Spectroscopy', 3<sup>rd</sup> Ed., by William Kemp. John Wiley & Sons.
- 15 "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming.
- 16 Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.), Ltd. London, 1975).
- 17 "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.

**M Sc CHEMISTRY, SEMESTER III**

**CODE: CH-316A**

**SUBJECT NAME: Organic Chemistry Lab-Special-III**

**NO OF CREDITS: 3**

L P  
0 6

SESSIONAL: 30  
FINAL EXAM: 70  
TOTAL: 100

**Course Objectives:**

To analyse a given mixture of compounds qualitatively in laboratory. To synthesise various organic compounds in laboratory.

- 1. Qualitative Analysis:** Separation of components of a binary (liquid-liquid, liquid-solid or solid-solid) organic mixture using physical and chemical methods and characterization of the components with the help of chemical analysis
- 2. Spectroscopic confirmation** of the binary mixtures using IR and NMR (IR & NMR spectra will be provided).

**Experiment: 45 marks**

**Lab Record: 15 marks**

**Viva-voce: 10 marks**

**Course Outcomes:** After the successful completion of the course the learner would be able to

- analyse a given mixture of compounds qualitatively by experiments
- Structural elucidation of organic compounds spectroscopically.
- Interpretation of various spectroscopic tools

**Reference Books:**

- "Elementary Practical Organic Chemistry by Arthur I.Vogel Longmans, Green and Co. 1958.
- "An Introduction to Practical Biochemistry", by David T. Plummer, Tata McGraw Hill Publishing Company, Ltd., N. Delhi, 1988.
- Practical Organic Chemistry' by Mann and Saunders.
- Text Book of Vogel's Practical Organic Chemistry by Longman Group, B.S. Furness et al., Ltd.
- "Experiments in Organic Chemistry" Louis F. Fieser O.C. Heath and Company Boston, 1955.
- "Organic Synthesis" Collective Vol. I.
- Laboratory Manual in Organic Chemistry' by R.K. Bansal, Wiley Eastern Ltd., New Delhi-1980.

8. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.), Ltd. London, 1975).
9. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.
10. "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966.
11. "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors.
12. "A Guide to spectroscopy in Organic Chemistry' by PAVY
13. "Spectrometric Identification of Organic Compounds", Fifth Ed., R.M. Silverstein, G.S. Bassler and T.C.Morrile, John Wiley and Sons, New York.
14. "Organic Spectroscopy', 3<sup>rd</sup> Ed., by William Kemp. John Wiley & Sons.
15. "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming.
16. Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.), Ltd. London, 1975).
17. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.

**M Sc CHEMISTRY, SEMESTER III**

**CODE: CH-324A**

**SUBJECT NAME: Physical Chemistry Lab-Special-I**

**NO OF CREDITS: 3**

L P  
0 6

SESSIONAL: 30  
FINAL EXAM: 70  
TOTAL: 100

**Course Objectives:**

To determine the equivalent conductance of given weak/strong acid conduct metric titration. To determine the critical micelle concentration (CMC) of a surfactant by conductivity method. To determine various parameters like activity coefficient, cell potential, ionization constant and strength of given mixture of strong and weak acid / base by potentiometric titration. To study the relative strength of acids polarimetrically.

**Potentiometry**

1. Determination of activity coefficient of  $\text{Ag}^+$  in a solution of silver nitrate and to study the effect of potassium nitrate on the activity coefficient of silver nitrate.
2. Determination of the cell  $\text{Pt}, \text{H}_2|\text{HCl} \text{ AgCl}|\text{Ag}$  with various concentrations of HCl and to obtain the activity coefficient of HCl.
3. Determination of solubility of silver halides in water.
4. Determination of first and second ionization constant of phosphoric acid.
5. Study of silver-ammonia complex and determination of the stability constant.
6. Determination of strength of ferrous ammonium sulphate using potassium dichromate or ceric sulphate and determination of redox potential.
7. Determination of strength of HCl and  $\text{CH}_3\text{COOH}$  in a mixture using NaOH.
8. Titration of weak/strong acid with strong base using quinhydrone and determination of dissociation constant of the acid.
9. To determine the degree of hydrolysis of aniline hydrochloride.

**Polarimetry**

1. Determine the percentage of two optically active substances in a mixture polarimetrically.
2. Determination of relative strength of acids by the study of inversion of sucrose.

### **Conductometry**

1. Determination of the equivalent conductance of weak acid (benzoic and acetic acid) at several concentrations and the dissociation constant of the acid.
2. Determination of the equivalent conductance of strong electrolytes such as HCl, KCl, KNO<sub>3</sub> and NaCl and the validity of Onsager equation.
3. Study of degree of hydrolysis of aniline hydrochloride.
4. Determine the critical micelle concentration (CMC) of a surfactant (sodium lauryl sulphate) by conductivity method.

**Experiment: 45 marks**

**Lab Record: 15 marks**

**Viva-voce: 10 marks**

**Course Outcomes:** After the successful completion of the course the learner would be able to:

- i find out the equivalent conductance of given weak/strong acid conductometrically
- ii solve problems related to the critical micelle concentration (CMC) of a surfactant by conductometric titration.
- iii determine various parameters of reaction associated with potentiometre via potentiometrically
- iv determine the relative strength of acids via polarimetre

### **Reference Books:**

1. Practical Physical Chemistry, S.R. Palit and S.K. De, Science.
2. Experimental Physical Chemistry, R.C. Das and B. Behera, McGraw Hill.
3. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.  
Findley's Practical Physical Chemistry, B.P. Lavitt, Longman.

## M Sc CHEMISTRY, SEMESTER III

CODE: CH-325A

SUBJECT NAME: Physical Chemistry Lab-Special-II

NO OF CREDITS: 3

L P  
0 6

SESSIONAL: 30  
FINAL EXAM: 70  
TOTAL: 100

### Course Objectives:

To study the Lambert-Beer's law and determine the composition of various mixtures by using Colorimetry/Spectrophotometry technique. To determine degree of hydrolysis and preparation of various buffer solutions with appropriate pH value by using pH-metric titration. To study the chemical kinetics of some reactions.

### Colorimetry/Spectrophotometry

1. Verification of the Lambert-Beer's law using solutions such as  $K_2Cr_2O_7$ ,  $CuSO_4$ ,  $KMnO_4$  in water and  $I_2$  in  $CCl_4$ .
2. Study of iron-tiron and iron-salicylic acid complexes.
3. Determination of the composition of various mixtures spectrophotometrically:
  - (i) Potassium dichromate and potassium permanganate
  - (ii) Crystal violet and aurine
4. Determine the dissociation constant of an indicator spectrophotometrically.

### pH-metry

1. Preparation of buffer solution of various pH and the determination of their pH values.
2. Determination of the degree of hydrolysis of aniline hydrochloride.
3. Determine the Hammett constant of a given substituted benzoic acid by pH measurements.

### Chemical Kinetics

1. Determination of the velocity constant and energy of activation of the reactions between  $H_2O_2$  and HI.
2. Investigation of the reaction between acetone and iodine (with respect to  $H^+$ ,  $I_2$  and acetone).



3. Determination of the order and velocity of the reaction between potassium persulphate and potassium iodide.
4. Study the rate of reaction between ethyl bromoacetate and sodium thiosulphate kinetically.

**Experiment: 45 marks**

**Lab Record: 15 marks**

**Viva-voce: 10 marks**

**Course Outcomes:** After the successful completion of the course the learner would be able to:

- i. handle the UV/Visible spectrophotometer and able to find out the various parameters associated with UV/Visible spectrophotometer.
- ii. find out the degree of hydrolysis of solution by pH-metry.
- iii. determine the kinetic parameter of reaction.

**Reference Books:**

1. Practical Chemistry, A.M. James and F.E. Pricherd, Longman.
2. Practical Physical Chemistry, B.P. Levitt and Zindley's, Longman.
3. Practical Physical Chemistry, S.R. Palit and S.K. De, Science Book Agency.
4. Experimental Physical Chemistry, R.C. Das and B. Behra, McGraw Hill.
5. Experiments in Physical Chemistry, Shoemaker and Gailand McGraw Hill.
6. Systematic experimental Physical Chemistry, T.K. Chandershekhar & S.K. Rajbhoj
7. Experimental Physical Chemistry, V.D.Athawale and Parul Mathur, New Age International.

**M Sc CHEMISTRY, SEMESTER III**

**CODE: CH-326A**

**SUBJECT NAME: Physical Chemistry Lab-Special-III**

**NO OF CREDITS: 3**

L P  
0 6

SESSIONAL: 30  
FINAL EXAM: 70  
TOTAL: 100

**Course Objectives:**

To determine the half wave potential of ionic mixtures by polarography. to determine the speed of sound by interferometry. to determine the ionic concentration via flame photometrically. determination of dielectric constant and dipole moment of unknown mixture. Able to handle the data in Excel and origin based software.

**Polarography**

1. To determine dissolved oxygen in aqueous solution of organic solvent.
2. Determination of half wave potentials of some cations in aqueous and in non-aqueous solutions.
3. Determination of half wave potentials of ions in mixtures.
4. Amperometric titrations involving: (i)  $\text{Pb}(\text{NO}_3)_2$  vs.  $\text{K}_2\text{Cr}_2\text{O}_7$  and (ii)  $\text{Pb}(\text{NO}_3)_2$  vs.  $\text{K}_2\text{SO}_4$ .

**Interferometry**

Determination of speed of sound of pure liquids/mixtures using interferometer.

**Flame Photometry**

Determination of  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  in tap water, juice, electrical etc.

**Dielectric Constant and Dipole Moment**

1. Determination of dielectric constants of some organic liquids and composition of unknown mixtures.
2. Determination of dipole moments of some organic liquids.

**Data-Handling/Representation**

1. Using origin-Lab draw data in different styles of graphs.
2. Linear Curve fitting and calculation of regression coefficient using EXCEL worksheet.
3. Calculate activation energy using /thermal analysis data by single/multiple heating rate methods using EXCEL worksheet.

**Note:** Any experiment may be introduced / deleted in the practical class based on the availability/non-availability of the instruments/chemicals.

**Experiment: 45 marks**

**Lab Record: 15 marks**

**Viva-voce: 10 marks**

**Course Outcomes:** After the successful completion of the course the learner would be able to:

- vi. find out the half wave potential of ionic mixtures polarographically.
- vii. find out speed of sound by interferometry.
- viii. determine the ionic concentration via flame photometrically.
- ix. work on the data in Excel and origin software

**Reference Books:**

1. Practical Chemistry, A.M. James and F.E. Pricherd, Longman.
2. Practical Physical Chemistry, B.P. Levitt and Zindley's, Longman.
3. Practical Physical Chemistry, S.R. Palit and S.K. De, Science Book Agency.
4. Experimental Physical Chemistry, R.C. Das and B. Behra, McGraw Hill.
5. Experiments in Physical Chemistry, Shoemaker and Gailand McGraw Hill.
6. Systematic experimental Physical Chemistry, T.K. Chandershekar & S.K. Rajbhoj
7. Experimental Physical Chemistry, V.D.Athawale and Parul Mathur, New Age International.

**M Sc CHEMISTRY, SEMESTER III**

**CODE: OCH-307A**

**SUBJECT NAME: Chemistry for Sustainable Development**

**(Open Elective)**

**NO OF CREDITS: 3**

L P  
3 0

SESSIONAL: 25  
THEORY EXAM: 75  
TOTAL: 100

**Course Objectives:**

To study about chemical aspects of environment. To learn about chemistry of different atmospheric components. To study about thermoanalytical techniques. To learn various chromatographic techniques. To have an idea of food analysis

**UNIT:I**

**Hydrosphere**

Hydrological cycle of water, Water pollution – inorganic, organic, pesticide, agricultural, industrial and sewage, detergents, oil spills and oil pollutants. Water quality parameters – dissolved oxygen, biochemical oxygen demand, solids, metals, content of chloride, sulphate, phosphate, nitrate and micro-organisms. Water quality standards.

**UNIT:II**

**Atmosphere**

Chemical composition of atmosphere – particles, ions and radicals and their formation, Chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S and their effect, air pollution controls and their chemistry.

**UNIT:III**

**Thermoanalytical methods:**

Introduction, Thermogravimetric analysis (TGA), Derivative Thermogravimetric analysis (DTGA), factors affecting TGA and applications, Differential thermal analysis (DTA): theory, factors affecting DTA and applications.

**UNIT:IV**

**Chromatography**

Introduction, Classification of chromatographic methods; Adsorption and Partition Chromatography (Column, Paper and Thin Layer Chromatography), ion exchange chromatography: Principles and Applications.

**Analysis of Food**

Importance of Food analysis, Determination of approximate composition: Moisture, Fat, Protein, Fiber, Carbohydrate etc.

**Course Outcomes:** After the successful completion of the course the learner would be able to

- i. Understand role of chemistry and chemical reactions in environment
- ii. Understand the concept of thermoanalytical techniques and their application
- iii. Perform chromatographic analysis
- iv. Perform basic food analysis

**Reference Books:**

1. Environmental Chemistry; A. K. De, Wiley Eastern.
2. Environmental Pollution Analysis; S. M. Khopkar, Wiley Eastern.
3. Environmental Chemistry; S. K. Banerji: Prentice – Hall.
4. Dynamics of Chromatography Part I; J. C. Gidding; Dekker, New York.
5. Instrumental methods of Analysis; L. L. Merits, R. H. Willard and J. A. Dean; Van Nostrand-Reinhold.

**M Sc CHEMISTRY, SEMESTER III**

**CODE: OCH-308A**

**SUBJECT NAME: Applied Chemistry (Open Elective)**

**NO OF CREDITS: 3**

L	P	SESSIONAL:	25
3	0	THEORY EXAM:	75
		TOTAL:	100

**Course Objectives:**

To study about polymer chemistry. To learn about properties and application of polymers. To study about different types of medicines and associated chemistry.

**UNIT:I**

**Polymer Chemistry-I**

Polymer basic concepts: monomers, degree of polymerization, classification of polymers, types of polymerization, Concept of no. average molecular weight and mass average molecular weight, Methods of determining molecular weights, concept of kinetic chain length Polydispersity index, kinetics of polymerization (addition and chain polymerization)

**UNIT:II**

**Polymer Chemistry-II**

Thermal properties of polymers, Flame retardant polymers, Flame retarding Thermoplastics and Thermosets, physical properties of polymers (glass transition temperature, crystalline melting point), factors affecting  $T_g$  and  $T_m$  Polymer composites, its classification, polymer composites using filler reinforcement, Biocomposites, application of biocomposites in automobiles and in construction materials. Polymer nanocomposites, Properties of polymer nanocomposites, application of polymer nanocomposites

**UNIT:III**

**Medicinal Chemistry-I**

Concept of drug and drug development, lead compound and lead modification, prodrugs and soft drugs, an elementary idea of structure reactivity relationship (SAR), Elementary idea about drug action: the receptor role, neurotransmitters and receptors, ion channels and their control, membrane bound enzymes-activation/deactivation, chemical basis of messenger induced change of shape by the receptor

**UNIT:IV**

**Medicinal Chemistry-II**

Definition, uses and side effects of the following categories of drugs:

Antipyretics, analgesics & anti-inflammatory agents (paracetamol, aspirin, mefenamic acid, ibuprofen and diclofenac), antimalarial (Chloroquine, chloroguanide), Anticancer (Chlorambucil, cyclophosphamide), Cardiovascular drugs (sorbitrate, diltiazem), Antifertility agents (introduction to hormonal and nonhormonal contraception only).

**Course Outcomes:** After the successful completion of the course the learner would be able to

- I understand chemistry of polymers and polymerization
- Ii understand and analyze thermal physical and chemical properties of polymers
- Iii know about drug and drug design
- iv have an analytical view against different types of medicines, their uses and side effects

**Reference Books:**

1. Polymer Chemistry, Billmayer
2. Polymer Chemistry, Gowarikar
3. Principles of Polymerization, Geroge Odian
4. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, Ed. Robert F. Dorge.
5. Burger's Medicinal Chemistry and Drug Discovery, Vol-I, Ed. M.E. Wolf, John Wiley.
6. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.

### Grading System

The Grading system shall be as per the UGC guidelines as given below:

Marks Percentage	Grade	Grade Points	Category
90-100	O	10	Outstanding
80≤ marks<90	A+	9	Excellent
70≤ marks<80	A	8	Very Good
60≤ marks<70	B+	7	Good
50≤ marks<60	B	6	Above Average
45≤ marks<50	C	5	Average
40≤ marks<45	P	4	Pass
< 40	F	0	Fail
-----	Ab	0	Absent

The procedure to Compute the SGPA and CGPA will continue as per the existing system which is similar as recommended by UGC and further percentage will also be calculated by the same formula( $CGPA \times 9.5$ ).