approved in 11(7) w.e.f Academic Session 2020-21 and also for 3rd & 4th Semester for Academic Session 2019-20

Chaudhary Ranbir Singh University, Jind, Haryana

M.Sc. Chemistry (Two years Course)

CHOICE BASED CREDIT SYSTEM

SCHEME OF EXAMINATION w.e.f. 2020-21

M.Sc. (Chemistry) 1st Semester

S. No.	Paper Code	Title	Contact hours (L+T+P)	External Marks		Internal Marks		Total Marks	Credits
				Max. marks	Min. marks	Max. marks	Min. marks		
1.	20CHE11C1	**Inorganic Chemistry- I** Reaction mechanism of #TM complexes & Bioinorganic Chemistry	3+1+0 = 04	80	32	20	08	100	04
2.	20CHE12C2	**Physical Chemistry- I** Chemical/thermo dynamics & Electrochemistry	3+1+0 = 04	80	32	20	08	100	04
3.	20CHE13C3	**Organic Chemistry- I** Stereochemistry, Nature of bonding & Reactive intermediates	3+1+0 = 04	80	32	20	08	100	04
4.	20CHE14CL1	**Inorganic Chemistry Practical- I** Volumetric analysis & green methods of synthesis of inorganic compounds	0+0+6 = 06	80	32	20	08	100	03
5.	20CHE15CL2	**Physical Chemistry Practical- I** Conductometry, thermochemistry, refractometry analysis, surface tension & adsorption	0+0+6 = 06	80	32	20	08	100	03
6.	20CHE16CL3	**Organic Chemistry Practical- I** Quantitative analysis of organic compounds	0+0+6 = 06	80	32	20	08	100	03
7.	*20CHE17F1	**(a) Computer for Chemists** Microsoft Office & Plotting/drawing software	2+0+0= 02	40	16	10	04	50	02
	*20CHE17F2	**(b) Mathematics for Chemist** Vectors, Matrices, Determinants Differential and Integral Calculus	2+0+0= 02	40	16	10	04	50	02
	*20CHE17F3	**(c) Biology for Chemist** Metabolic Processes, Carbohydrates, Lipids, Proteins, Nucleic acids	2+0+0= 02	40	16	10	04	50	02
Grand Total								**700**	**25**

Transition metal

*There are three Groups in this Course (Foundation Course)

Group 1: Students without Mathematics in B.Sc. will opt:
(a) Computer for Chemist and (b) Mathematics for Chemists.

Group 2: Students without Biology in B.Sc. will opt:
(a) Computer for Chemist and (c) Biology for chemists

Group 3: Students without Mathematics and Biology in B.Sc. will opt:
(b) Mathematics for chemists and (c) Biology for Chemists

Note:

- All the papers in M.Sc. 1st semester are mandatory for M.Sc. 1st semester students. C1. C2. C3 are the core theory paper and CL1, CL2, CL3 are the core practical.
- Each theory and practical paper will include 20% marks (15% marks of internal theory/practical tests + 5% marks of Attendance) as internal assessment as per University rules.
- Each practical examination will be of 06 hours and will be conducted in two sessions (Morning & Evening) of 03 hours each.
- Maximum marks of M.Sc. 1st semester will be 700. Theory 400 marks; Practical 300 marks
- The payment of practical examination to the internal as well as external examiners will be made on the basis of sessions.
- Total credits: 25, Core = 21 (Core Theory= 12 & Core Practical = 09); Foundation Course = 04

M.Sc. (Chemistry) 2nd Semester

S. No.	Paper Code	Title	Contact hours (L+T+P)	External Marks		Internal Marks		Total Marks	Credits
				Max. marks	Min. marks	Max. marks	Min. marks		
1	20CHE21C4	**Inorganic Chemistry- II** Coordination chemistry & Magnetic Studies of #TM complexes	3+1+0 =04	80	32	20	08	100	04
2	20CHE22C5	**Physical Chemistry- II** Quantum mechanics, Statistical thermodynamics & Group theory	3+1+0 =04	80	32	20	08	100	04
3	20CHE23C6	**Organic Chemistry- II** Organic reaction mechanism & Pericyclic reactions	3+1+0 =04	80	32	20	08	100	04
4	20CHE24CL4	**Inorganic Chemistry Practical- II** Quantitative inorganic analysis & estimation of metal ions by Cerimetry.	0+0+6 =06	80	32	20	08	100	03
5	20CHE25CL5	**Physical Chemistry practical- II** Potentiometry, pH metry,Chemical Kinetics and Distribution Law	0+0+6 =06	80	32	20	08	100	03
6	20CHE26CL6	**Organic Chemistry Practical –II** Two step organic synthesis	0+0+6 =06	80	32	20	08	100	03
7	20CHE27E1 or 20CHE27E2	**General Spectroscopy** Rotational, Vibrational, Raman & NMR, IR spectroscopy or **Green & Sustainable Chemistry** Green Chemistry, Sustainable energy resources, catalysis & Supramolecules	3+1+0=04	80	32	20	08	100	04
8	20CHE28OE (Open Elective)	* **Environmental Chemistry-I** Environment, Hydrosphere & Environmental Toxicology	3+1+0 =04	80	32	20	08	100	04
Grand Total								800	29

Transition metal

* This paper is offered to students of other Departments. For M.Sc. Chemistry students, it is to be chosen from other Departments/disciplines.

Note:

- Core papers (C4, C5, C6, CL4, CL5, CL6) are mandatory for M.Sc. 2nd semester students.
- Candidate has to opt one Discipline Specific Elective (DSE) paper out of two, namely, 20CHE27E1 & E2.
- 20CHE28OE is to be opted by M.Sc. students from Chemistry Department/other Departments. (Open Elective).
- Maximum marks of M.Sc. 2nd semester will be 800 (Theory 500; Practical 300).
- Each theory and practical paper will include 20% marks (15% marks of internal theory/practical tests + 5% marks of Attendance) as internal assessment as per University rules.
- Each practical examination will be of 06 hours and will be conducted in two sessions (Morning & Evening) of 03 hours each.
- The payment of practical examination to the internal as well as external examiners will be made on the basis of Sessions.
- Total Credits = 29, Core = 21 (Core Theory= 12 & Core Practical = 09); DSE = 04; Open Elective = 04

M.Sc. (Chemistry) 3rd Semester

S. No.	Paper Code	Title	Contact hours (L+T+P)	External Marks		Internal Marks		Total Marks	Credits
				Max. marks	Min. marks	Max. marks	Min. marks		
1.	20CHE31C7	*Techniques in Chemistry **AAS,AES, Nanomaterials Technology & Chromatographic Separation	3+1+0 = 04	80	32	20	08	100	04
2.	20CHE35 OE (Open Elective)	* **Environmental Chemistry-II** Water quality parameters/standards, Industrial/Organic Pollutants & Green Chemistry	3+1+0 =04	80	32	20	08	100	04

Special Elective Papers

M.Sc. (Chemistry) 3rd Semester (Inorganic Specialization)

S. No.	Paper Code	Title	Contact hours (L+T+P)	External Marks		Internal Marks		Total Marks	Credits
				Max. marks	Min. marks	Max. marks	Min. marks		
1.	20CHE31IS1	**Inorganic Chemistry Special-I** Vibrational, ESR, Mossbauer, Mass, NMR Spectroscopy	3+1+0 = 04	80	32	20	08	100	04
2.	20CHE32IS2	**Inorganic Chemistry Special-II** Nuclear & radiochemistry	3+1+0 = 04	80	32	20	08	100	04
3.	20CHE33IS3	**Inorganic Chemistry Special-III** Bioinorganic & environmental chemistry	3+1+0 = 04	80	32	20	08	100	04
4.	20CHE34ISP W1	**Project Work**	0+0+18 = 18	240	96	60	24	300	09

M.Sc. (Chemistry) 3rd Semester (Physical Specialization)

S. No.	Paper Code	Title	Contact hours (L+T+P)	External Marks		Internal Marks		Total Marks	Credits
				Max. marks	Min. marks	Max. marks	Min. marks		
1.	20CHE31PS1	**Physical Chemistry Special-I** Electrochemistry, Adsorption & Chemical dynamics	3+1+0 = 04	80	32	20	08	100	04
2.	20CHE32PS2	**Physical Chemistry Special-II** Statistical, thermodynamics & Quantum mechanics	3+1+0 = 04	80	32	20	08	100	04
3.	20CHE33PS3	**Physical Chemistry Special-III** Spectroscopy & Polymers	3+1+0 = 04	80	32	20	08	100	04
4.	20CHE34PSP W1	**Project Work**	0+0+18 = 18	240	96	60	24	300	09

M.Sc. (Chemistry) 3rd Semester (Organic Specialization)

S. No.	Paper Code	Title	Contact hours (L+T+P)	External Marks		Internal Marks		Total Marks	Credits
				Max. marks	Min. marks	Max. marks	Min. marks		
1.	20CHE31OS1	**Organic Chemistry Special- I** Organic spectroscopy	3+1+0 = 04	80	32	20	08	100	04
2.	20CHE32OS2	**Organic Chemistry Special- II** Chemistry of natural products	3+1+0 = 04	80	32	20	08	100	04
3.	20CHE33OS3	**Organic Chemistry Special- III** Heterocyclic Chemistry	3+1+0 = 04	80	32	20	08	100	04
4.	20CHE34OSPW1	**Project Work**	0+0+18 = 18	240	96	60	24	300	09
Grand Total								**800**	**29**

* This paper is offered to students of other Departments. For M.Sc. Chemistry students, it is to be chosen from other Departments/disciplines.

** Atomic Absorption/emission Spectroscopy

Note:

- The Core Paper (C7) is mandatory for M.Sc. 3rd semester students.
- IS1, IS2, IS3, PS1, PS2, PS3, OS1, OS2, and OS3 are Specialization Elective Theory (SET).
- ISPW, PSPW, OSPW are Specialization Elective Practical (SEP) and are discipline specific.
- Candidate has either to opt Inorganic or Physical or Organic Specialization, and change in opted specialization will not be permitted in 4th semester.
- Maximum marks of M.Sc. 3rd semester will be 800 (Theory 500; Project Work 300).
- Each theory paper will include 20% marks (15% marks of class tests + 5% marks of attendance) as internal assessment as per University rules.
- Each practical examination will be of 06 hours and will be conducted in two sessions (Morning & Evening) of 03 hours each.
- Project work marks will include 20% internal assessment. 40% dissertation, and 40% for external viva-voce.
- The payment to the internal as well as external examiners will be made on the basis of sessions.
- Total Credits = 29 (Core= 04, SET = 12, SEP= 09, OE= 04).
- Project will be assessed by Discipline Specific external examiner.
- Topic of project work will be finalized in discussion with the Supervisior.

M.Sc. (Chemistry) 4th Semester

S. No.	Paper Code	Title	Contact hours (L+T+P)	External Marks		Internal Marks		Total Marks	Credits
				Max. marks	Min. marks	Max. marks	Min. marks		
1.	20CHE41C8	**Polymer Chemistry** Introduction, Characterization, Properties & Processing	3+1+0 = 04	80	32	20	08	100	04

Special Elective Papers

M.Sc. (Chemistry) 4th Semester (Inorganic Specialization)

S. No.	Paper Code	Title	Contact hours (L+T+P)	External Marks		Internal Marks		Total Marks	Credits
				Max. marks	Min. marks	Max. marks	Min. marks		
1.	20CHE41IS4	**Inorganic Chemistry Special-IV** Organotransition metal chemistry	3+1+0 = 04	80	32	20	08	100	04
2.	20CHE42IS5	**Inorganic Chemistry Special- V** Analytical Chemistry	3+1+0 = 04	80	32	20	08	100	04
3.	20CHE43IS6	**Inorganic Chemistry Special-VI** Medicinal aspects of Inorganic Chemistry	3+1+0 = 04	80	32	20	08	100	04
4.	20CHE44ISL4	**Inorganic Chemistry Special Practical- I** Interpretation/determination of IR spectrum of inorganic compounds	0+0+6= 06	80	32	20	08	100	03
5.	20CHE45ISL5	**Inorganic Chemistry Special Practical- II** Conductometry, pH metry & potentiometry	0+0+6= 06	80	32	20	08	100	03
6.	20CHE46ISL6	**Inorganic Chemistry Special Practical- III** Ion exchange method in column chromatographic analysis	0+0+6= 06	80	32	20	08	100	03

M.Sc. (Chemistry) 4th Semester (Physical Specialization)

S. No.	Paper Code	Title	Contact hours (L+T+P)	External Marks		Internal Marks		Total Marks	Credits
				Max. marks	Min. marks	Max. marks	Min. marks		
1.	20CHE41PS4	**Physical Chemistry Special-IV** Applications of Electrochemistry	3+1+0 = 04	80	32	20	08	100	04
2.	20CHE42PS5	**Physical Chemistry Special-V** Statistical, Non-equilibrium thermodynamics & Quantum Mechanics	3+1+0 = 04	80	32	20	08	100	04
3.	20CHE43PS6	**Physical Chemistry Special-VI** Electrochemistry & Corrosion	3+1+0 = 04	80	32	20	08	100	04
4.	20CHE44PSL4	**Physical Chemistry Special Practical- I:Potentiometry &** pH metry titration	0+0+6= 06	80	32	20	08	100	03

5.	20CHE45PSL5	**Physical Chemistry Special Practical- II** Conductometric titration, polarometry, Flame photometry	0+0+6= 06	80	32	20	08	100	03
6.	20CHE46PSL6	**Physical Chemistry Special Practical- III :** Ultrasonic interferrometry,spectrocolorimetry & chemical kinetics	0+0+6= 06	80	32	20	08	100	03

M.Sc. (Chemistry) 4th Semester (Organic Specialization)

S. No.	Paper Code	Title	Contact hours (L+T+P)	External Marks		Internal Marks		Total Marks	Credits
				Max. marks	Min. marks	Max. marks	Min. marks		
1.	20CHE41OS4	**Organic Chemistry Special-IV** Photochemistry & Disconnection approach	3+1+0 = 04	80	32	20	08	100	04
2.	20CHE42OS5	**Organic Chemistry Special- V** Medicinal and Natural Products Chemistry	3+1+0 = 04	80	32	20	08	100	04
3.	20CHE43OSE1 or OSE2 or OSE3 **(Organic special Elective)**	**Organic Chemistry Special-VI** (a) Organic reaction & reagents or (b) Bioorganic chemistry	3+1+0 = 04	80	32	20	08	100	04
4.	20CHE44OSL4	**Organic Chemistry Special Practical- I :** Multistep synthesis & Quantitative analysis of organic compounds	0+0+6= 06	80	32	20	08	100	03
5.	20CHE45OSL5	**Organic Chemistry Special Practical- II :** Isolation and chromatography of organic compounds	0+0+6= 06	80	32	20	08	100	03
6.	20CHE46OSL6	**Organic Chemistry Special Practical- III :** Qualitative analysis using spectroscopic, chemical methods & Spectrophotometric estimations	0+0+6= 06	80	32	20	08	100	03
Grand Total								700	25

Note:

- The Core Paper (C8) is mandatory for M.Sc. 4th semester students.
- IS4, IS5, IS6, PS4, PS5, PS6, OS4,OS5, and OS6 are specialization elective theory (SET) papers.
- ISL4, ISL5, ISL6, PSL4, PSL5, PSL6, OSL4, OSL5, and OSL6 are specialization elective practical (SEP)/Discipline Specific papers.
- Candidate has to continue the same Specialization as opted in 3rd semester.
- Maximum marks of M.Sc. 4th semester will be 700 (Theory 400; Practical 300).
- Each theory and practical paper will include 20% marks (15% marks of internal theory/practical tests + 5% marks of Attendance) as internal assessment as per University rules.
- Each practical examination will be of 06 hours and will be conducted in two sessions (Morning & Evening) of 03 hours each.
- Total credits 25 (SET = 16 SEP = 09)

Semester	Core Courses		Elective Courses		Open Elective Courses		Foundation Course		Total Credits	Total Marks
	Credits (L+T+P)	Total Credits	Credits (L+T+P)	Total Credits	Credits (L+T+P)	Total Credits	Credits (L+T+P)	Total Credits		
I	9+3+9	21	0	0	0	0	4+0+0	4	25	700
II	9+3+9	21	3+1+0	4	3+1+0	4	0	0	29	800
III	3+1+0	4	9+3+9	21	3+1+0	4	0	0	29	800
IV	3+1+0	4	9+3+9	21	0	0	0	0	25	700
Total Credits for the course		50		46		8		4	108	3000

Note: 96 Credits as Core/Elective Courses, 4 credits as Foundation Course and 08 Credits as Open Elective are Compulsory to obtain the M.Sc. degree.

M.Sc. Chemistry (1st Semester)

Inorganic Chemistry- I
Paper Code: 20CHE11C1
Reaction mechanism of transition metal complexes & Bioinorganic Compounds

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

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.

Unit -II

Reaction Mechanism of Transition Metal Complexes-I

Basic principles of lability and Inertness, Mechanisms for ligand replacement reactions, Formation of complexes from aquo ions, Ligand displacement reactions in octahedral complexes- acid hydrolysis, Base hydrolysis, electrophilic attack on ligands.

Unit -III

Reaction Mechanism of Transition Metal Complexes-II

Mechanism of ligand, displacement reactions in square planar complexes, the trans effect, theories of trans effect, mechanism of electron transfer reactions – types; outer sphere electron transfer mechanism and inner sphere electron transfer mechanism, electron exchange.

Unit - IV

Catalysis and Bio-inorganic Chemistry

Transition metal ion catalysts for organic transformations and their application in hydrogenation. Wilkinson's catalysis, Asymmetric hydrogenation, Hydroformylation or oxo process, Wacker's Process, Monsanto Acetic acid process, Cativa process. Alkenes metathesis, Alkyne metathesis, Alkene polymerization, Water-Gas reaction. Role of metal ions in biological systems. Toxic metal ions and their detoxification, chelation therapy/chelating agents in medicine. Recent advances in cancer chemotherapy using chelates.

Recommended Readings:

1. J.D. Lee: Concise Inorganic Chemistry, Oxford University Press Publication, 5th edition (2008).
2. G.L. Miesseler and D.A. Tarr: Inorganic Chemistry, Prentice Hall; 3rd edition (2003).
3. H.J. Emeleus & A.G. Sharpe: Modern aspects of inorganic chemistry, Routledge & Kegan Paul Publication (1973).
4. B.N. Figgis: Introduction to ligand field, John Wiley & Sons Publication (1966).
5. R.H. Crabetree: The Organometallic Chemistry of the Transition Metals, Wiley-Blackwell publication, 6th edition (2014).
6. A.J. Elias, B.D. Gupta: Basic Organometallic Chemistry: Concepts, Syntheses, and Applications of Transition Metals CRC Press, 1st edition (2010).

Further Readings:

1. J.E. Huheey: Inorganic Chemistry: Principles of Structure &reactivity, Pearson publication, 4th edition (1997).
2. O.P. Aggarwal: Chemical bonding, Dhanpat Rai & Co (P) Ltd. 5th edition(2003).
3. Basolo Pearson: Inorganic Reaction Mechanism, John Wiley & Sons Publication, 2nd edition (1967).
4. M.N. Hughes: The inorganic chemistry of biological processes, Wiley Publication, 2nd edition (1981).
5. C. Masters: Homogeneous transition metal catalysis, Springer Publication(1981).
6. I. Bertini , Harry B. Gray, Stephen J. Lippard, Joan S. Valentine: Bioinorganic Chemistry,University Science Books, U.S. (1994).

M.Sc. Chemistry (1st Semester)

Physical Chemistry- I
Paper Code: 20CHE12C2
Chemical/Thermo dynamics & Electrochemistry

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

Chemical Dynamics-I

Effect of temperature on reaction rates, Rate law for opposing reactions of 1st and 2nd order. Rate law for consecutive & parallel reactions of 1st order reactions, Collision theory of reaction rates and its limitations. steric factor, Activated complex theory. Ionic reactions: single and double sphere models, influence of solvent and ionic strength, the comparison of collision and activated complex theory.

Unit -II

Chemical Dynamics – II

Chain reactions: hydrogen - bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane. Photochemical reactions (hydrogen - bromine & hydrogen -chlorine reactions). General treatment of chain reactions (ortho -para hydrogen conversion and hydrogen - bromine reactions), apparent activation energy of chain reactions, chain length, Rice- Herzfeld mechanism of organic molecules decomposition(acetaldehyde) Branching chain reactions and explosions (H_2 - O_2 reaction). Kinetics of (one intermediate) enzymatic reaction : Michaelis - Menten treatment, evaluation of Michaeli's constant for enzyme - substrate binding by Lineweaver - Burk plot and Eadie- Hofstae methods. Competitive and non-competitive inhibition.

Unit -III

Thermodynamics-I

Brief resume 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, enthalpy functions and their significance, criteria for spontaneity of a process; partial molar quantities (free energy, volume, heat concept), Gibb's-Duhem equation. Clausius – Clayperon equation; law of mass action and its thermodynamic derivation.

Unit - IV

Electrochemistry-I

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, the solvent effect on the mobility at infinite dilution,

equivalent conductivity (Λ) vs. concentration $c^{1/2}$ as a function of the solvent, effect of ion association upon conductivity (Debye- Huckel - Bjerrum equation).

Recommended Readings:

1. K.J. Laidler: Chemical Kinetics, Pearson Publication, 3rd edition (2003).
2. W. Moore & G.Pearson: Kinetics & Mechanism, Wiley, 3rd edition (1981).
3. S. Glasstone: Thermodynamics for chemists, Macmillan Publisher 2nd edition (2008).
4. J.O.M. Bockris and A.K.N. Reddy: Modern electrochemistry Vol.1: Ionics, 2nd edition (1998).
5. Peter Atkins, Julio De Paula, James Keeler, Atkin's Physical chemistry, Oxford University Press; 11th edition (2018).
6. H. Eyring, M. Eyring: Modern chemical kinetics, Reinhold Publishing Corp., New York, New Impression Edition (1963).
7. F. Daniels and R.A. Alberty: Physical Chemistry, John Wiley and Sons, Inc. (1987).

Further Readings:

1. K.J. Laidler, H.Eyring & S. Glasstone: The theory of Rate processes, McGraw-Hill, New York (1941).
2. G.M. Barrow: Physical Chemistry Mcgraw Hill education, 5th edition (2006).
3. R.C. Srivastava, S.K. Saha & A.K. Jain: Thermodynamics: A core Course, Prentice Hall India Learning Private Limited; 3rd edition (2007).
4. S. Glasstone: Theoretical Chemistry, Van Nostrand Reinhold Inc.,U.S. (1944).
5. R. Puri, S. Pathania, R. Sharma: Principles of Physical Chemistry, Vishal Publishing Co. (2019).
6. D.R. Crow: Principles and Applications of Electrochemistry, Chapman and Hall, London, 4th edition (1994).

M.Sc. Chemistry (1st Semester)

Organic Chemistry- I
Paper Code: 20CHE13C3
Stereochemistry, Nature of Bonding & Reactive Intermediates

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit-I

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 of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding. Axial and planer chirality, optical isomerism in allenes, biphenyls (atropoisomerism), spiranes, hemispiranes, elementary ideas about stereochemistry of tertiary amines, quaternary salts, sulphur and phosphorous compounds.

Unit-II

Stereochemistry –II

Methods of resolution, optical purity, Topicity of ligands and faces, their nomenclature and prostereoisomerism, stereogenecity, 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.

Curtin-Hammett Principle. Molecular dissymmetry and chiroptical properties: Linear and circularly polarised lights, circular birefringence and circular dichroism, ORD and CD curves, Cotton effect.

Unit-III

Nature of Bonding in Organic Molecules

Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule level of π-molecular orbitals, annulenes, antiaromaticity, homoaromaticity. Bonds weaker than covalent, addition compounds, crown ether complex and cryptands, inclusion compounds,cylodextrins, catenanes and rotaxanes.

Reactive Intermediates

Linear free energy relationships and their applications (Hammett equation and modifications). Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbene and nitrenes.

Unit- IV

Free Radical Reactions

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity. Allylic halogenations (NBS), oxidation of aldehydes to carboxylic acids, autooxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction.

Addition to Carbon-Carbon Multiple Bonds

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio-and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.

Recommended Readings:

1. D. Nasipuri: Stereochemistry of Organic Compounds, NEW AGE; 3rd edition (2018).
2. P.S. Kalsi: Stereochemistry of Organic Compounds, New Age International Private Limited, 2nd edition (2016).
3. P.S. Kalsi, Organic Reactions and their Mechanisms, 2nd edition, New Age International Publishers, (2000).
4. J. March: Advanced Organic Chemistry-Reactions Mechanism and Structure, Wiley Publication, 6th edition (2007).
5. Peter Sykes: A guide Book to Mechanism in Organic Chemistry, Pearson Education; 6th edition (2003).
6. S.H. Pine, J.B. Hendrickson, D.J. Cram, G.S. Hammond, Organic Chemistry, McGraw-Hill Inc., Tokyo, (1980).

Further Readings:

1. R.T. Morrison and R.N. Boyd: Organic Chemistry, Pearson India; Sixth Edition (2016).
2. P.S. Kalsi, Stereochemistry: Conformation and Mechanism, 2nd edition, Wiley Eastern Limited, (1993).
3. S.M. Mukherji and S.P. Singh: Reaction Mechanism in Organic Chemistry, Laxmi Publications; 3rd edition (2007).
4. S.P. Bhutani: Carbohydrate, Ane Books Pvt. Ltd (2010).
5. I.L. Finar: Organic Chemistry, Pearson Education India; 6th edition (2002).
6. H.O. House: Modern Synthetic Reactions, Benjamin-Cummings Publishing Co., Subs. of Addison Wesley Longman, US; 2nd Revised edition (1972).
7. Organic Chemistry by Clyden, Oxford University Press; 2nd edition (2014).

M.Sc. Chemistry (1st Semester)

Inorganic Chemistry Practical- I
Paper Code: 20CHE14CL1
Volumetric analysis &Green methods of synthesis of Inorganic Compounds

6 hrs./week
Credits: 03
Max. Marks: 80+20
Time: 6 hrs.

1 **Volumetric Analysis**

(a) Potassium iodide titrations

Determination of iodide and antimony (III)

(b) Potassium bromate titrations

(i) Determination of antimony (III) (by Direct Method)

(ii) Determination of Aluminium, and Magnesium (by Oxine method)

(c) EDTA titrations

(i) Determination of Calcium. Copper, Barium, Zinc.

(ii) Back titration

(iii) Titration of mixtures using masking

2. **Green methods of Preparation of the following**

(i) Bis (acetylacetonato) copper (II)

(ii) Tris (acetylacetonato) iron (III)

(iii) Tris (acetylacetonato) manganese (III)

(iv) $[Cu(NH_3)_4]\ SO_4.\ H_2O$

(v) $K_3[Fe(C_2O_4)_3]$

(vi) $[Ni(en)_3]\ S_2O_3$

Viva-Voce	**10 Marks**
Note Book	**10 Marks**

Recommended Readings:

1. A.I. Vogel: A text Book of Quantitative Inorganic Analysis, Longman Publication, 5th edition (1989).
2. O.P. Vermani: Applied Analytical Chemistry, New Age International Publication, 2nd edition (2017).

M.Sc. Chemistry (1st Semester)

Physical Chemistry Practical- I
Paper Code: 20CHE15CL2
Conductometry, Thermochemistry, Refractometry, Surface Tension & Adsorption

6 hrs./week
Credits: 03
Max. Marks: 80+20
Time: 6 hrs.

1. Conductometry

(i) To determine cell constant of conductivity cell.

(ii) NaOH vs. HCl titration.

(iii) NaOH vs. Oxalic acid titration.

(iv) NaOH vs CH_3 COOH titration

(v) Ba $(NO_3)_2$ vs. Na_2 SO_4 titration

2. Thermochemistry: Determination of heat of neutralization of the followings:-

(i) NaOH vs. HCl

(ii) NaOH vs. CH_3COOH

(iii) NaOH vs. Oxalic acid

3. Refractometry

(i) To determine molar refractivity of the given liquid.

(ii) To determine percentage composition of liquids in the given binary mixture.

(iii) To determine concentration of sugar in a given solution.

4 Surface Tension

To determine interfacial tension of two immiscible liquids.

5. Adsorption

To study the adsorption of Oxalic acid and Acetic acid on charcoal.

Viva Voce	**(10 Marks)**
Note Book	**(10 Marks)**

Recommended Readings:

1. J.B. Yadav: Advanced Practical Physical Chemistry. K Prakashan Media (P) Ltd (2015).
2. B.D. Khosla, V.C. Garg and A. Khosla: Senior practical physical chemistry. R. Chand & Co.. New Delhi (2011).

Further Readings:

1. B. Vishwanathan and P.S. Raghav: Practical Physical Chemistry. Viva Books (2014).
2. P.S. Sindhu: Practical in Physical Chemistry, Macmillan Publishers India (2005).
3. A Thawale and P. Mathur: Experimental Physical Chemistry. New Age International Private Limited: 1st edition (2001).

M.Sc. Chemistry (1st Semester)

Organic Chemistry Practical- I
Paper Code: 20CHE16CL3
Quantitative Analysis of organic compounds

6 hrs/week
Credits: 03
Max. Marks: 80+20
Time: 6 hrs

1. Quantitative Analysis.

Separation, purification and identification of organic compounds in binary mixtures by chemical tests and preparation of their derivatives.

Viva-Voce	**10 Marks**
Note Book	**10 Marks**

Recommended Readings:

1. H. Clark: Handbook of Organic Analysis-Qualitative and Quantitative, CBS; 4th Revised edition (2007).
2. A. R. Tatchell, Peter W.G. Smith, A.J. Hannaford, B.S. Furniss: Vogel's Textbook of Practical Organic Chemistry, Pearson Education; 5th edition (2003).
3. D. Pasto, C. Johnson and M. Miller: Experiments and Techniques in Organic Chemistry, Prentice Hall; Instructor's edition (1992).

Further Readings:

1. K.L. Williamson, & K.M. Masters: Macroscale and Microscale Organic Experiments, Cengage Learning; 6th edition (2010).
2. H. Middleton: Systematic Qualitative Organic Analysis,Edward Arnold & Co. (1948).

M.Sc. Chemistry (1st Semester)

Computer for Chemists
Paper Code: 20CHE17F1
Microsoft office &Plotting/drawing software

2 hrs./week
Credits: 02
Max. Marks: 40+10
Time: 2 hrs.

Note:-The question paper will comprise of 9 questions, three questions from each Unit. The candidates will be required to attempt five questions selecting at least one question from each Unit. All questions will carry equal marks.

UNIT-I

Computer Fundamentals

Basic working Principle of Computers, Input & Output Devices, Memory Devices, Operating System. Introduction to Database Management Systems and Internet.

Word Processing

Page Setting, Creating Letter, Formatting a Document, Searching in Document, Bullets and Numbering, Text Wrapping, Insert Table, Page Break, Picture, ClipArt, Shapes, Smart Art, Water Mark, Columns, Chart, Hyper Link, Bookmark, Cross Reference, Header, Footer, Endnote, Footnote, Page Number, Text Box, Mathematical and Other Symbols.

UNIT-II

Spreadsheet

Worksheet and Workbook, Creating a Worksheet, Cell Formatting, Text Wrapping, Merge and Centre, Table Formatting, Sorting, Filtering, Searching, Insert Picture, Shapes, Graphs, Chart, Symbols, Applying Formula and Function, Calculation Options, Importing Data from Other Sources.

UNIT-III

Power Point Presentation

Create New Slide, Setting Layout of New Slide, Insert Slide, Delete Slide, Insert Table, Picture, Shapes, Chart, Hyper Link, Header, Footer, Slide Number, Text Box, Signature and Line, Data and Time, Mathematical and Other Symbols, Sound and Video, Transition and Animation, Set and Present a Slide Show.

Plotting/Drawing software: Introduction to Chemdraw & Origin software and their basic application in Chemistry:- Linear Plot & fit, drawing of simple organic molecules.

Recommended Readings:

1. Anita Goel: Computer Fundamentals, Pearson Education, India (2010).
2. Ramesh Bangia: Computer Fundamentals and Information Technology, Firewall Media (2008).

Further Readings:

1. Ashok Arora: Computer Fundamentals and Applications, Vikas Publishing (2015).
2. Sudipto Das: A Complete Guide to Computer Fundamentals, Science Press (2010).

M.Sc. Chemistry (1st Semester)

Mathematics for Chemists
Paper Code: 20CHE17F2
Vectors, Matrices, Determinants, Differential & Integral Calculus

2 hrs./week
Credits: 02
Max. Marks: 40+10
Time: 2 hrs.

Note:-The question paper will comprise of 9 questions, three questions from each Unit. The candidates will be required to attempt five questions selecting at least one question from each Unit. All questions will carry equal marks.

UNIT-I

Vector

Vectors- Definition and its properties, Examples of scalar and 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 and vector product.

Matrices and Determinants

Definition of matrix, types of matrices, addition, subtraction and multiplication by a number, matrix multiplication. Transpose and adjoint of matrix, elementary transformation. Definition of determinant, properties of determinants.

Elements of Algebraic and Trigonometric Functions

The binomial expansion, some example from chemistry, sines, cosines and tangents, trigonometric identities.

UNIT-II

Statistical:

Measures of dispersion, range, mean deviation, frequency distribution, variance and standard deviation.

Differential and Integral Calculus:

Theory, rules of differentiation, powers, added and subtracted functions, constants, products, quotients, functions of a function, logarithmic differentiation, parametric functions. Algebraic simplification, differentiation of implicit functions, graphical significance of differentiation, rate of change of slope, successive differentiation Examples related to maximally populated rotational energy levels, Bohr's radius and most probable velocity from Maxwell's distribution. Exact and inexact differential with their

application to thermodynamic principles. Integral theory, basic rules of integration, integration by parts, partial fraction, and substitution.

UNIT-III

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.

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, application to chemical problems.

Differential Equation

Simple differential equations, partial differential equation, separable variables, homogeneous equations, exact equations, linear equations, equation of the first and second order,

Recommended Readings:

1. G. Stephemen: ELBS: Mathematical Methods for Science Students, Pearson (1973).
2. E. Steiner: The Chemistry Mathematics Book, Oxford University Press, 2nd edition (2008).
3. G. Doggett, B.T. Sutcliffe: Mathematics for Chemistry, Longman Scientific & Technical (1995).
4. B. Richard: Schaum series: Differential equation, McGraw-Hill Education, 2nd edition (2013)
5. F. Daniels: Mathematical Preparation for Physical Chemistry, McGraw Hill Book Co., 1st edition (1928).

Further Readings:

1. D.M. Hirst: Chemical Mathematics, Chemical Publishing Company, 2nd edition (2011).
2. J.R. Barrante: Applied Mathematics for Physical Chemistry, Waveland Pr Inc, reissue edition (2016).
3. I.N. Sneddom: Elements of Partial Differential Equation, Tata McGraw Hill (1957).

M.Sc. Chemistry (1st Semester)

Biology for Chemists
Paper Code: 20CHE17F3
Metabolic Processes, Carbohydrates, Lipids, Proteins & Nucleic Acids

2 hrs./week
Credits: 02
Max. Marks: 40+10
Time: 2 hrs.

Note:-The question paper will comprise of 9 questions, three questions from each Unit. The candidates will be required to attempt five questions selecting at least one question from each Unit. All questions will carry equal marks.

UNIT - I

Metabolic Processes

Overview of metabolic processes - catabolism and anabolism. ATP - the biological energy currency.

Carbohydrates

Conformation of monosaccharides, structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars. N-acetylmuramic acid, sialic acid, disaccharides and polysaccharides. Structural polysaccharides - cellulose and chitin. Storage polysaccharides - starch and glycogen.

Carbohydrates of glycoproteins and glycolipids. Role of sugars in biological recognition. Blood group substances. Ascorbic acid.

Carbohydrate metabolism - Kreb's cycle, glycolysis, glycogenesis and glycogenolysis, gluconeogenesis, pentose phosphate pathway.

UNIT - II

Lipids

Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Lipoproteins - composition and function. Properties of lipid aggregates-micelles, bilayers, liposomes and their possible biological functions.

Lipid metabolism - -oxidation of fatty acids.

Proteins

Chemical and enzymatic hydrolysis of proteins to peptides. Secondary structure of proteins, forces responsible for holding of secondary structures. -helix, -sheets, super secondary structure, triple helix structure of collagen. Tertiary structure of protein- folding and domain structure. Quaternary structure.

UNIT - III

Nucleic Acids and Genetic Code

Structure of nucleotides, nucleosides, DNA (Watson-Crick model) RNA structure and conformation, Replication of DNA, transcription, translation of genetic material, genetic code, universality of the code, codon, anticodon pairing, RNA, protein biosynthesis (initiation,Elongation, termination and processing of the peptide chain).

Recommended Readings:

1. A. L. Lehninger: Principles of Biochemistry, Worth Publishers (1983).
2. J. M. Berg, J. L. Tymoczko, L. Stryer: W.H.Freeman: Biochemistry, 5th edition (2002).
3. J. D. Rawn: Biochemistry, Neil Patterson Pub. (1989).

Further Readings:

1. D. Voet, J.G. Voet: Biochemistry, John Wiley, 4th edition (2010).
2. E. E.Conn, P. K. Stumpf: Outlines of Biochemistry, John Wiley, 4th edition (1976).

M.Sc. Chemistry (2nd Semester)

Inorganic Chemistry- II
Paper Code: 20CHE21C4
Coordination chemistry & Magnetic Studies of TM complexes

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

Metal-Ligand Bonding

Limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral or square planar complexes, π-bonding and molecular orbital theory.

Unit-II

Electronic Spectra of Transition Metal Complexes

Spectroscopic ground states, correlation and spin-orbit coupling in free ions for Ist series of transition metals, Orgel and Tanabe -Sugano diagrams for transition metal complexes (d1 – d9 states) calculation of Dq, B and β parameters, effect of distortion on the d-orbital energy levels. Structural evidence from electronic spectrum, Jahn-Teller effect, Spectrochemical and nephalauxetic series, charge transfer spectra, electronic spectra of molecular addition compounds.

Unit-III

Magantic Properties of transition metal complexes

Elementary theory of magneto - chemistry, Guoy's method for determination of magnetic susceptibility, calculation of magnetic moments, magnetic properties of free ions, orbital contribution, effect of ligand-field, spectral and magnetic properties of transition and inner transition metals. Magnetic exchange coupling and spin state cross over.

Metal Clusters

Structure and bonding in higher boranes, Wade's rules, Carboranes, Metal Carbonyl clusters-Low Nuclearity Carbonyl clusters, total electron count (TEC), HNCC, structure of Zintl ions.

Unit - IV

Metal- π Complexes

Metal carbonyls. structure and bonding, vibrational spectra of metal carbonyls for bonding and structure elucidation, important reactions of metal carbonyls; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand.

Recommended Readings:

1. F.A. Cotton & G. Wilkinson: Advanced Inorganic Chemistry, Wiley Publication, 6th edition (1999).
2. J.E. Huheey: Inorganic Chemistry: Principles of Structure &reactivity, Pearson publication, 4th edition (1997).
3. G.L. Miesseler and D.A. Tarr: Inorganic Chemistry, Prentice Hall; 3rd edition (2003).
4. N.N. Greenwood & A. Earnshaw: Chemistry of the Elements, Butterworth-Heinemann publication. 2nd edition (1997).

Further Readings:

1. R. Gopalan & R. Ramalingam: Concise Co-ordination Chemistry. Vikas Publication House , 1st edition (2008).
2. R.L. Carlin: MagnetoChemistry,Springer-Verlag Berlin Heidelberg publication, 1st edition (1986).
3. J.D. Lee: Concise Inorganic Chemistry, Oxford University Press publication ; 5th edition (2008).
4. A. Earnshaw: Introduction to Magneto Chemistry, Elsevier (2013).

M.Sc. Chemistry (2nd Semester)

Physical Chemistry- II
Paper Code: 20CHE22C5
Quantum mechanics, Statistical, thermodynamics & Group theory

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

Quantum Mechanics-I

Postulates of Quantum Mechanics; derivation of Schrodinger wave equation; Max-Born interpretation of wave functions (Ψ) and the Heisenberg's uncertainty principle; Quantum mechanical operators and their commutation relations, Hermitian operators, (elementary ideas, quantum mechanical operator for linear momentum, angular momentum and energy as Hermitian operator). The average value of the square of Hermitian operators; commuting operators and uncertainty principle(x & p; E &t); Schrodinger wave equation for a particle in one dimensional box; evaluation of average position, average momentum and determination of uncertainty in position and momentum and hence Heisenberg's uncertainty principle, pictorial representation of the wave equation of a particle in one dimensional box and its influence on the kinetic energy of the particle in each successive quantum level, lowest energy of the particle.

Unit -II

Quantum Mechanics-II

Schrodinger wave equation for a particle in a three dimensional box. The concept of degeneracy among energy levels for a particle in three dimensional box. Schrodinger wave equation for a linear harmonic oscillator & its solution by polynomial method. Zero point energy of a particle possessing harmonic motion and its consequence. Schrodinger wave equation for three dimensional Rigid rotator, energy of rigid rotator, space quantization; Schrodinger wave equation for hydrogen atom, separation of variable in polar spherical coordinates and its solution, principle, azimuthal and magnetic quantum numbers and the magnitude of their values, probability distribution function, radial distribution function and shape of atomic orbitals (s,p, d).

Unit -III

Symmetry and Group Theory

Symmetry elements and symmetry operation group and its properties. Multiplication table, point symmetry groups. Schonflies symbol, representations of groups by matrices (representation for the Cn, Cnv, Cnh, Dnh etc. Groups to be worked out explicity). Irreducible representation of groups. The great orthogonality theorem (without proof) and its importance. Character tables and their use in spectroscopy

Unit -IV

Statistical Thermodynamics-I

Concept of distribution, Thermodynamic probability and most probable distribution; Canonical, grand canonical and micro canonical ensembles. Maxwell - Boltzmann statistics, Statistical thermodynamic formulation of Maxwell - Boltzmann distribution law, Maxwell - Boltzmann law of distribution of energy and evaluation of average velocity, root mean square velocity; Law of equipartition of energy; Partition function and its factorization, relationship of atomic and molar partition function to thermodynamic properties (i) internal energy (ii) entropy (iii) Gibb's free energy (iv) heat constant (v) work function (vi) pressure and heat capacity at constant volume and pressure. Derivation of equation of state for a mono atomic ideal gas.

Recommended Readings:

1. R. Chandra: Introductory Quantum Chemistry, McGraw Hill Education; 4th edition (2017).
2. D.A. McQuarrie: Quantum Chemistry, Viva Books student edition (2016).
3. A. Vincent: Molecular symmetry and group theory, Wiley, 2nd edition (2013).
4. S. Swarnlakshmi, T. Saroja & R.M. Ezhilarasi: A simple approach to group theory in Chemistry, Universities Press (India) Private Limited (2019).

Further Readings:

1. B. Bagchi:. Statistical Mechanics for Chemistry and Material Science, CRC Press, 1st edition (2018)
2. L.K. Nash: Elements of Statistical Thermodynamics, Dover Publications; 2nd edition (2006).
3. Levine: Quantum Chemistry, Pearson publication, 7th edition (2013).
4. A. Nass Bauim: Applied group theory for Chemists, Physicists and Engineers, Prentice Hall (1971).
5. F.A. Cotton, Chemical Applications of Group Theory, Wiley Interscience: N.Y (1990).
6. D.M. Bishop, Group Theory and Chemistry, Clarendon Press: Oxford, U.K. (1973).

M.Sc. Chemistry (2nd Semester)

Organic Chemistry- II
Paper Code: 20CHE23C6
Organic reaction mechanism & Pericyclic reactions

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit – I

Aliphatic Nucleophilic Substitution

The S_N2, S_N1, mixed S_N1 & S_N2 and SET mechanisms. The neighbouring group mechanism, neighbouring group participation by π and σ bonds, anchimeric assistance. Classical and non-classical carbocations, phenoniumions, nonbornyl system, Common carbocation rearrangements.

The S_Ni mechanism, Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium. Phase transfer catalysis, ambident nucleophile, regioselectivity. Bimolecular mechanism-SE2 and SE1. The SE1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Unit – II

Aromatic Nucleophilic Substitution

The S_NAr, S_N1, benzyne and SRN1 mechanisms. Reactivity - effect of substrate structure, leaving group and attacking nucleophile. The Von Richter, Sommelet-Hauser, and Smiles rearrangements.

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. Diazonium coupling, Vilsmeier reaction, Gattermann-Koch reaction.

Unit – III

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.

Elimination Reactions

The E1, E2 and ElcB mechanisms and their spectrum. Orientation of the double bond. Reactivity - effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination.

Unit – IV

Pericyclic Reactions

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions - conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems. Cycloadditions - antarafacial and suprafacial additions, 4n and 4n+2 systems, [2+2] addition of ketenes, 1,3- dipolar cycloadditions and cheleotropic reactions.

Sigmatropic Rearrangements

Suprafacial and antarafacial shifts of H, Sigmatropic shifts involving carbon moieties, 3,3- and 5,5-Sigmatropic rearrangements. Claisen cope, Sommelet Hauser rearrangement, Ene reaction.

Recommended Readings:

1. Jerry March: Advanced Organic Chemistry -Reactions, Mechanism and Structure, John Wiley Publication, 6th edition (2007).
2. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Longman Publication, 6th edition, (1989).
3. H.O. House: Modern Synthetic Reactions, Benjamin-Cummings Publishing Co. Subs. of Addison Wesley Longman US, 2nd edition (1972).
4. W. Carruthers, L.Coldham, Modern Methods of Organic Synthesis Cambridge University Press, South Asia Edition (2015).
5. S.H. Pine, J.B. Hendrickson, D.J. Cram, G.S. Hammond, Organic Chemistry, McGraw-Hill Inc., Tokyo, (1980).

Further Readings:

1. C.K. Ingold: Structure and Mechanism in Organic Chemistry, CBS Publication, 2nd edition (2000).
2. R.T. Morrison and R.N. Boyd: Organic Chemistry, Prentice Hall Publication, 6th edition (1992).
3. F.A. Carey, R.J. Sundberg: Advanced Organic Chemistry, Plenum Publication, 3rd edition (1990).
4. R.O.C. Norman and J.M. Coxon: Principles of Organic Synthesis. Springer publication, 3rd edition (1993).
5. S.M. Mukherji and S.P. Singh: Reaction Mechanism in Organic Chemistry, Macmillan Publication (1985).

M.Sc. Chemistry (2nd Semester)

Inorganic Chemistry Practical- II
Paper Code: 20CHE24CL4
Quantitative Inorganic Analysis & estimation of metal ions by Cerimetry

6 hrs./week
Credits: 03
Max. Marks: 80+20
Time: 6 hrs.

1. Quantitative Inorganic Analysis

Separation and determination of two metal ions such as

i) Silver- Copper

ii) Copper-Nickel

iii) Copper-Zinc

iv) Nickel-Zinc

v) Copper-Iron Involving volumetric and gravimetric methods

2. Determination by Cerimetry

i) Ferrous

ii) Oxalate

iii) Nitrite

Viva-Voce	**(10 Marks)**
Note Book	**(10 Marks)**

Recommended Readings:

1. A.I. Vogel: A text Book of Quantitative InorganicAnalysis. Longman Publication, 5th edition (1989).
2. O.P. Vermani: Applied AnalyticalChemistry, New Age International Publication, 2nd edition (2017).

M.Sc. Chemistry (2nd Semester)

Physical Chemistry Practical- II
Paper Code: 20CHE25CL5
Potentionmetry, pH metry, Chemical Kinetics & Distribution Law

6 hrs./week
Credits: 03
Max. Marks 80+20
Time: 6 hrs.

1. Potentionmetry

(i) NaOH vs. HCl titration.

(ii) NaOH vs. Oxalic acid titration.

(iii) NaOH vs. CH_3COOH titration.

2. pH metry

(i) NaOH Vs. HCl titration.

(ii) NaOH vs Oxalic acid titration.

(iii) NaOH vs. CH_3COOH titration.

3. Chemical Kinetics

(i) To study kinetics of hydrolysis of ester in the presence of acid.

(ii) To compare the relative strength of acids (HCl and H_2SO_4).

4. Distribution Law

(i) To determine partition coefficient of benzoic acid between benzene and water.

(ii) To determine partition coefficient of Iodine between Carbon tetrachloride and water.

(iii) Determination of Equilibrium constant for $I_2 + I^- = I_3^-$

Viva Voce	**(10 Marks)**
Note Book	**(10 Marks)**

Recommended Readings:

1. J.B.Yadav: Advanced Practical Physical Chemistry, K Prakashan Media (P) Ltd (2015).
2. B.D. Khosla, V.C. Garg, A. Khosla: Senior practical physical chemistry, R. Chand& Co., New Delhi (2011).
3. A Thawale and P. Mathur: Experimental Physical Chemistry, New Age International Private Limited; 1st edition (2001).

Further Readings:

1. B. Vishwanathan, P.S. Raghav: Practical Physical Chemistry, Viva Books (2014).
2. P.S. Sindhu: Practical in Physical Chemistry, Macmillan Publishers India (2005)
3. A Thawale and P. Mathur: Experimental Physical Chemistry, New Age International Private Limited; 1st edition (2001).

M.Sc. Chemistry (2nd Semester)

Organic Chemistry Practical- II
Paper Code: 20CHE26CL6
Two step Organic Synthesis

6 hrs./week
Credits: 03
Max. Marks: 80+20
Time: 6 hrs.

1. Organic Synthesis and checking purity of samples prepared.

Two Step preparations:

1. p-Nitroaniline from acetanilide.
2. p-Bromoaniline from acetanilide
3. Anthranilic acid from phthalic anhydride.
4. p-Bromoacetanilide from aniline.
5. p-Nitroacetanilide from aniline.
6. Sym-tribromobenzene from aniline.
7. 2,4-Dinitrophenyl hydrazine from Chlorobenzene.
8. 2,5-Dihydroxyacetophenone from hydroquinone.

Viva-Voce	**10 Marks**
Note Book	**10 Marks**

Recommended Readings:

1. H. Clark: Handbook of Organic Analysis-Qualitative and Quantitative, CBS; 4th Revised edition (2007).
2. A. R. Tatchell, Peter W.G. Smith, A.J. Hannaford, B.S. Furniss: Vogel's Textbook of Practical Organic Chemistry, Pearson Education; 5th edition (2003).
3. D. Pasto, C. Johnson and M. Miller: Experiments and Techniques in Organic Chemistry, Prentice Hall; Instructor's edition (1992).

Further Readings:

1. K.L. Williamson, & K.M. Masters: Macroscale and Microscale Organic Experiments. Cengage Learning; 6th edition (2010).
2. H. Middleton: Systematic Qualitative Organic Analysis, Edward Arnold & Co. (1948).

M.Sc. Chemistry (2nd Semester)

General Spectroscopy
Paper- XIV; 20CHE27E1
Rotational, Vibrational, Raman & NMR, IR Spectroscopy

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 03 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit-I

Electromagnetic radiation, interaction of electromagnetic radiation with matter, regions of the Spectrum the width and intensity of spectral transitions. Resolving power.

Rotational Spectra

The rotation of molecules, rotational spectra of diatomic molecules, the spectrum of non rigid rotator, the effect of isotopic substitutions rotational spectra of linear and symmetric top polyatomic molecules.

Unit-II

Vibrational and Vibrational- Rotational Spectra

The vibrating diatomic molecule; simple harmonic vibrations, anharmonicity of vibrations, the diatomic vibrating rotator, the interaction of rotations and vibrations the vibrations of polyatomic molecules, analysis by infrared technique.

Electronics Spectra

Electronic spectra of diatomic molecules, vibrational course structure, and rotational fine structure of electronic band. The Frank- Condon principle, intensity of vibrational-electronic band, dissociation energy, the Fortrat diagram.

Unit-III

Raman Spectroscopy

Quantum theory of Raman effect, Classical theory of Raman effect, Pure rotational Raman spectra, Raman activity of vibrations, vibrational Raman spectra, polarization of light and Raman effect, applications.

NMR Spectra for Organic Compounds

Spin active nuclei, chemical shift, shielding and deshielding, internal standards, spin-spin coupling, equivalent and non- Equivalent Protons, effect of changing solvents and hydrogen bonding on chemical shifts, anisotropic effect.

Principles and Applications of UV, IR and NMR Spectra in the structure elucidation of Organic Compounds.

Unit – IV

NMR spectra for Inorganic Compounds

Applications of spin-spin coupling to structure alignment of inorganic compounds, evaluation of reaction rates of fast exchange reactions. The double resonance technique. Application of infra-red spectroscopy to the determination of inorganic compounds.

Recommended Readings:

1. R.S. Drago: Physical Methods in Inorganic Chemistry, affiliated east-west press pvt. Ltd.-New Delhi (2012).
2. C.N.Banwell: Fundamentals of Molecules Spectroscopy, McGraw Hill Education; 4th edition (2017).
3. D.L. Pavia, G.M. Lampman, G.S. Kriz and J.R. Vyvyan: Introduction to Spectroscopy, Cengage Learning India Private Limited; 5th edition (2015).

Further Readings:

1. R.M. Silverstein, G.C. Bassler, and T.C. Morrill: Spectrometric Identification of Organic Compounds, John Wiley, 6th edition, (2002).
2. K. Nakamoto: Infrared Spectra of Inorganic and Coordination Compounds, Wiley, 6th edition (2009).
3. D.N. Sathyanarayan: Introduction to Magnetic Resonance Spectroscopy ESR, NMR, NRR, I. K. International Publishing House Pvt. Ltd (2009).
4. W.E. Addison: Structural Principles in Inorganic Compounds, Prentice Hall Press (1963).

M.Sc. Chemistry (2nd Semester)

Green and Sustainable Chemistry
Paper Code: 20CHE27E2
Green Chemistry, Sustainable energy resources, Catalysis and Supramolecules

4 hrs./week
Credits: 04
Max Marks: 80+20
Time: 03 hrs.

Unit-I

Green Chemistry

Definition, need and goals. Green chemistry and its interdisciplinary nature, atom economy, twelve principles of green chemistry and its applications. Elementary idea of green reagent, green solvent, green catalyst. Introduction to biocatalysts, role of biocatalysts in green synthesis- enzyme catalyzed oxidation, reduction and hydrolytic reactions, synthesis involving basic principle of green chemistry- synthesis of adipic acid and BHC.

Unit-II

Sustainable energy resources:

Various non-conventional energy resources- Introduction, availability, classification, relative merits and demerits. Solar Cells: Theory of solar cells. Solar cell materials, solar cell array, solar cell power plant, limitations.

Waste management: production, problem and prevention

Introduction, source of waste from chemical industry, waste minimization techniques, onsite waste treatment, design for degradation of DDT & surfactant, polymer recycling.

Unit -III

Industrial Solvent:

Industrial uses of Aqueous Solvents, Super Critical Fluids, and Ionic liquids

Homogenous and Heterogenous Catalysis:

Phase Transfer Catalysis (PTC), Hydroformylation, Metathesis, Zeolite usage in Menthol synthesis, Caprolactam synthesis.

Brief introduction to IPR, need for patenting, conditions for invention to be patentable.

UNIT-IV

Supramolecules

Molecules and Supramolecules, supermolecules, nature of supramolecular interactions, host-guest chemistry, solvation and hydrophobic effect, Utilisation of H-bonds to create supramolecular structures, Thermodynamic and Kinetic selectivity, Chelate and macrocyclic effects, Template synthesis

Application of Supermolecules

Molecular device, reading signal from molecular device, molecular electronic and photonic devices, molecular computers and molecular machines.

Recommended Readings:

1. P.T. Anastas and J.C. Warner, Green Chemistry- Theory and Practical, Oxford University Press (1998).
2. A.S. Matlack, Introduction to Green Chemistry, Marcel Dekker (2001).
3. J. W. Steed and J. L. Atwood, Supramolecular Chemistry Wiley, 2nd edition (2009).
4. M. Lancaster, Green Chemistry: An introduction text, RSC, 3rd edition (2016).
5. R. A. Sheldon, I. Arends and V. Hanefield, Green Chemistry and Catalysis,Wiley-VCH (2007).
6. P. Bansal, IPR Handbook for Pharma Students and Researchers, BSP Books Private Limited (2015).

M.Sc. Chemistry (2nd Semester)

Environmental Chemistry-I (Open Elective)
Paper Code: 20CHE27E2
Environment, Hydrosphere & Environmental Toxicology

4 hrs./week
Credit: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit-I

Environment

Atmosphere, environmental segments, composition of the atmosphere, earth's radiation balance, particulates, ions, radicals and their formation, chemical and photochemical reactions in the atmosphere,

Noise Pollution: sources, effect on human health, mitigation and control.

Unit-II

Air pollution: oxides of C,N,S and their effects, acid-rain, smog formation, Green house effects (global warming and ozone depletion). Analytical Methods for measuring air pollutants. Continuous monitoring instruments.

Unit-III

Hydrosphere

Chemical composition of water bodies-lakes, streams rivers, sea etc, hydrological cycle, complexation in natural and waste water and microbially mediated redox reactions. Water pollution-inorganic, organic pesticides, industrial and radioactive materials, oil spills and oil pollutants eutrophication, acid-mine drainage, waste water treatment, domestic waste water aerobic and (anaerobic treatment), and industrial waste water treatment

Unit -IV

Environmental Toxicology

Chemical solutions to environmental problems, biodegradability, principles of decomposition, better industrial processes. Bhopal gas tragedy, Chernobyl, three mile island, Seveso and Minamata disasters.

Recommended Readings:

1. A.K. De: Environmental Chemistry, New Age International Publishers; Ninth - Multicolor Edition (2018).
2. Manaham: Environmental Chemistry, Taylor & Francis, 10th edition (2017).
3. Khopkar: Environmental Pollution Analysis, New Age International Pvt. Ltd., 2nd edition (2015).
4. Sharma & Kaur: Environmental Chemistry, Goel Publishing House, Meerut (1996).
5. F.J. Welcher: Standard Method of Chemical analysis, vol. III, Van Nostrand Reinhold; 6th edition (1966).

Further Readings:

1. Ed. J. Rose, Environmental Toxicology: Current Developments, Volume 7, CRC Press (1988).
2. Ed. S. Landsberger and M-Creatchman: Elemental Analysis of Airborne particles, CRC Press (1999).
3. C. Baird: Environmental Chemistry, WH Freeman; 5th edition (2012).

M.Sc. Chemistry (3rd Semester)

Techniques in Chemistry
Paper Code: 20CHE31C7
Atomic Absorption/emission Spectroscopy, Nanomaterials Technology & Chromatographic Separation

4 hrs./week
Credits: 04
Max Marks: 80+20
Time: 03 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit-I

Flame Photometry

Principles, Interferences, Evaluation methods in Flame Photometry.

Nano-techniques

Principle and Instrumentation of TGA and DTA, XRD, SEM, TEM and AFM.

Unit-II

Atomic Absorption Spectroscopy- Principles, Instrumentation, Sensitivity and detection limits, Interferences in AAS and their elimination.

Atomic Emission Spectroscopy- Principles, Sources for excitation, Instrumentation, Qualitative and quantitative Analysis.

Unit – III

Nano materials Technology

Nano materials and their historical perspective. Applications of nanoscience and nanotechnology in various fields. Unique properties of nanomaterials due to their nanosize, techniques for their synthesis:- Hydrothermal, Solvothermal, Microwave irradiation, sol-gel, Precipitation, Reverse Micelle Synthesis, Physical Vapour deposition (PVD), Chemical Vapour Deposition (CVD), Electro deposition, Characterization of nanomaterials by X-ray diffraction (XRD), Scanning Electron Microscope (SEM),

Energy dispersive X-ray Analysis, Transmission Electron Microscope (TEM), Atomic Force microscopy (AFM) techniques. Properties of nanostructured materials: optical, magnetic, chemical and photo catalytic properties.

Unit – IV

Chromatographic Separation

Purification of organic compounds using chromatographic techniques: paper chromatography, Thin-Layer Chromatography, Column Chromatography, High Pressure Liquid Chromatography (HPLC), Gas Chromatography, Ion-Exchange Chromatography, Counter- Current distribution and Electrophoresis

Recommended Readings:

1. Charles P. Poole, Jr. Frank, J. Owens: Introduction to nanotechnology, Wiley-Blackwell; 1st edition (2003).
2. R.P. Budhiraja: Separation Chemistry, New age International Publishers (2016).
3. G. B. Sergeev, K. L. Klabunde, Nanochemistry, Elsevier, 2nd edition (2013).
4. W.R. Fahrner: Nano Technology and Nanoelectronics, Springer (2005).
5. M. D. Vantra, S. Evoy, J.R. Heflin: Introduction to Nanoscience and Technology Edited - Springer (2004).
6. B.K. Sharma: Instrumental Methods of Chemical analysis, Krishna Prakashan Media (P) Ltd. (2014).

Further Readings:

1. M. V. Sachdeva: Basics of nanochemistry, Anmol Publications Pvt. Ltd, 1st edition (2011).
2. S. M. Lindsey: Introduction to Nanosciences, Oxford University Press, Pap/Cdr Edition (2009).
3. V. S. Muralidharan, A. Subramania: Nano Science and Technolony, CRC Press; 1st edition (2008).
4. S.M. Khopkar: Basic Concepts of Analytical Chemistry, New age International Publishers (2008).

M.Sc. Chemistry (3rd Semester)

Environmental Chemistry-II (Open Elective)
Paper Code: 20CHE35OE
Water Quality parameters/standards, Industrial/Organic pollutants & Green Chemistry

4 hrs./week
Credits: 04
Max Marks: 80+20
Time: 03 hrs

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit-I

Water Quality parameters and standards

Analytical methods for measuring DO, BOD, COD, fluoride, oils and grease and metals (As, Cd, Hg, Pb, Zn Cu, Cr), Biochemical effects of As, Cd, Hg, Pb, Cr, CN and pesticides.

Lithosphere: soil composition, micro and macro nutrients, soil pollution-fertilizers, pesticides.

Unit-II

Industrial Pollution

Cement, Sugar, distillery, drug, paper and pulp, thermal power plants, nuclear power plants, metallurgy, Polymers, drugs etc. Radionuclide analysis. Disposal of wastes and their management.

Unit-III

Green Chemistry

Importance, Principles of Green Chemistry, Thrust Areas, Applications of non-conventional techniques in organic synthesis: Ultrasonic, microwave and grinding, solid state synthesis and synthesis under solvent free conditions, Use of Ionic Liquids.

Unit-IV

Persistant Organic Pollutants

Aldrin, chlordane, Dieldrin,, Dioxins, DDT, Endrin, Furans, Helptachlor, Hexachlorobenzene, Mirex, Polychlorinated biphenyls, Toxaphene.

Recommended Readings:

1. A.K. De: Environmental Chemistry, New Age International Publishers; Ninth - Multicolor Edition (2018).
2. Manaham: Environmental Chemistry, Taylor & Francis, 10th edition (2017).
3. Khopkar: Environmental Pollution Analysis, New Age International Pvt. Ltd., 2nd edition (2015).
4. V. Subramanian: A Textbook of Environmental Chemistry, IK International Publishing House (2011).

Further Readings:

1. M. J. M. Ewan and L. F. Philips: Chemistry of Atmosphere, Wiley/Halsted Press, (1975).
2. J. Heichlen: Atmospheric Chemistry, Academic Press, 1st edition (1976).

M.Sc. Chemistry (3rd Semester)

Inorganic Chemistry Special- I
Paper Code: 20CHE31IS1
Vibrational, ESR, Mossbauer, Mass & NMR Spectroscopy

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

Vibrational Spectroscopy: Symmetry and shapes of AB_2, AB_3, AB_4. AB_5 and AB_6, modes of bonding of ambidentate ligands, ethylenediamine and diketonate complexes, application of resonance Raman Spectroscopy particularly for the study of active sites of metalloproteins as myoglobin and haemoglobin.

Unit -II

Electron Spin Resonance Spectroscopy: Principle, Presentation of the spectrum, hyperfine coupling, hyperfine splitting in various structures, Factors affecting magnitude of g, zero field splitting and Kramer's degeneracy. Applications to transition metal complexes having one and more than one unpaired electron, applications to inorganic free radicals, study of electron exchange reactions.

Unit -III

Mossbauer Spectroscopy: Basic Principles, spectral display, isomer shift, factors affecting the magnitude of isomer shift, quadrupole and magnetic hyperfine interaction, applications of technique to the study of bonding and structure of Fe^{2+}, Fe^{3+} ; Sn^{2+} and Sn^{4+} compounds; detection of oxidation states, nature of M-L bond.

Mass Spectrometry: Principle, representation, interaction of molecule with high energy electrons, interpretation of mass spectrum, effect of isotopes on appearance of mass spectrum; applications- finger print application, molecular weight determination, evaluation of heat of sublimation of high melting solids.

Unit - IV

Nuclear Magnetic Resonance Spectroscopy: ^{19}F and ^{31}P NMR spectra – Chemical shifts, coupling constants, ^{19}F Spectra of fluoroacetone, 1-bromo-1-Fluoroethane, dimethyl phosphorus trifluoride and bromine pentafluoride ; ^{31}P spectra of HPF_2 $HPO(OH)_2$, $H_2PO(OH)$, cis- $Pt(Pet_3)_2Cl_2$, Application of ^{31}P NMR for structural determination of Complexes with phosphorus ligands.

Spectra of Paramagnetic materials: Contact shift, its origin and application, Pseudo contact shift, Diamagnetic complexes, Spectra of free radicals, Lanthanide shift Reagents, Magnetic susceptibility Measurement.

Solid state NMR- Wide line NMR, Magnetic Angle spinning and Applications Magnetic Resonance Imaging.

Nuclear Quadrupole Resonance Spectroscopy: Introduction, Nuclear Quadropole Moment, Electric field gradient and Asymmetry Parameter.

Nuclear Quadrupole Transitions- Axially symmetric and Non-symmetric Molecules. Effect of an External magnetic field

Applications:- (i) Chemical bonding and Structure, (ii) Solid state Effects, (iii) Hydrogen Bonding. Experimental aspects.

Recommended Readings:

1. D.N. Sathyanarayana: Introduction to Magnetic Resonace Spectroscopy ESR, NMR, NQR, I K International Publication, 2nd edition (2013).
2. R.S. Drago: Physical methods in Inorganic Chemistry, East-West Press Publication (2012).
3. K. Nakamoto: Infrared & Raman Spectra of Inorganic & Co-ordination compounds, John Wiley & Sons publication, 6th edition (2008).

Further Readings:

1. S.D. Ross: Inorganic Infrared & Raman Spectra, McGraw-Hill publication (1972).
2. D.N. Sathyanarayana: Vibrational Spectrosocpy, New Age publication, 1st edition (2004).

M.Sc. Chemistry (3rd Semester)

Inorganic Chemistry Special- II
Paper Code: 20CHE32IS2
Nuclear & Radiochemistry

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

Nuclear Binding Energy

Justifications and applications; nuclear stability rules and decay of unstable nuclei.

Nuclear Structure

Nuclear forces; liquid drop model, Shell Model and collective model.

Unit -II

Interaction of Radiation with matter

Physical and chemical effects of radiation on matter (photoelectric effect, Compton effect and pair production).

Radiochemical Techniques:

NAA - Principle, Application and Limitation

IDA - Principle, Application and Limitation

Radiometric titrations and activation analysis

Unit -III

Detection of Nuclear Radiation

Various methods of detecting nuclear radiations, Gas-filled counters – Ionization chamber; Proportional counter and G.M. counters. Scintillation detectors; Solid state detectors.

Unit - IV

Nuclear Reactions

Energetics of nuclear reactions; various types of nuclear reactions including photonuclear, thermonuclear and spallation reactions; mechanism of nuclear reaction by compound nucleus model.

Nuclear fission

Fission probability; energy release; theories of fission.

Nuclear Fusion

Brief idea about breeder reactors,; accelerators and cyclotron.

Recommended Readings:

1. H.J. Arnikar: Essentials of Nuclear Chemistry, New Age International Publication, 4th edition (2011).
2. G. Choppin, J.O. Liljenzin & J. Rydberg: Radio Chemistry & Nuclear Chemistry, Academic Press publication, 4th edition (2013).
3. R.K. Malik and Neelam Kumari: Flow through nuclear chemistry (Pragati Prakashan Meerut). Anu Books (2019).
4. G. Friedlander, J.W. Kennedy, E. Macias, J. M. Miller: Nuclear and Radiochemistry, John Wiley & Sons, 3rd edition (1981).

Further Readings:

1. M. Sharon: Nuclear Chemistry, Ane Books publication; 2nd edition (2018).
2. W.D. Loveland, D.J. Morrissey & G.T. Seaborg: Modern Nuclear Chemistry, Wiley publication, 2nd edition (2017).
3. A. Vertes, S. Nagy & Z. Klencsar: Handbook of Nuclear Chemistry: Instrumentation, Separation Techniques, Environmental issues, Springer publication, Volume 1, 2nd edition (2011).

M.Sc. Chemistry (3rd Semester)

Inorganic Chemistry Special- III
Paper Code: 20CHE33IS3
Bio-inorganic Chemistry & Environmental Chemistry

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

Metal Ions in Biological Systems

General survey of essential and trace metals, Disturbing factors in metabolic process and causes of diseases, different classes of drugs.

Alkali and alkaline earth metals in biological systems

Ionophores, active transport of cations across membranes, sodium pump, Calcium pump, Calcium carriers, role of carriers in muscle contraction, blood clotting and hormones.

Interaction of metal ions with Nucleotides

Metal ions in nucleotide systems, effect of metal ions on nuclei acids.

Unit -II

Oxygen carriers

Porphyrins, metalloporphyrins, Hemoproteins, structure and functions of hemoglobin and myoglobin, synthetic oxygen carrier model systems

Nitrogen fixation

Biological nitrogen fixation, Nitrogenase, model for nitrogenase, metal-N2 complexes, photosynthesis and chlorophyll.

Metal transport and storage: Transferrin, Ferritin, Siderophores

Unit -III

Metalloenzymes

Zinc Enzymes-Carboxypeptidase & Carbonic anhydrase, Iron Enzymes-Catalase, peroxidase & cytochrome P- 450 Copper Enzymes – Superoxide dismutase, blue copper proteins, Coenzymes-Vitamins B12

Unit - IV

Environmental Chemistry

Atmosphere: Chemical composition of atmosphere, atmospheric structure, Earth's radiation balance; oxides of N,C,S and their effects, Green house effect, acid rain, photochemical smog , air quality standards, depletion of ozone, particulate matter in atmosphere , mechanism of aerosol formation in air, Noise pollution and their health hazards.

Recommended Readings:

1. J.E. Huheey: Inorganic Chemistry: Principles of Structure & Reactivity, Pearson Publication, 4th edition (2006).
2. S.J. Lippard, J.M. Berg: Principles of Biochemistry, University Science Books (1994).
3. R.K. Malik and Neelam Kumari, Environmental and Bioinorganic Chemistry, Sunrise publication, Ansari Road, New Delhi (2019).

Further Readings:

1. G.L. Miesseler and D.A. Tarr: Inorganic Chemistry, Prentice Hall; 3rd edition (2003).
2. Khopkar: Environmental Pollution Analysis.New Age International publications, 2nd edition (2015).
3. V. Subramaniam: Environmental Chemistry, I K International Publication; 1st edition (2011).
4. A.K. De: Environmental Chemistry, New Age Publication, 7th edition (2007).

M.Sc. Chemistry (3rd Semester)

Paper Code: 20CHE34ISPW1
Project Work

18 hrs./week
Credits: 09
Max. Marks: 240+60
Time: 6 hrs.

Note: The project work will be based on knowledge of scientific research which may include literature survey, experimental section, basic software handling, different Instrumental and data analysis techniques etc. For the same, the Department may have to collaborate with various universities/institutes of high repute. The topic of project work will be finalized in discussion with the Supervisor. It will be divided into three parts: Internal assessment, writing a dissertation followed by viva-voce through presentation.

Marks Distribution:

Internal assessment	- 60 marks
Dissertation Work	- 120 Marks
External Viva- Voce	- 120 marks

M.Sc. Chemistry (3rd Semester)

Physical Chemistry Special- I
Paper Code: 20CHE31PS1
Electrochemistry, Adsorption & Chemical Dynamics

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

Electrified Interfaces

Thermodynamics of electrified interfaces: electrocapillary thermodynamics, non-polarizable interface and thermodynamic equilibrium, fundamental thermodynamic equation of polarizable interfaces. determination of excess charge density on the electrode, electrical capacitance and surface excess of the interface, potential of zero charge, Helmholtz-Perrin model, Gouy - Chapman model and Stern model of electrified interfaces.

Unit -II

Ionic Liquids

The thermal dismantling of an ionic lattice, characteristics of ionic liquids, The fundamental problems in the study of pure liquid electrolytes, models of simple ionic liquids: lattice oriented models (Vacancy model, Hole model) , quantification of the hole model, The Furth approach to the work of hole formation, distribution function for the sizes of the holes and the average size of a hole.

Electrodics

Rate of charge - transfer reactions under zero fields, under the influence of an electric field, the equilibrium exchange current density, the non-equilibrium drift-current density (Butler-Volmer) equation. Some general and special cases of Butler- Volmer equation, the high-field and low-field approximations, physical meaning of the symmetry factor (β), a preliminary to a second theory of β , a simple picture of the symmetry factor and its dependence on overpotential. Polarizable and non-polarizable interfaces.

Unit -III

Adsorption

Surface tension, capillary action, pressure difference across curved surface (Laplace equation), Gibb's adsorption equation and its applications, determination of BET equation and its application for the determination of surface area; surface active agents and their classification, concept of micelles, critical micelle concentration (cmc), determination of cmc by conductivity and surface tension methods; factors affecting cmc, counter - ion binding to micelles, thermodynamics of micellization

Unit - IV

Chemical Dynamics-III

Study of fast reactions, Flow method, Relaxation method, Flash photolysis and shocktube method. Theories of unimolecular reactions: Lindemann's theory, Hinshelwood's treatment, R.R.K. and R.R.K.M. theories. The theory of absolute reaction rates, potential energy surfaces, activation energies, London—Eyring - Polanyi method for the calculation of energy of activation.

Recommended Readings:

1. J.O.M. Bockris and A.K.N. Reddy: Modern electrochemistry Vol.1&2 , 2nd edition(1998).
2. K.J. Laidler: Chemical Kinetics, Pearson Publication, 3rd edition (2003).
3. S. Glasstone: An Introduction To Electrochemistry, East-West Press (Pvt.) Ltd. (2006).
4. W. Moore & G. Pearson: Kinetics & Mechanism, Wiley, 3rd edition (1981).
5. F. Daniels and R.A. Alberty: Physical Chemistry, John Wiley and Sons, Inc. (1987).

Further readings:

1. K.J. laidler, H.Eyring & S.Glasstone: The theory of Rate processes, McGraw-Hill, New York, (1941).
2. H.K. Moudgil, Textbook of Physical chemistry, PHI (2010).

M.Sc. Chemistry (3rd Semester)

Physical Chemistry Special- II
Paper Code: 20CHE32PS2
Statistical, thermodynamics & Quantum Mechanics

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

Thermodynamics-II

Clausius-Clayperon equation; law of mass action and its thermodynamic derivation. Third law of thermodynamics (Nernst heat theorem, determination of absolute entropy, unattainability of absolute zero) and its limitation. Phase diagram for two completely miscible components systems. Eutectic systems, Calculation of eutectic point, systems forming solid compounds Ax By with congruent and incongruent melting points, phase diagram and thermodynamic treatment of solid solutions.

Unit -II

Statistical Thermodynamics-II

Translational partition function, calculation of absolute entropy of an ideal monoatomic gas, Sackure - Tetrode equation, Vibrational , Rotational, and electronic partition function of diatomic molecules. Derivation of expressions for transitional ,vibrational, rotational and electronic energies; expressions for entropy, Gibbs free energy, work function due to transitional, vibrational and rotational motion of a molecule. Effect of change of zero point energy on partition function and also on thermodynamic properties like internal energy, Gibbs free energy, enthalpy, work function & entropy. Chemical equilibrium and equilibrium constant in terms of partition functions, Free energy function.

Unit -III

Quantum Mechanics-III

Quantum mechanical treatment of Helium atom and the failure of rigorous quantum mechanical method. Need of approximate methods, first order perturbation theory (excluding time dependent), Variation principle. Application of first order perturbation and variation principle to evaluate ground state of helium atom. Applicability of perturbation theory to an electron in a one dimensional box under the influence of electric field.

Unit - IV

Quantum Mechanics-IV

Valance bond method, valance bond method to hydrogen, hydrogen molecule ion (their symmetric and anti symmetric solution without actual valuation of various integrals, energy of molecular hydrogen system. LCAO-MO approximation, refined treatment of hydrogen molecules Concept of resonance and its role in the stability of hydrogen molecule ion, electron spin, Pauli's exclusion principle, hybridization.

Recommended Readings:

1. Levine: Quantum Chemistry, Pearson publication, 7th edition (2013).
2. S.Glasstone: Thermodynamics for chemists, Macmillan Publisher 2nd edition (2008).
3. B. Bagchi, Statistical Mechanics for Chemistry and Material Science, CRC Press, 1stedition (2018).
4. L.K. Nash: Elements of Statistical Thermodynamics, Dover Publications; 2nd edition (2006).
5. D. A. McQuarrie, Quantum Chemistry, Viva Books student edition (2016).
6. R.C. Srivastava, S.K. Saha & A.K.Jain: Thermodynamics: A core Course, Prentice Hall India Learning Private Limited; 3rd edition (2007).
7. S. Glasstone: Theoretical Chemistry, Van Nostrand Reinhold Inc.U.S. (1944).
8. R. Puri,S. Pathania,R. Sharma: Principles of Physical Chemistry, Vishal Publishing Co. (2019).

Further readings:

1. B. Bagchi. Statistical Mechanics for Chemistry and Material Science, CRC Press, 1st edition (2018).
2. Pauling & Wilson: Introduction to Quantum Mechanics: With Applications to Chemistry, Dover Publications Inc.; New edition (1985).
3. F. Daniels and R.A. Alberty: Physical Chemistry, John Wiley and Sons, Inc. (1987).

M.Sc. Chemistry (3rd Semester)

Physical Chemistry Special- III
Paper Code: 20CHE33PS3
Spectroscopy & Polymers

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

Spin Resonance Spectroscopy

Spin and an applied field; the nature of spinning particles, interaction between spin and magnetic field. Larmor precession, population of energy levels. Nuclear Magnetic Resonance Spectroscopy; Hydrogen Nuclei, the chemical shift, the coupling constant, coupling between several nuclei, analysis by NMR technique, exchange phenomena, simplification of complex spectra.

Unit -II

Electron spin resonance spectroscopy

The theory of E.S.R. the position of E.S.R. absorption, the g factor, the fine and hyperfine structures of E.S.R. absorption. Applications of E.S.R. spectroscopy.

Moss Bauer Spectroscopy: Theory of Moss-Bauer spectroscopy, the chemical shift quadrupole effects, the effect of magnetic field. Applications of Moss-Bauer spectroscopy.

Electronic Spectroscopy of Polyatomic Molecules

Free electron model, spectra of carbonyl group, spectra of ethene, n-Π and Π-Π transitions, spectra of benzene , spectra of transition metals, charge-transfer transition, fluorescence phosphorescence.

Unit -III

Polymers-I

Classification of polymers and polymerisation, condensation and addition polymers, kinetics of condensation (step-wise) polymerisation, size distribution in linear condensation polymers, molecular size control, degree of polymerization; mechanism of vinyl radical polymerisation, molecular weight and its

determination, effect of temperature and pressure on chain polymerisation, stereochemistry of polymer chain & stereo regular polymerisation, Ionic polymerisation (similarities and contrast), kinetics of cationic, anionic polymerisation, kinetics of copolymerisation, criteria for polymer solubility; Mass number and Mass average molecular weight, determination of molecular weight of polymers by osmometry, viscometry, light scattering and sedimentation methods.

Unit -IV

Polymers-II

Statistical method of biopolymers: Chain configuration of polymer chains, statistical distribution of end to end dimensions (freely jointed chains in 1-D & 3-D); influence of bond angle restriction, radius of gyration, thermodynamics of biopolymer solution (entropy of mixing & liquid state model along with limitation), free volume theory, heat and free energy of mixing.

Recommended Readings:

1. C.N.Banwell: Fundamentals of Molecular Spectroscopy, McGraw Hill Education; 4th edition.(2017).
2. G.M. Barrow: Introduction of molecular spectroscopy, McGraw-Hill Inc.,US (1962).
3. F.W. Billmeyer, Jr. Wiley: Text book of Polymer science, Wiley,1st edition (1984).
4. J.M.G. Cowie: Polymers: Chemistry and Physics of Modern Materials, CRC Press; 3rdedition (2007).
5. P.J. Flory: Principles of Polymer Chemistry, University Press, London (1953).

Further Readings:

1. R.B. Seymour, C.E. Carraher: Polymer chemistry: an introduction, Marcel Dekker, New York (1992).
2. H.R. Alcock, F.W. Lambe: Contemporary polymer chemistry, Prentice hall (1981).

M.Sc. Chemistry (3rd Semester)

Paper Code: 20CHE34PSPW1
Project Work

18 hrs./week
Credits: 09
Max. Marks: 240+60
Time: 6 hrs.

Note:- The project work will be based on knowledge of scientific research which may include literature survey, experimental section, basic software handling, different Instrumental and data analysis techniques etc. For the same, the Department may have to collaborate with various universities/institutes of high repute. The topic of project work will be finalized in discussion with the Supervisor. It will be divided into three parts: Internal assessment, writing a dissertation followed by viva-voce through presentation.

Marks Distribution

Internal assessment	- 60 marks
Dissertation Work	- 120 Marks
External Viva- Voce	- 120 marks

M.Sc. Chemistry (3rd Semester)

Organic Chemistry Special- I
Paper Code: 20CHE31OS1
Organic Spectroscopy

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

Ultraviolet and Visible Spectroscopy

Introduction – Electronic energy levels, electronic transitions and selection rules. The origin, general appearance and designation of UV bands, absorption laws and measurement of absorption intensity, chromophores, auxochromes, bathochromic shift, hypsocromic shift, hypochromic effect, hyperchromic effect and solvent effect. Woodward and Fieser's rules for calculating ultraviolet absorption maxima for substituted dienes and conjugated dienes, unsaturated carbonyl compounds and aromatic carbonyl compounds. Applications of UV spectroscopy to problems in organic chemistry.

Unit -II

Infrared Spectroscopy

Introduction – basic theory and instrumentation including FTIR infrared spectrum. Functional group and finger print regions. Absorption of infrared radiation and molecular vibrations. Fundamental vibrations and overtones. Intensity and position of infrared absorption bands and bands resulting from combination or difference of vibrational frequencies or by the interaction of overtones (or combination bands) with the fundamental vibrations (Fermi resonance). Frequency of vibrations of a diatomic molecule, spectral features of major functional groups: alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams, conjugated carbonyl compounds and amines. Effect of hydrogen bonding and solvent effect on vibrational frequencies, Overtones, combination bands and fermi resonance. Applications of IR spectroscopy to problems in organic chemistry.

Unit -III

Nuclear Magnetic Resonance Spectroscopy

Introduction – spin active nuclei behave as spinning nuclear magnets, orientation of spinning nuclear magnets in a uniform magnetic field and energy description of NMR phenomenon. Continuous wave (CW) NMR spectrometer and Fourier transform (FT) NMR spectrometer.

Phenomenon of resonance and relaxation, chemical shift , chemical shift parameters and internal standards, Factors affecting the chemical shift: shielding and deshielding of a nucleus, substitution effects leading to empirical co-relations for proton chemical shifts, anisotropic effect, effect of changing solvents, effect of hydrogen bonding, influence of chirality on the chemical shifts of enantiomers, Spin spin coupling, multiplicity of splitting and relative intensity of lines in a multiplet, integration, mechanism of coupling-one bond coupling (^1J), two bond coupling (^2J) three bond coupling (^3J) including Karplus relationship. Techniques for simplification of complex spectra, solvent effects, Lanthanide shift reagents, spin decoupling (double resonance), Fourier Transform technique and Nuclear Overhauser effect (NOE). Effect of sensitivity of C-13 NMR compared to H–1 NMR, comparison of C-13 NMR and H-1 NMR, chemical shifts of C-13 NMR. Simplification of C-13 spectra by process of decoupling, off resonance decoupling.

Unit - IV

Mass Spectroscopy

Introduction – basic theory, instrumentation, process of introducing the sample into mass spectrometer. Methods of generation of positively charged ions, electron ionization method , chemical ionization, FD and fast atom bombardment (FAB) techniques. Mass spectrum, base peak, molecular and parent ion. Mass to charge ratio (M/Z), relative intensity, fragment ions, even electron rule, nitrogen rule, metastable ions, McLafferty rearrangement and ortho effect. Determination of molecular weight and molecular formula using mass spectrometry

Recommended Readings:

1. D.L. Pavia, G.M. Lampman, G.S. Kriz and J.R. Vyvyan: Introduction to Spectroscopy, Cengage Learning India Private Limited; 5th edition (2015).
2. R.M. Silverstein, G.C. Bassler, and T.C. Morrill: Spectrometric Identification of Organic Compounds, John Wiley, 6th edition, (2002).
3. L.D.S. Yadav: Organic Spectroscopy, Anamaya Publishers, New Delhi (2005).

Further Readings:

1. J.R. Dyer: Applications of Spectroscopy of Organic Compounds, Prentice Hall (1978).
2. D.H. Williams and I. Fleming: Spectroscopic Methods in Organic Chemistry, McGraw-Hill Education, 6th edition (2007).
3. J. Mohan: Organic Spectroscopy, Narosa, 2nd edition (2004)
4. W. Kemp: Organic Spectroscopy, MACMILLAN, 2nd edition (2019).

M.Sc. Chemistry (3rd Semester)

Organic Chemistry Special- II
Paper Code: 20CHE32OS2
Chemistry of Natural Products

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

Vitamins

Structure and synthesis of vitamins A, B1, C, D, E, nicotinic acid and pantothenic acid.

Porphyrins

Structure and synthesis of Hemoglobin and chlorophyll.

Unit -II

Terpenoids and Caroteniods

Classification, nomenclature, occurrence, isolation, general methods of structure, determination, isoprene rule, Structure determination, stereochemistry biosynthesis and synthesis of the following representative molecules: Citral, Geraniol, terpineol, Menthol, Farnesol, Zingiberene.

Unit -III

Plant pigments

Occurance, general chemical and spectroscopic methods for structure determination. Structure elucidation and synthesis of Flavone, Chrysin, Flavonol, Quercetin, Diadazin, Xanthone, Euxanthone, Cyanidin chloride, Malvidin chloride, Hirsudin chloride. Biosynthesis of flavonoids: Acetate pathway and shikimic acid pathways.

Unit - IV

Enzymes and co-enzymes

Introduction to biological catalysis, nomenclature, classification and specificity.

Kind of reaction catalysed by enzymes: Oxidation-reduction, isomerisation, epimerisation, hydrolysis, phosphorylation, acylation, methylation, decarboxylation and dehydration.

Co-enzymes: Chemistry of Co-enzymes; Co-I, Co-II, Co-A, Co-carboxylase, FMN, FAD and Pyridoxal phosphate

Recommended Readings:

1. O.P. Aggarwal, Chemistry of Organic Natural Products: Vol. I & 2, Krishna Prakashan Media (P) Ltd. (2015).
2. I.L. Finar: Organic Chemistry Vol. 2, Pearson Education India; 5th edition (2002).
3. Atta-ur-Rahman and, M. I. Choudhary: New Trends in Natural Product Chemistry, Harwood Academic Publishers, Amsterdam (1998).
4. H. Duags and C. Penny: Bioinorganic Chemistry: A Chemical Approach to Enzyme Action, Springer, 3nd edition (1981).

Further Readings:

1. Trevor Palmer: Understanding Enzymes, Ellis Horwood Ltd, Publisher; 4th Revised edition (1995).
2. Ed. Collin J. Suckling: Enzyme Chemistry, Impact and Applications, Springer, Reprint edition (1984).
3. M.I. Page and A. Williams: Enzyme Mechanisms, RSC, London (1987).
4. N.C. Price and L. Stevens: Fundamentals of Enzymology, Oxford University Press; 3rd edition (1999).

M.Sc. Chemistry (3rd Semester)

Organic Chemistry Special- III
Paper Code: 20CHE33OS3
Heterocyclic Chemistry

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit - I

Nomenclature of Heterocycles

Replacement and systematic nomenclature (Hantzsch-Sidman System) for monocycle, fused and bridged heterocycles.

Aromatic Heterocycles

General chemical behavior of aromatic heterocycles, classification (structural type), criteria of aromaticity (bond lengths, ring current and chemical shifts in H) NMR-spectra, empirical resonance energy, delocalization energy and Dewar resonance energy, diamagnetic susceptibility exaltations. Heteroaromatic reactivity and tautomerism in aromatic heterocycles.

Unit- II

Non-Aromatic Heterocycles

Heterocyclic Synthesis: Principles of heterocyclic synthesis involving cyclization reactions and cycloaddition reactions.

Small Rings Heterocycles

Three-membered and four membered heterocycles-synthesis and reactions of aziridines, Oxiranes, thiranes, azetidines, oxetanes and theitanes.

Unit- III

Benzo –Fused Five-Membered Heterocycles

Synthesis and reactions including medical application of benzopyrroles, benzofurans and benzothiophenes.

Meso-ionic Heterocycles

General classification, chemistry of some important meso-ionic heterocycles of type- A and type-B and their application.

Unit- IV

Six-Membered heterocycles with One Heteroatom

Synthesis and reactions of pyrylium salts and pyrones and their comparison with pyridinium and thiopyrylium salts and pyridines. Synthesis snd reactions of quinolizinium and benzopyrylium salts, cumarins and chromones.

Seven or large membered heterocycles

Synthesis and reactions of azepines, oxepines, thiepines, azocines.

Recommended Readings:

1. R.R. Gupta, M. Kumar and V. Gupta: Hetrocyclic Chemistry, Vol.1-3, Springer Verlag (1998).
2. T.L. Gilchrist: Hetrocyclic Chemistry, Longman Scientific Technical, 3rd edition (1992).
3. I.L. Finar Vol. 2: Organic Chemistry, Pearson Education India; 5th edition (2002).

Further Readings:

1. V.K. Ahluwalia: Hetrocyclic Chemistry, Alpha Science International Ltd, 1st edition (2012).
2. V.K. Ahluwalia & R.K. Parashar: Organic Reaction Mechanism, Narosa Publishing House; 4th edition (2010).
3. S.M. Mukherji, S.P. Mukharji, S.P. Singh & R.P. Kapoor. Reaction Mechanism in Organic Synthesis, Trinity, 1st edition (2017).
4. G. Brahmachari: Organic Name Reactions- A Unified Approach, Alpha Science International Ltd; Revised Edition (2006).

M.Sc. Chemistry (3rd Semester)

Project Work
Paper Code: 20CHE34OSPW1

18 hrs./week
Credits: 09
Max. Marks: 240+60
Time: 6 hrs.

Note:- The project work will be based on knowledge of scientific research which may include literature survey, experimental section, basic software handling, different Instrumental and data analysis techniques etc. For the same, the Department may have to collaborate with various universities/institutes of high repute. The topic of project work will be finalized in discussion with the Supervisor. It will be divided into three parts: Internal assessment, writing a dissertation followed by viva-voce through presentation.

Marks Distribution

Internal assessment	- 60 marks
Dissertation Work	- 120 Marks
External Viva- Voce	- 120 marks

M.Sc. Chemistry (4th Semester)

Polymers Chemistry
Paper Code: 20CHE41C8
Introduction, Characterization, Properties & Processing

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit- I

Introduction

Importance of polymers. Basic concepts: Monomers, repeat units, degree of polymerization. Polymer synthesis criteria:- Linear, branched and network polymers. Classification of polymers. Polymerization: condensation, addition, radical chain-ionic and co-ordination and copolymerization in homogeneous and heterogeneous systems, Polymerization Techniques:- Mass (bulk), suspension, emulsion and solution processes.

Unit- II

Polymer Characterization

Average molecular weight concept: Number, Weight and Viscosity average molecular weight. Polydispersity and molecular weight distribution. The practical significance of molecular weight. Measurement of molecular weight by End group, viscosity light scattering, cryoscopy, ebulliometry osmometry, gel permeation chromatography and ultracentrifugation methods, chemical analysis of polymers, spectroscopic methods.

Unit- III

Structure and Properties

Configuration and conformation of polymers, nature of molecular interactions in polymers, random chain model and RMS end-to-end distance. Crystal structures of polymers. Morphology of crystalline polymers, Lamellae, spherulites, strain-induced morphology, crystallization and melting. Physical properties, structure property relationship, glass transition temperature (T_g), crystalline melting point (T_m), T_g relationship between T_m & T_g. Effect of chain flexibility and other steric factors, entropy and heat of fusion. Effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking, and copolymerization on Tg, WLF equation. Mechanical properties- tensile strength,

flexural strength, fatigue, impact, Tear resistance, hardness and abrasion resistance, creep and stress relaxation. Electrical properties-dielectric strength, surface resistivity, volume resistivity, Power factor. Flow properties.

Unit- IV

Polymer Processing

Plastics, elastomers and fibers. Compounding. Processing techniques: Calendaring, die casting, rotational casting, film casting, Moulding:- injection, blow, compression, transfer, extrusion, thermoforming, foaming, reinforcing and fiber spinning.

Preparation, Properties and applications of Commercial Polymers

Polyethylene, polypropylene, polystyrene, Polyvinyl chloride, aliphatic polyamides, polyesters, phenolic resins, epoxy resins and silicon polymers. Functional Polymers- Fire retarding polymers and electrically conducting polymers. Polymers for Biomedical applications, biomedical polymers-contact lens, dental cement, artificial heart, pace maker, kidney, skin and blood cells, controlled drug delivery, dressing strips and antimicrobial polymers.

Recommended Readings:

1. V.R. Gowarikar: Polymer Science, New Age Publications (2019).
2. F.W. Billmeyer: Text book of Polymer Science, Willey, 3rd edition (1984).
3. J.A. Brydson, Butterworth- Heinemann: Plastic material, 7th edition (1999).
4. C.E. Carraher, Jr. Marcel Dekker: Polymer Chemistry, 6th edition (2003).
5. V. Shah: Handbook of Plastics Testing Tchnology, Wiley Interscience, 3rd edition (2007).
6. A.B. Strong; Plastics: Materials & Processing, Prentice Hall, 3rd edition (2005).
7. G. Odian: Principles of Polymerization, Wiley, 4th edition (2004).
8. D. Braun: Polymer Synthesis: Theory and Practice, Springer (2004).

Further Readings:

1. M.S. Bhatnagar: A Text book of Polymers VOL. I, II, III, S. Chand Publishing (2003).
2. C.E. Carraher, Jr. Marcel Dekker: Polymer Chemistry, Taylor & Francis Ltd., 6th edition (2005).
3. P.A. Mirau: A practical guide to understanding the NMR of polymers, Wiley-Blackwell; Illustrated edition (2005).
4. J. I. Kroschwitz: Polymer Characterization and analysis, Wiley Interscience, 1st edition (1990).
5. E.A. Turi: Thermal Characterisation of Polymeric Materials, Vol. 1-2, 2nd edition,(1997).
6. J. Brown: Injection moulding of plastic components, McGraw-Hill (1979).
7. P.C. Heimenz, T.P. Lodge: Polymer chemistry, CRC Press, Ist edition (1984).
8. V. Raghavan: Material Science and engineering. PHI learning, 6th edition (2015).
9. M.E. Brown, M. Ewart: Introduction to Thermal Analysis, Kluwer Academic Publisher, 2nd edition (2001).
10. Z. Tadmor, C. G. Gogos: Principals of Polymer Processing, Wiley Interscience, 2nd edition (2013).
11. R.M. Silverstein, G.C. Bassler, and T.C. Morrill: Spectrometric Identification of Organic Compounds, John Wiley, 6th edition (2002).

M.Sc. Chemistry (4th Semester)

Inorganic Chemistry Special- IV
Paper Code: 20CHE411S4
Organotransition metal Chemistry

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

Introduction and Classification of organometallic compounds by bond types viz. covalent, ionic, electron deficient and cluster compounds.

Alkyls and Aryls of Transition Metals

Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis.

Unit -II

Transition Metal π–Complexes

Transition metal π–complexes with unsaturated molecules-alkenes, alkynes, allyl, & dienyl(metallocene) complexes, preparation, properties and nature of bonding and structural features, important reactions related to nucleophilic and electrophilic attack on ligands and to organic synthesis.

Unit -III

Compounds of Transition Metal-Carbon Multiple Bonds

Transition metal- carbene complexes: Fischer type and Schrock type carbene complexes, their synthesis, reactions and structures & bonding; Transition metal-carbyne complexes: their synthesis, reactions and structural features.

Unit -IV

Fluxional Organometallic Compounds

Fluxionality & dynamic equilibria in compounds such as acyclic alkenes,σ-bonded and π–bonded cyclic alkenes, rotation of ligands on metals, ligand scrambling on metals.

Applications of Transition metal Organometallics as Catalysts: Zeigler-Natta polymerization ; homogeneous catalytic hydrogenation; alkene hydrogenation-Wilkinson Catalyst; Oxidation of olefins-Wacker's process; hydroformylation of olefins – the oxo process.

Recommended Readings:

1. R.H. Crabetree: The Organometallic Chemistry of the Transition Metals, Wiley-Blackwell publication, 6th edition (2014).
2. A.J. Elias, B.D. Gupta: Basic Organometallic Chemistry: Concepts, Syntheses, and Applications of Transition Metals CRC Press, 1st edition (2010).

Further Readings:

1. R.B. King: Transition Metal OrganometallicChemistry, Academic Press Publication(1970).
2. V. Ishii, M. Tsutsui: Organotransition Metal Chemistry, Springer US publication, 1st edition (1975).
3. J.P. Collman, L.S. Hegedus, J.R. Norton, R.G. Finke: Principles & Applications of Organotransition metal Chemistry, University Science Books, U.S., 2nd edition (1987).
4. R.C. Mehrotra, A. Singh: Organometallic Chemistry. New Age Publishers, 2nd edition (1991).
5. G.E. Coates, M.L.H. Green, P. Powel, K. Wade: Principles of Organometallic Chemistry.Springer Netherlands, 1st edition (1968).

M.Sc. Chemistry (4th Semester)

Inorganic Chemistry Special- V
Paper Code: 20CHE42IS5
Analytical Chemistry

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

Electrons at and across interfaces, Electro-chemical and chemical reactions. Basic principles, residual current, migration current, diffusion current and limiting current, saturated calomel electrode(SCE) and dropping mercury electrode (DME). Ilkovic equation, Koutecky equation for diffusion current. Polarographic waves(anodic and cathodic), Half wave potentials. Oxygen interference, maxima, function of supporting electrolyte,

Unit -II

Determination of stability constants of complexes (reversible systems only) by D.C. Polarography. Catalytic hydrogen wave. Principles of Amperometric titrations, types of titration curves, apparatus and techniques.

Hanging mercury drop electrode, rotating dropping mercury electrode, platinum electrodes(RPE), Gold electrode, carbon paste electrode, glassy carbon electrode and graphite electrode.

Unit -III

Analytical applications of Redox chemistry of inner transition elements. Analytical Chemistry-separation, spectroscopy, electro and Thermo analytical methods. Thermal methods of analysis:- Introduction to different thermal methods, Thermogravimetry- TGA, DTA, Static and dynamic. Thermogram and factor affecting . Chronopotentiometry, chronoamperometry and coulometry.

Unit -IV

Theory of anodic stripping voltametry, concentration process, rest period, stripping process, Cathodic stripping voltametry, Anodic deposition, Cathodic redissolution, Experimental and applications of above system to Inorganic systems. Theory of ion selective electrodes, Experimental and applications of ISE to Inorganic systems.

Recommended Readings:

1. G. D. Christian: Analytical Chemistry, John Wiley & Sons Publication, 6th edition, (2003).
2. S. West: Fundamentals of Analytical Chemistry, Brooks/Cole Publication, 9th edition (2013).
3. S.M. Khopkar: Basic concepts of Analytical Chemistry,New Age International Publishers , 3rd edition (2008).

Further Readings:

1. R.C. Kapoor & B.S. Aggarwal: Principles ofPolarography, John Wiley & Sons publication (1991).
2. K. Zutshi: Introduction to Polarography & Allied Techniques, New Age International publication, 2nd edition (2006).

M.Sc. Chemistry (4th Semester)

Inorganic Chemistry Special- VI
Paper Code: 20CHE431S6
Medicinal Aspects of Inorganic Chemistry

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

Metals in Medicine: Biochemical bases of essential metal deficient diseases; Iron, copper and zinc deficiencies and their therapies, carcinogens and carcinostatic agents, zinc in tumour growth and inhibition, anticancer activity and mechanism of platinum complexes, anticancer activity of Rhodium, copper and Gold complexes, anti cancer activity of Selenium, antibacterial and antiviral properties of metal complexes, polyamino carboxylic acids and polyethylene amines as chelating drugs.

Unit -II

Miscellaneous applications of Inorganic compounds as medicines

Drugs in hypo and hyper activity of thyroids, Inorganic drugs in dental carries, clinical disorders of alkali and alkaline earth metals and their remedies, lithium drugs in psychiatry.

Heavy metals in Biological systems

Toxicity of heavy metals – and their detoxification, role of Selenium in Biological systems with reference to its essentiality and toxicity, mechanism of metal ion induced toxicity, interaction between orally administered drugs and metal ions in gut.

Unit -III

Ligand Therapy: Ligand induced toxicity, interference with haemoglobin in oxygen transport system, interfererence with metallo-enzymes, beneficial effects of ligand chelation; carcinogenic ligands, carcinostatic ligands, alkylating agents as anticancer drugs, Thiosemicarbazones as anticancer drugs, macrocyclic antibiotic ligands and probable mechanism of the drug, antiviral activity of chelating agents, aspirin chelation, drugs where chelation and therapeutic activity are unrelated.

Unit -IV

Vitamins and their functions in general, recommended dietary allowances, deficiencies and supplementations, dietary miners, calcium and vitamin D, antioxidants and their health effects, biomineralisation.

Radiopharmacology, nuclear medicines, radioiodine -131, technetium – 99m, gallium and indium scan.

Recommended Readings:

1. A.K. Das: A Text Book on Medicinal Aspects of Bio-Inorganic Chemistry, Books & Allied Publication (2013).
2. E. Alessio: Bioinorganic Medicinal Chemistry, Wiley-VCH Publication, 1st edition (2011).
3. J.E. Huheey, E.A. Keiter,R.L.Keiter: Inorganic Chemistry: Principle of Structure Reactivity, Pearson Publication, 4thedition(1997).
4. M.J. Welch, C.S. Redvanly: Handbook of Radiopharmaceuticals: Radio Chemistry & Applications, Wiley Publication, 1stedition (2002).

Further Readings:

1. R.W. Hay, J.R. Dilworth, K.B. Nolan: Persspectives on Bioinorganic Chemistry, Elsevier Publication, Volume 4, 1stedition (1999).
2. K.H. Reddy: Bioinorganic Chemistry, New Age Publishers, 1stedition (2003).

M.Sc. Chemistry (4th Semester)

Inorganic Chemistry Special Practical-1
Paper Code: 20CHE44ISL4
Interpretation/determination of IR spectrum of Inorganic Compounds

6 hrs/week
Credits: 03
Max. Marks: 80+20
Time: 6 hrs.

Interpretation of IR spectrum and determination of structure/bonding in some simple inorganic compounds and coordination compounds, such as:

(i) Ammonium salts [NH_4Cl, $(NH_4)_2SO_4$, NH_4SCN, NH_4NO_3]

(ii) Sulphate ions in different bonding mode: ionic -K_2SO_4, $CaSO_4$ etc., unidentate, bidentate, bridged etc.

(iii) Thiocyanate and Isothiocyanate complexes

(iv) Oxalato complexes

(v) Cyano complexes – $K_4[Fe(CN)_6]$, $Na_2[Fe(CN)_5NO]$

(vi) Ammine complexes

(vii) Spectra of isomers:- Nitro - and Nitrito.

Record File	**10 marks**
Viva-Voce	**10 marks**

M.Sc. Chemistry (4th Semester)

Inorganic Chemistry Special Practical- II
Paper Code: 20CHE45ISL5
Conductometry, pH metry & Potentiometry

6hrs./week
Credits: 03
Max. Marks: 80+20
Time: 6 hrs.

1. **Conductometrically:-** Composition of mixture of weak and strong acid, Precipitation and displacement titrations.
2. **pH-metry:-** Composition of mixture of strong and weak acid pK_a value of organic acids.
3. **Potentiometry:-** Redox titrations, Precipitations, Simultaneous determination of Halide ions.
4. **Ion-selective electrodes** – F, Ca, Na, K etc.

Record File	**10 marks**
Viva-Voce	**10 marks**

M.Sc. Chemistry (4th Semester)

Inorganic Chemistry Special Practical- III
Paper Code: 20CHE46ISL6
Ion Exchange methods in Column Chromatographic Analysis

6 hrs./week
Credits: 03
Max. Marks 80+20
Time: 6 hrs.

Ion Exchange methods in Column Chromatographic Analysis:-

1. Determination of the capacity of a cation – exchange resin i.e. Amberlite IR - 120.
2. Determination of the capacity of an anion exchange resin i.e. Amberlite IRA - 400 or De - Acidite FF.
3. Separation of Ions by Ion -exchangers.

Note: Candidate is required to perform one experiment in the examination

Record File	**10 marks**
Viva-Voce	**10 marks**

Recommended Readings:

1. A.I. Vogel: A text Book of Quantitative Inorganic Analysis, Longman Publication, 5th edition (1989).
2. O.P. Vermani: Applied Analytical Chemistry, New Age International Publication, 2nd edition (2017).
3. A.I. Vogel: A Text Book of Qualitative Analysis, Pearson Education India, 7th edition (2012).

Further Readings:

1. B.D. Khosla, V.C. Garg & A. Gulati: Senior Practical Physical Chemistry, R. Chand & Co Publication.
2. K. Nakamoto: Infrared and Raman Spectra of Inorganic & Co-ordination compounds. Wiley-Blackwell Publication, 5th edition (1997).
3. S.D. Ross: Inorganic Infrared & Raman Spectra, McGraw-Hill Publication (1972).
4. S.M. Khopkar: Basic Concepts of Analytical Chemistry, New Age International Publication (2008).

M.Sc. Chemistry (4th Semester)

Physical Chemistry Special- IV
Paper Code: 20CHE41PS4
Applications of electrochemistry

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Kinetics of Passivity

Introduction , electrochemical behaviour of active/passive metals, Flade potential, criteria for selecting a metal exhibiting passivity, factors influencing electrochemical passivity and corrosion rate, theories of passivity.

Protection Methods against Corrosion

Change of metal, design improvement, change of environment, anodic protection, cathodic protection and protective coatings.

Corrosion inhibitors: classification, mechanism, selection of corrosion inhibitors, inhibition efficiency and factors influencing inhibition efficiency, measurement of inhibition efficiency.

Unit -I

Applications of Electrochemistry

The maximum intrinsic efficiency, actual efficiency and current - potential relation in an electrochemical energy converter, factors influencing the electrochemical energy conversion, the power output of an electrochemical energy converter. Electrochemical electricity generators (fuel cells), brief idea about H_2-O_2, hydrocarbon - air, and natural gas & CO -air fuel cells. Electricity storage: some important quantities in electricity storage (electricity storage density, energy density, power), desirable conditions for an ideal storage, storage of electricity using the lead-Acid battery, dry cell, silver-zinc cell and Sodium-Sulfur cell, Amperometric titrations determination of activation energy for an irreversible electrode process.

Unit -II

Polarography

General principles of polarography, the limiting current, diffusion current, derivation of Ilkovic equation, consequences of the Ilkovic equation, Koutecky's equation for diffusion current, half -wave potential, equations for reversible cathodic, anodic, and cathodic-anodic waves, analysis of reversible polarographic wave, factors affecting the half- wave potential, reversible processes controlled by diffusion of complex ions, ($Me^{n+} + pX^{m-} \leftrightarrow [MeX_p]^{(np-n)+}$), reversible reduction of organic substances (quinone - quinol system).

Irreversible electrode processes

An approximate treatment of a slow electrode process and rigorous treatment of a slow electrode process, irreversible reduction of complexes, polarography of organic substances, polarographic coulometry at constant potential, determination of number of electrons by analysis of the decrease in the limiting current.

Recommended Readings:

1. J.O.M. Bockris, A.K.N. Reddy: Modern electrochemistry Vol.1 and 2: Ionics, 2nd edition (1998).
2. P.H. Reiger: Electrochemistry, Springer, 2nd edition (1994).
3. Heyrovsky: Polarography, Academic Press, 1st edition (1966).
4. Z. Kannala: Introduction to Polarography & Allied Techniques, New Age International; 2nd edition (2006).
5. S. Glasstone: An Introduction To Electrochemistry, East-West Press (Pvt.) Ltd. (2006).
6. R. Narain: Introduction to Metallic corrosion & its prevention, Oxford & IBH publishing Co Pvt ltd (1988).
7. S.N. Banerjee: An introduction to the Science of Corrosion and its inhibition, Oxnonion press Pvt. Ltd, New Delhi, India (1985).
8. M.G. Fontana: Corrosion engineering, McGraw Hill Education; 3rd edition (2017).
9. V.S. Sastri: Corrosion inhibitors: Principle & Applications, Wiley; First edition (2015).
10. K.R. Trephewey & J. Chamberlain: Corrosion for Science and engineering, Pearson; 2nd edition (1995).

M.Sc. Chemistry (4th Semester)

Physical Chemistry Special- V
Paper Code: 20CHE42PS5
Statistical, Non-equilibrium thermodynamics & Quantum Mechanics

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

Statistical Thermodynamics

Free energy functions and the partition functions, calculation of equilibrium constant using partition function. Bose - Einstein statistics, statistics of photon gas, gas degeneration, Fermi-Dirac statistics, extreme gas degeneration, energy of Bosons &Fermi particles, specific heat of electron gas, , Thermionic emission, comparison of Maxwell-Boltzmann, Bose –Einstein and Fermi-Dirac statistics.

Unit -II

Non –Equilibrium Thermodynamics

General theory of non-equilibrium processes, entropy production and entropy flow; thermodynamic criteria for non -equilibrium states, entropy production in heat flow, mass flow, electric current, chemical reactions, Saxen's relation, Onsager's reciprocity relation, , Electro kinetic phenomenon.

Theory of fluctuation, energy fluctuations in the canonical ensemble, distribution function and fluctuations, fluctuations of density and energy.

Unit -III

Angular Momentum

Angular momentum, angular momentum operators in cartesian coordinates, eigen function & eigen values, commutation relation between angular momentum operators (L_x, L_y, L_z, L^2), total orbital angular momentum and spin angular momentum, commutation relation between components of total orbital angular momentum and spin angular momentum, ladder operators, commutators of $[L^2, L_+]$ and $[L^2, L_-]$, application of ladder operators to an eigen function of L_z.

Unit -IV

Molecular Orbital Theory

Huckel molecular orbital (HMO) theory of linear and cyclic conjugated systems, Applications of HMO theory to (i) set up and solve Huckel determent equation; (ii) calculate resonance energy; (iii) wave functions for molecular orbitals and molecular diagrams for the following :

(a) Ethylene molecule (b) Allyl system (Allyl radical and the related cation and anion) (c) Butadiene; (d) Cyclobutadiene (e) Cyclopropenyl system (cyclopropenyl radical and the related cation and anion).

Recommended Readings:

1. I. Prigogine: Non-Equilibrium Statistical Mechanics, Dover Publications Inc., Reprint Edition (2017).
2. Puri, Sharma, Pathania: Quantum Mechanics and Spectroscopy, Vishal Publishing Co., 1st (Reprint) edition (2013).
3. L. Pauling, E.B. Wilson: Introduction to Quantum Mechanics: With Applications to Chemistry, Dover Publications Inc.; New edition (1985).
4. C. Kalidas, M. Sangaranarayanan: Non-Equilibrium Thermodynamics, Macmillan India Limited. 1stedition (2002).
5. D.A. McQuarrie: Quantum Chemistry, Viva Books student edition (2016).
6. S. Glasstone: Theoretical Chemistry, Van Nostrand Reinhold Inc., U.S. (1944).
7. F. Daniels and R.A. Alberty: Physical Chemistry, John Wiley and Sons, Inc. (1987).

M.Sc. Chemistry (4th Semester)

Physical Chemistry Special- VI
Paper Code: 20CHE43PS6
Electrochemistry & Corrosion

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

Electrochemistry

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, Walden's 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.

Unit -II

Electrochemistry of Corrosion

Definition of corrosion, importance and cost of corrosion classification of corrosion

Electrochemistry of Corrosion: Electrode reactions, electrode potentials, electrochemical cell formation, Nernst equation, exchange current density, polarization of electrode (resistance, concentration and activation), mixed potential theory, polarization diagrams, pourbaix diagrams, corrosion rate expression and weight loss method for corrosion rate, galvanic series. Electrochemical techniques to study corrosion – Galvanostatic and potentiostatic techniques, Stern –Geary equation, Tafel slopes, measurement of corrosion potential and corrosion current density, Tafel extrapolation and Linear polarization resistance methods, recording and interpretation of anodic and cathodic polarization curves

Unit -III

Forms of Corrosion

Uniform corrosion, galvanic corrosion, pitting corrosion, crevice corrosion, intergranular corrosion, stress corrosion cracking, corrosion fatigue, fretting corrosion, dealloying, hydrogen embrittlement, erosion corrosion, microbial induced corrosion, filliform corrosion and exfoliation.

Unit -IV

Industrial Corrosion Problems

Atmospheric corrosion and high temperature oxidation. Corrosion in industrial cooling water system, corrosion in boilers and condensate pipe lines, corrosion due to acids, corrosion during metal surface cleaning and descaling, corrosion in chemical industries, corrosion in oil and gas wells, corrosion in refinery and petrochemical plants, corrosion in fertilizer industries.

Recommended Readings:

1. J.O.M. Bockris, A.K.N. Reddy: Modern electrochemistry Vol.1: Ionics, 2nd edition(1998).
2. V.S. Sastri: Corrosion inhibitors: Principle & Applications, Wiley; First edition (2015).
3. K.R. Trephewey, J. Chambertain: Corrosion for Science and engineering, Pearson; 2nd edition (1995).
4. R. Narain: Introduction to Metallic corrosion & its prevention, Oxford & IBH publishing Co Pvt. Ltd (1988).
5. S.N. Banerjee: An introduction to the Science of Corrosion and its inhibition, Oxnonion press Pvt. Ltd, New Delhi, India (1985).
6. M.G. Fontana: Corrosion engineering, McGraw Hill Education; 3rd edition (2017).
7. A.J. Bard, L.R. Faulkner, Electrochemical Methods: Fundamentals and Applications, Wiley, 2nd edition (2001).
8. F. Daniels and R.A. Alberty: Physical Chemistry, John Wiley and Sons, Inc. (1987).

M.Sc. Chemistry (4th Semester)

Physical Chemistry Special Practical - I
Paper Code: 20CHE44PSL4
Potentiometry & pH metry titrations

6 hrs./week
Credits: 03
Max. Marks: 80+20
Time: 6 hrs.

1. Potentiometry:

(i) $KMnO_4$ vs. Mohr's salt or $FeSO_4$ titration

(ii) NaOH vs. H_3PO_4 titration.

(iii) NaOH vs. (HCl + CH_3COOH) mixture.

(iv) NaOH vs. Boric Acid

(v) $ZnSO_4$ vs. $K_4[Fe(CN)_6]$

(vi) $Na_2S_2O_3$ vs. Iodine

(vii) To determine solubility and solubility product of sparingly soluble salts $BaSO_4$, AgCl and $PbSO_4$

(viii) To determine degree of hydrolysis of aniline hydro chloride

(ix) To determine dissociation constant of weak acid.

(x) $AgNO_3$ vs. KCl or KI Titration.

2. pH metry Titrations

(i) NaOH vs. H_3PO_4

(ii) NaOH vs. (HCl + CH_3COOH) mixture

(iii) NH_4OH vs. HCl

(iv) NH_4OH vs. CH_3COOH

(v) To determine dissociation constant of weak acid.

Record File	**10 marks**
Viva-Voce	**10 marks**

M.Sc. Chemistry (4th Semester)

Physical Chemistry Special Practical - II
Paper Code: 20CHE45PSL5
Conductometry Titrations, Polarometry & Flame Photometry

6 hrs./week
Credits: 03
Max. Marks 80+20
Time: 6 hrs.

1. Conductometry Titrations

(i) NH_4OH vs CH_3COOH

(ii) CH_3COONa vs HCl

(iii) NaOH vs. (HCl + CH_3COOH) mixture

(iv) $AgNO_3$ vs. KCl or KI

(v) $AgNO_3$ vs. KCl+ KI

(vi) To determine concentration of Salicylic acid by (a) Salt line method and (b) Double alkali method

(vii) To determine solubility and solubility product of sparingly soluble salts (AgCl. $PbSO_4$. $BaSO_4$)

(viii) To study the kinetics of saponification of ester conductometrically

(ix) Verification of D.H.O. equation for strong electrolytes.

(x) To estimate the concentration of each component in a mixture of $AgNO_3$ and HNO_3.

2. Polarometry

(i) To determine specific rotation for various optically active substances.

(ii) To determine concentration of glucose or fructose or sucrose or tartaric acid in solution

(iii) To determine the percentage composition of optical substances in the binary mixture (components comprise of Glucose or Fructose or sucrose or Tartaric acid).

(iv) To determine the rate constant for inversion of sugar using polarometry technique.

3. Flame Photometry

(i) To determine the concentration of Na^+ or Li^+ or Ca^{++} ions in solution.

Record File	**10 marks**
Viva-Voce	**10 marks**

M.Sc. Chemistry (4th Semester)

Physical Chemistry Special Practical - III
Paper Code: 20CHE46PSL6
Ultrasonic Interferrometry, Spectrocolorimetry & Chemical Kinetics

6 hrs./week
Credits: 03
Max. Marks: 80+20
Time: 6 hrs.

1. Ultrasonic Interferrometry:

(i) To measure speed of sound for various liquids.

(ii) To determine the isentropic compressibility of liquids.

(iii) To determine excess isentropic compressibility of given binary liquid mixture.

2. Spectrocolorimetry:

(i) Determine the composition of $KMnO_4$ and $K_2Cr_2O_7$ in the given mixture.

(ii) Determine the pK_a value of the methyl red and phenolphthalein indicator.

(iii) To study complex formation between ferric and thiocyanate ions.

3. Chemical Kinetics:

(i) To study of kinetics of iodination of acetone.

(ii) To study the kinetics of saponification of ethyl or methyl acetate.

(iii) To study the kinetics of acid catalyzed inversion of cane sugar.

(iv) To study of kinetics of bromination of Gallic acid by bromide-bromate mixture in acid medium. (Clock reaction).

Record File	**10 marks**
Viva-Voce	**10 marks**

Recommended Readings:

1. J.B. Yadav: Advanced Practical Physical Chemistry, K Prakashan Media (P) Ltd (2015).
2. B.D. Khosla, V.C. Garg, A. Khosla: Senior practical physical chemistry, R. Chand & Co., New Delhi (2011).

Further Readings:

1. A. Thawale, P. Mathur: Experimental Physical Chemistry, New Age International Private Limited; 1st edition (2001).
2. B. Vishwanathan, P. S. Raghav: Practical Physical Chemistry, Viva Books (2014).
3. P.S. Sindhu: Practical in Physical Chemistry, Macmillan Publishers India (2005).

M.Sc. Chemistry (4th Semester)

Organic Chemistry Special- IV
Paper Code: 20CHE41OS4
Photochemistry and Disconnection Approach

4 hrs./week
Credits : 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit- I

Photochemical Reactions

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

Photochemistry of Alkenes

Intramolecular reactions of the olefinic bond– geometrical isomerism, sensitized cyclization reactions, rearrangement of 1,4-dienes.

Unit-II

Photochemistry of Carbonyl Compounds

Intramolecular reactions of carbonyl compounds– saturated cyclic and acyclic, α, β-unsaturated compounds and β,γ-unsaturated. Cycloaddition to alkenes.

Photochemistry of Aromatic Compounds

Isomerisations, additions and substitutions

Miscellaneous Photochemical Reactions

Photo-Fries rearrangement, Barton reaction and Hofmann-Lofler-Freytag reaction.

Unit-III

Disconnection Approach

An introduction to synthons and synthetic equivalents, disconnection approach, functional group inter-conversions, the importance of the order of events in organic synthesis, one group C-X disconnections and two-group C-X disconnections, chemoselectivity, cyclisation reactions, amine synthesis.

Protecting Groups

Principles of protection of alcohol, amine, carbonyl and carboxyl groups.

Unit-IV

One Group C-C Disconnections

Alcohols and carbonyl compounds, regioselectivity. Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis.

Two Group C-C Disconnections

Diels-Alder reaction, 1,3-difunctionalised compounds, α,β-unsaturated carbonyl compounds. 1.5-difunctionalised compounds. Michael addition and Robinson annelation.

Recommended Readings:

1. J.D. Coyal: Introduction to Organic Photochemistry. Wiley, 1st edition (1986)
2. N. J. Turo and W.A. Benjamin: Molecular Photochemistry, University Science Book, 1st edition (2010).
3. A. Cox and T. Camp: Introductory Photochemistry, McGraw-Hill Publication, US (1971).
4. J. Singh and J. Singh: Photochemistry and Pericyclic Reactions, New age science (2012).
5. S. Warren: Organic Synthesis: The Disconnection Approach, John Wiley & Sons Publication, 2nd edition (2008).
6. S.H. Pine, J.B. Hendrickson, D.J. Cram, G.S. Hammond, Organic Chemistry, McGraw-Hill Inc., Tokyo, (1980).

Further Readings:

1. R.P. Kundall and A. Gilbert: Photochemistry (1996).
2. J. Coxon and B. Halton: Organic Photochemistry, Cambridge University Press Publication; 2nd edition (2011).
3. Orville L. Chapman: Organic Photochemistry, Dekker (Marcel) Inc., U.S. Publication (1970).
4. S.M. Mukherji: Pericyclic Reactions, Volume-3, Inter science Publication (1985).
5. R.B. Woodward and R. Hoffman: The Conservation of Orbital Symmetry, Academic Press Publication (2013).
6. R.E. Lehr and A.P. Merchant: Orbital Symmetry, Academic Press Publication (1972).
7. S.M. Mukherji and S.P. Singh: Reaction Mechanism in Organic Chemistry, Laxmi Publications, 3rd edition (2007).
8. D. Nasipuri: Stereochemistry of Organic Compounds. NEW AGE; 3rd edition (2018).
9. P.S. Kalsi: Stereochemistry of Organic Compounds, New Age International Private Limited, 2nd edition (2016).

M.Sc. Chemistry (4th Semester)

Organic Chemistry Special- V
Paper Code: 20CHE42OS5
Medicinal and Natural Products Chemistry

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit-I

Drug Design

Introduction, development of new drugs, structure-activity relationship (SAR) - isosterism, bio-isosterism. Theories of drug activity: occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship, Concepts of drugs receptor, Elementary treatment of drug receptor interactions, Physico-chemical parameters: lipophilicity, partition coefficient, electronic ionization constants, steric factors.

Unit-II

Antineoplastic Agents

Introduction, role of alkylating agents and antimetabolites in treatment of cancer. Synthesis and uses of the following antineoplastic agents: mechlorethamine, cyclophosphamide, melphalan, uracil and 6-mercapto purine, Introduction to taxol.

Antibiotics

Cell wall biosynthesis inhibitors, antibiotics inhibiting protein synthesis, Synthesis and uses of the following antibiotics: penicillin G, amoxycillin, cephalosporin, ciprofloxacin. Introduction to tetracycline and streptomycin.

Unit- III

Alkaloids

Definition,nomenclature and physiological action, occurrence, isolation, general methods or structure elucidation, degradation, classification based on nitrogen heterocyclic rings, role of alkaloids in plants.

structure, stereochemistry, synthesis and biosynthesis if the following: Ephedrine.(+) Coniline, Atropine, Quinine and Morphine.

Unit- IV

Steroids

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry, Isolation, Structure determination and synthesis of Cholesterol, Bile acids, Androsterone, Testosterone, Estrone, Progestrone, Aldosterone, Biosynthesis of steroids.

Recommended Readings:

1. G.L. Patrick: Introduction to Medicinal Chemistry, Oxford University Press (2001).
2. A. Gringauz: Introduction to Medicinal Chemistry: How Drugs Act and Why? John Wiley & Sons Publication (1997).
3. I.R. Finar: Organic Chemistry, Pearson Education India Publication, 5th edition (2002).
4. J. Singh and J. Singh: Natural Products Chemistry, Pragati Prakashan 9th edition (2019).

Further Readings:

1. T.L. Lemke and D.A. William, Foye's Principles of Medicinal Chemistry, Lippincott Williams and Wilkins Publication, 7th edition (2012).
2. P.S. Kalsi: The Chemistry of Natural Products, Alpha Science Publication (2013).
3. J. Mann, R.S. Davidson, J.B. Hobbs: Natural Products - Chemistry and Biological significance, New York : Wiley Publication, 1st edition, 1994.
4. Att-ur-Retiman, M.I. Choudhary: New Trends in Natural Products chemistry, Harwood Academic Publishers, Amsterdam (1998).
5. C. O. Wilson, O. Gisvold & R.F. Doerge: Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams and Wilkins Publication, 12th edition (2011).
6. M.E. Wolff Burgers: Medicinal Chemistry and Drug, Wiley-Blackwell Publication, 5th edition (1996).

M.Sc. Chemistry (4th Semester)

Organic Chemistry Special- VI
Paper Code: 20CHE43OSE1
Organic Reactions and Reagents
(Elective (a))

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit -I

Preparation, properties and applications of following reagents in organic synthesis with mechanistic details:

Organometallic Reagents

n-Butyllithium, Grignard reagent, Organo chromium(III) compounds, Dialkyl copper lithium, Pentacarbonyl iron, Tetracarbonyl nickel, octacarbonyl dicobalt, Alkene Palladium (II) complexes, Wilkinsons catalyst, Methyl triisopropoxy titanium, Tri-n-butyl tin hydride, Trimethyl silyl iodide, Diborane.

Unit -II

General Reagents

DCC I, 1,3-dithianes, Polyphosphoric acid, Diazomethane, Ethyldiazoacetate, Boron Trifluoride, Trifluoro acetic acid, Cuprous chloride, N-Bromosuccinamide, Mont- K-10, and KSF (clays).

Unit -III

Oxidation

Leadtetraacetate, Osmium tetraoxide, Selenium dioxide, Potassium permanganate, Fenton's reagent, Ozone, Perbenzoic acid, Periodic acid, Chromium oxide, Thallium (III) nitrate.

Reduction

Catalytic hydrogenation, lithium aluminium hydride, Sodium borohydride, Sodamide, Zinc dust, Sodiumliquid ammonia reduction of carbonyl compounds, acids, their derivatives, epoxides, nitro and azo compounds.

Unit -IV

Rearrangement

General mechanistic considerations – nature of migration, migratory aptitude. A detailed study of following rearrangements: Pinacol – pinacolone, Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hofman, Curtius, Schmidt, Baeyer-Villiger and Shapiro reaction, Barton, Chihibaben, Wittig reaction, Hoffman- Lofler Freytag reaction.

Recommended Readings:

1. W. Carruthers, L. Coldham, Modern Methods of Organic Synthesis Cambridge University Press, South Asia Edition (2015).
2. J. March: Advanced Organic Chemistry -Reactions Mechanism and Structure, Wiley, 6th Edition (2012).
3. H.O. House: Modern Synthetic Reactions, Benjamin-Cummings Publishing Co., Subs. of Addison Wesley Longman, US; 2nd Revised edition (1972).
4. R.C. Mehrotra & A. Singh: Organometallic Chemistry-A Unified Approach, New Age International, 2nd edition (2005).

Further Readings:

1. G.S. Sondhi: Organometallic Chemistry, Ane Books Pvt. Ltd, 1st edition (2009).
2. R. Norman and J.M. Coxon: Principles of Organic Synthesis, CRC Press; 3rd edition (1993).
3. R. Gopalan & V. Ramalingam: Concise Coordination Chemistry, Vikas Publication House Pvt Ltd, 1st ddition (2008).
4. J. Fuhrhop and G. Penzillin: Organic Synthesis Concept, Methods and Starting Materials, Vch Pub (1997).
5. S. Warren: Designing Organic Synthesis, Wiley India Pvt. Ltd (2009).

M.Sc. Chemistry (4th Semester)

Organic Chemistry Special- VI
Paper Code: 20CHE43OSE2
Bioorganic Chemistry
(Elective (b))

4 hrs./week
Credits: 04
Max. Marks: 80+20
Time: 3 hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions, first question will be compulsory containing 08 short answer type questions covering the entire syllabus. For next 08 questions, examiner will set 02 questions from each Unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Unit- I

Proteins

Peptides and proteins: Classification of naturally occurring peptides, depsipeptide. Sequence determination, chemical, enzymatic and mass spectral methods. Solid phase synthesis, combinatorial synthesis of peptides. Modern methods of peptide synthesis with protection and deprotection, aggregation of peptides, Chemistry of oxytocin, valinomycin, enkephalins.

Unit- II

Lipids

Fatty acids and lipids: Classification and biological importance, stereochemical notation in lipids, chemical synthesis of phospholipids and glycolipids, properties of lipid aggregates, micelles, bilayers, lyposomes and biological membranes.

Unit- III

Nucleic Acids

Nucleic acids: Secondary structure of DNA and RNA, stabilizing forces, polymorphic nature of DNA, multistranded DNA structures, sequence determination by chemical and enzymatic methods, genome sequencing, chemical synthesis of DNA, solution phase and solid phase synthesis, phosphodiestertriester and phosphite methods, phosphoramide approach; PNA, LNA, UNA, automated DNA synthesizers, purification of oligonucleotides.

Unit- IV

Carbohydrates

Naturally occurring sugars, amino sugars, branched chain sugars, deoxy sugars, sugar methyl ethers and acid derivatives of sugars, polysaccharides of industrial and biological importance, cell-cell recognition and blood group substances.

Recommended Readings:

1. L. Stryer: Biochemistry, W. H. Freeman & Co., 4th edition (1995).
2. D.L. Nelson and M. Cox: Lehninger Principles of Biochemistry: WH Freeman, International Edition (2017).
3. H. Dugas & C. Penney, Bioorganic Chemistry: A Chemical Approach to Enzyme Action, Springer-Verlag (1989).

Further Readings:

1. M. Bodansky: Peptide Chemistry: A Practical Textbook, Springer-Verlag (1988).
2. S. Zubay: Biochemistry, Addison-Wesley (1983).

M.Sc. Chemistry (4th Semester)

Organic Chemistry Special Practical-I
Paper Code: 20CHE44OSL4
Multi-step synthesis & Quantitative analysis of Organic Compounds

6 hrs./week
Credits: 03
Max. Marks 80+20
Time: 6 hrs.

1. Multi-step synthesis

(i) m-Nitroaniline from benzene

(ii) 5-Acetoxy-1,3-benzoxathiol-2-one from hydroquinone

(iii) 2'-Hydroxy-4-methoxyphenylstyryl ketone from resorcinol.

(iv) Acridone from anthranilic

2. Quantitative analysis:

(i) Estimation of glucose by chemical methods

(ii) Estimation of amino acids by chemical methods

(iii) Estimation of iodine value of oils and fats

(iv) Any other possible estimation

Record File	**10 marks**
Viva-Voce	**10 marks**

M.Sc. Chemistry (4th Semester)

Organic Chemistry Special Practical-II
Paper Code: 20CHE45OSL5
Isolation & Chromatography of organic compounds

6 hrs./week
Credits: 03
Max. Marks 80+20
Time: 6 hrs.

1. Isolation of organic compounds from natural sources:

(i) Caffeine from tea leaves

(ii) Lactose and casein from milk

(iii) Nicotine from tobacco

(iv) Piperene from black pepper

(v) β-carotene from carrots

2. Study of TLC, Column Chromatography and Paper Chromatography for organic mixture.

Record File	**10 marks**
Viva-Voce	**10 marks**

M.Sc. Chemistry (4th Semester)

Organic Chemistry Special Practical-III
Paper Code: 20CHE46OSL6
Qualitative Analysis using Spectroscopic, chemical methods & Spectrophotometric Estimations

6 hrs./week
Credits: 03
Max. Marks 80+20
Time: 6 hrs.

1. Qualitative Analysis:

Identification of organic compound using spectroscopic methods (UV, IR, NMR & Mass) followed by characterization by chemical methods.

2. Spectrophotometric (UV/VISIBLE) Estimations:

a. Proteins
b. Carbohydrates
c. Caffeine
d. Ascorbic acid

Record File	**10 marks**
Viva-Voce	**10 marks**

Recommended Readings:

1. A. R. Tatchell, Peter W G. Smith, A.J. Hannaford, B.S. Furniss: Vogel's Textbook of Practical Organic Chemistry, Pearson Education; 5th edition (2003).
2. H. Middleton: Systematic Qualitative Organic Analysis, Edward Arnold & Co. (1948) .
3. H. Clark: Handbook of Organic Analysis-Qualitative and Quantitative, CBS. 4th revised edition (2007).
4. Stout, G.H. & Jensen, L. H. X- Ray structure Determination A Practical Guide Iled (John Wiley & Sons (1989).

Further Readings:

1. D. Pasto, C. Johnson and M. Miller: Experiments and Techniques in Organic Chemistry, Prentice Hall; Instructor's edition (1992).
2. K.L. Williamson, K.M. Masters: Macroscale and Microscale Organic Experiments, Cengage Learning, 6th edition (2010).