Chaudhary Bansi Lal University, Bhiwani

(A State University established under Haryana Act No. 25 of 2014)

Examination Scheme
&
Syllabus
For

M.Sc. CHEMISTRY
(SEMESTER- I to IV)
(w.e.f. 2019-20)

Chaudhary Bansi Lal University, Bhiwani

(A State University established under Haryana Act No. 25 of 2014)

Study & Evaluation Scheme
Of
M.Sc. Chemistry

Summary

Programme	M.Sc. Chemistry
Duration	Two year full time (Four Semesters)
Medium	English
Minimum Required Attendance	75%
Total Credits	121

Assessment/Evaluation

Internal Marks	Major Test (End Semester Exam) Marks	Total Marks
20	80	100

Internal Evaluation

Minor Test	Attendance	Assignment	Total Marks
10	5	5	20

Duration of Examination

Major Test (End Semester Exam)	Internal (Minor Test)
3 hrs.	1½ hrs.

To qualify the course, a student is required to secure a minimum of 40% marks in aggregate including the Major Test (End Semester Examination) and internal evaluation. A candidate who secures less than 40% of marks in a course shall be deemed to have failed in that course. The student should have obtained at least 40% marks in aggregate to qualify the semester.

***Note:* The students should be involved in extracurricular activities through Hobbies Club (Non-CGPA) such as Poetry, Science Club, and Drama etc. and will be awarded a letter grade at the completion of M. Sc.**

Question Paper Structure

There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Chaudhary Bansi Lal University, Bhiwani
Scheme of Examination for M.Sc. Chemistry
Under
CBCS (Choice Based Credit System)

Duration: 02 Years (04 Semesters) **Total Credits: 121** **Total Marks: 2425**

Semester-I **Credits= 30** **Marks= 600**

Paper Code	Subjects	Type of Course	Contact Hours Per Week			Credits			Examination Scheme			Total
			Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessment	Practical	
19CHE-101	Inorganic Chemistry - I	C.C.	04	--	04	04	--	04	80	20	--	100
19CHE-102	Physical Chemistry – I	C.C.	04	--	04	04	--	04	80	20	--	100
19CHE-103	Organic Chemistry – I	C.C.	04	--	04	04	--	04	80	20	--	100
19CHE-104	Spectroscopy-I	C.C.	04	--	04	04	--	04	80	20	--	100
Open Elective – I	Open Elective – I	O.E.C.	02	--	02	02	--	02	40	10	--	50
19CHE-105	**Practical - I** Inorganic Chemistry	S.E.C.	--	02×04	08	--	04	04	--	--	50	50
19CHE-106	**Practical - II** Physical Chemistry	S.E.C.	--	02×04	08	--	04	04	--	--	50	50
19CHE-107	**Practical - III** Organic Chemistry	S.E.C.	--	02×04	08	--	04	04	--	--	50	50
Total			**18**	**24**	**42**	**18**	**12**	**30**	**400**	**100**	**150**	**600**

C.C. = Core Course **O.E.C. = Open Elective Course** **S.E.C. = Skill Enhancement Course**

Note: 1. *For Open Elective Course, students will have to choose a course out of list of open electives offered by other UTDs (University Teaching Departments).*

2. *Practical I, II, III are based on theory papers.*

Semester-II ` Credits= 32 Marks= 650

Paper Code	Subjects	Type of Course	Contact Hours Per Week			Credits			Examination Scheme			Total
			Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessment	Practical	
19CHE-201	Inorganic Chemistry – II	C.C.	04	--	04	04	--	04	80	20	--	100
19CHE-202	Physical Chemistry – II	C.C.	04	--	04	04	--	04	80	20	--	100
19CHE-203	Organic Chemistry – II	C.C.	04	--	04	04	--	04	80	20	--	100
19CHE-204	Statistics for Chemists	C.C.	04	--	04	04	--	04	80	20	--	100
19CHE-205	IT Skills	S.E.C	02	--	02	02	--	02	40	10	--	50
19CHE-206	**Practical IV** Inorganic Chemistry	S.E.C.	--	02×04	08	--	04	04	--	--	50	50
19CHE-207	**Practical V** Physical Chemistry	S.E.C.	--	02×04	08	--	04	04	--	--	50	50
19CHE-208	**Practical VI** Organic Chemistry	S.E.C.	--	02×04	08	--	04	04	--	--	50	50
19CHE-209	Summer Training		--	--	--	--	--	02	--	--	--	50
Total			**18**	**24**	**42**	**18**	**12**	**32**	**360**	**90**	**150**	**650**

C.C. = Core Course **S.E.C. = Skill Enhancement Course**

Note: 1. *Practicals IV, V, VI are based on theory papers.*

2. *Evaluation of Summer Training will be done by Chairperson, Department of Chemistry, CBLU Bhiwani. Students both from UTD's and Colleges have to submit a copy of report to Chairperson, Department of Chemistry, Chaudhary Bansi Lal University, Bhiwani.*

Semester-III ` **Credits=30** **Marks= 600**

Paper Code	Subjects	Type of Course	Contact Hours Per Week			Credit			Examination Scheme			Total
			Theory/Group discussion	Practical	Total	Theory/Group Discussion	Practical	Total	Exam	Internal Assessment	Practical	
19CHE-301	Spectroscopy-II	C.C.	04	--	04	04	--	04	80	20	--	100
19CHE-302 19CHE-303 19CHE-304	Inorganic Chemistry Special-I Physical Chemistry Special - I Organic Chemistry Special - I	D.S.E.	04	--	04	04	--	04	80	20	--	100
19CHE-305 19CHE-306 19CHE-307	Inorganic Chemistry Special - II Physical Chemistry Special - II Organic Chemistry Special – II	D.S.E.	04	--	04	04	--	04	80	20	--	100
19CHE-308 19CHE-309 19CHE-310	Inorganic Chemistry Special - III Physical Chemistry Special - III Organic Chemistry Special - III	D.S.E.	04	--	04	04	--	04	80	20	--	100
Open Elective – II	Open Elective – II	O.E.C.	02	--	02	02	--	02	40	10	--	50
19CHE-311 19CHE-312 19CHE-313	**Practical VII** Inorganic Chemistry Special Physical Chemistry Special Organic Chemistry Special	S.E.C.	--	02×04	08	--	04	04	--	--	50	50
19CHE-314 19CHE-315 19CHE-316	**Practical VIII** Inorganic Chemistry Special Physical Chemistry Special Organic Chemistry Special	S.E.C.	--	02×04	08	--	04	04	--	--	50	50
19CHE-317 19CHE-318 19CHE-319	**Practical IX** Inorganic Chemistry Special Physical Chemistry Special Organic Chemistry Special	S.E.C.	--	02×04	08	--	04	04	--	--	50	50
Total			**18**	**24**	**42**	**18**	**12**	**30**	**400**	**100**	**150**	**600**

C.C. = Core Course **D.S.E. = Discipline Specific Elective Course** **O.E.C. = Open Elective Course**

S.E.C. = Skill Enhancement Course

Note: 1. *For Open Elective Course, students will have to choose a course out of list of open electives offered by other UTD*

2. *Practicals VII, VIII and IX are based on theory papers.*

3. *Special paper will be allotted on the basis of merit of 1st semester result and choice.*

Semester-IV **Credits =29** **Marks = 575**

Paper Code	Subjects	Type of Course	Contact Hours Per Week			Credit			Examination Scheme			Total
			Theory/Group discussion	Practical	Total	Theory/Group Discussion	Practical	Total	Theory	Internal Assessment	Practical	
19CHE- 401 19CHE-402 19CHE-403	Inorganic Chemistry Special IV Physical Chemistry Special IV Organic Chemistry Special IV	D.S.E.	04	--	04	04	--	04	80	20	--	100
19CHE- 404 19CHE-405 19CHE-406	Inorganic Chemistry Special V Physical Chemistry Special V Organic Chemistry Special V	D.S.E.	04	--	04	04	--	04	80	20	--	100
19CHE- 407 19CHE-408 19CHE-409	Inorganic Chemistry Special VI Physical Chemistry Special VI Organic Chemistry Special VI	D.S.E.	04	--	04	04	--	04	80	20	--	100
19CHE-410	Communication Skills	D.S.E.	02	-	02	02	-	02	40	10	-	50
19CHE- 411 19CHE-412 19CHE-413	**Practical X** Inorganic Chemistry Special Physical Chemistry Special Organic Chemistry Special	S.E.C.	--	02×04	08	--	04	04	--	--	50	50
19CHE- 414 19CHE-415 19CHE-416	**Practical XI** Inorganic Chemistry Special Physical Chemistry Special Organic Chemistry Special	S.E.C.	--	02×04	08	--	04	04	--	--	50	50
19CHE- 417 19CHE-418 19CHE-419	**Practical XII** Inorganic Chemistry Special Physical Chemistry Special Organic Chemistry Special	S.E.C.	--	02×04	08	--	04	04	--	--	50	50
19CHE-420	Seminar/Journal club	A.E.C.C.	02	--	02	02	--	02	--	--	--	50
19CHE-421	Self Study	A.E.C.C.	01		01	02		02				50
Total			**17**	**24**	**41**	**17**	**12**	**29**	**280**	**700**	**150**	**575**

D.S.E. = Discipline Specific Elective Course A.E.C.E. = Ability Enhancement Compulsory Course S.E.C. = Skill Enhancement Course

Note: 1. *Practicals X, XI, XII are based on theory papers.*

GENERAL INSTRUCTIONS

I. SELF-STUDY PAPER: Maximum Marks-50

Objective: This course intends to create habits of reading books and to develop writing skills in a manner of creativity and originality. The students are to emphasis his/her own ideas/words which he/she has learnt from different books, journals and newspapers and deliberate the same by adopting different ways of communication techniques and adopting time scheduling techniques in their respective fields. This course aims:

- To motivate the students for innovative, research and analytical work
- To inculcate the habit of Self-Study and comprehension
- To infuse the sense of historical back ground of the problems
- To assess intensity of originality and creativity of the students

Students are guided to select topic of their own interest in the given area in consultation with their teachers/Incharge/Resource Person.

Instructions for Students

1. Choose the topic of your interest in the given areas and if necessary, seek the help of your teacher.
2. Select a suitable title for your paper.
3. You are expected to be creative and original in your approach.
4. Submit your paper in two typed copies of A4 size 5-6 pages (both sides in 1.5 line spaces in Times New Roman Font size 12).
5. Organize your paper in three broad steps:
   (a) Introductions
   (b) Main Body
   (c) Conclusions
6. Use headings and sub-headings
7. Use graphics wherever necessary
8. Give a list of books/references cited/used
9. The evaluation of self study paper will be done by external examiner. (30 Marks for write up and 20 Marks for Viva-Voce.

Distribution of Marks

1. The evaluation is divided into different segments as under : **30 Marks**

   The 15 marks evaluation is further subdivided as under:

   (i) Selection of Topic - 6 Marks

   (ii) Logical Organization of subject matter - 10 Marks

   (iii) Conclusions - 10 Marks

   (iv) References - 4 Marks

2. Viva-Voce: **20 Marks**

The external examiner will hold Viva-Voce based on contents of the student's Self Study Paper focusing upon the description by the Candidate.

Summer Training

Objective:

The objective of Summer training is to render the students to work environment in the field of Chemistry at industry, academic institute and research institute. It helps them to learn the latest technologies, skills, methodologies and to build a strong foundation for their career growth. It will provide learning platform to students where they can enhance their ability, skills and become job ready. Particularly, Summer training program will:

i) enable the students to get important tips from the professionals to gain valuable practical experience.

ii) test the students' career interest.

iii) provide the students with in depth knowledge about career field.

iv) develop the students' job related skills.

v) enhance relationship between the chemistry department and public as well as private sectors.

Outcome:

i) Capability to acquire and apply fundamental principles of chemistry.

ii) Become master in one's specialization.

iii) Become updated with all latest changes occurring in particular field.

iv) Capability and enthusiasm for self-improvement through professional development and lifelong learning.

v) Awareness of the social, cultural, global and environmental responsibility as a chemist.

Duration of Summer Training

The Summer/Industrial training will comprise of 3-4 weeks.

Evaluation of Summer Training

Summer Training will be evaluated as per the Performa mentioned below:-

M.Sc. Chemistry II Semester

EVALUATION SHEET FOR SUMMER-TRAINING

Paper Code: 19CHE-209 **Max Marks: 50**

S.No.	Roll No.	Name of Students	Writing Report (20)	Attendance (15)	Viva-Voce (15)	Total (50)

Signature of Evaluation committee:

M.Sc.-CHEMISTRY
SEMESTER-I

19CHE-101: Inorganic Chemistry-I
(Concepts in Inorganic Chemistry)

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Group Theory: Symmetry elements and symmetry operations, Pure Rotations (Cn Rotations), Improper Rotations, Rotation- Reflection (S_n) & Rotation-Inversion (n-bar) Axes, Point symmetry group, Schönflies symbols, representations of groups by matrices (representation for the C_n, C_{nv}, C_{nh}, D_{nh} etc. groups to be worked out explicitly), Character of a representation, reducible and irreducible representations. The great orthogonality theorem (without proof) and its importance, Derivation of character tables of C_{2v}, C_{3v} and D_{2h} and their use.

Unit-II

Stereochemistry and Bonding in Main Group Compounds: VSEPR Theory, dπ-pπ bonds, Bent rule and energetics of hybridization.

Metal Ligand Equillibria in solution: Stepwise and Overall formation Constants and their interactions trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, Irving-William series, chelate effect and its thermodynamic origin.

Unit-III

Metal-Ligand Bonding: Crystal field theory and its limitation, crystal field effects: d-orbital splitting in octahedral, square planar, square pyramidal and trigonal bipyramidal complexes, Jahn Teller distortion, molecular orbital theory of octahedral, tetrahedral and square planar complexes (with and without π -bonding).

Unit-IV

Reaction Mechanism of Transition Metal Complexes-I: Inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors

affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage,racemization of tris chelate complexes.

Suggested Readings:

1. Cotton, F.A., Garg, V.C. & Wilkinson, *Advanced Inorganic Chemistry*, John Wiley 4th ed. (1930).
2. Huheey, J. E., Keiter, E.A. & Keiter R. L., *Inorganic Chemistry: Principles of structure and reactivity*, Harper & Row 4th ed. (1993).
3. Cotton, F.A., *Chemical Applications of Group Theory*, Wiley 3rd ed. (1930).
4. Greenwood, N.N. & Earnshaw, A., *Chemistry of the Elements*, Elseiver 2nd ed. (2012)
5. Murrel, J.N., Kettle, SFA & Tedder, J.M., Valence Theory, John Wiley (1965).
6. Figgis, B.N., *Introduction to Ligand fields*, John Wiley (1966).
7. Modern Aspects of Inorganic Chemistry; H.J. Emeleus and Sharpe.
8. Introduction to Ligand Field Theory; C.J.Ballahyen, McGraw Hill, New York.
7. Douglas, B., McDaniel, D.H. & Alexander, J.J., *Concepts and Models of Inorganic Chemistry*; John Wiley 2nd ed. (1983).
8. Moeller, T., *Inorganic Chemistry, A Modern Introduction*, John Wiley 2nd ed. (1982).

M.Sc.-CHEMISTRY
SEMESTER-I

19CHE-102: Physical Chemistry-I
(Principles of Physical Chemistry-I)

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Quantum Mechanics: Introduction to Quantum Mechanics, Postulates of Quantum Mechanics, Quantum mechanical operators and their commutation relation, Hermition operators, eigen function and eigen values, Angular momentum operators and their commutation relation (L_x, L_y, L_z & L^2) ladder operators and its effect on angular momentum operator. Derivation of uncertainty principle (x & p),

Schrodinger wave equation for a free particle and for particle in one dimensional box; evaluation of average position, average momentum and average energy, pictorial representation of the wave equation and energy for particle in one dimensional box, utility of particle in 1-D box and Schrodinger wave equation for a particle in a three dimensional box and the concept of degeneracy of energy levels.

Unit-II

Thermodynamics: First and second Law of thermodynamics including Carnot cycle, Refrigerator, Entropy changes in reversible and irreversible processes; variation of entropy with temperature, pressure and volume, criteria for the spontaneity of reaction; free energy functions and their significance, Maxwell relations, partial molar quantities (free energy, volume, heat capacity), Gibb's-Duhem equation, variation of chemical potential with temperature and pressure, chemical potential for an ideal gas, thermodynamic functions of mixing (free energy, entropy, volume and enthalpy).

Unit-III

Chemical Dynamics: Brief description of integrated rate laws of zero, first and second order reactions with graphical representation, Lindemann – Hinshelwood mechanism of unimolecular reactions. Rate law for opposing reactions (Ist & IInd order), Rate law for consecutive reactions, Kinetics of parallel reactions.

Chain reactions (Formation of HBr & HCl, decomposition of acetaldehyde & ethane), apparent activation energy, chain length, Rice- Herzfeld mechanism (acetaldehyde).

Unit-IV

Electrochemistry: Debye -Huckel theory of ion- ion interactions (ionic cloud, Poisson's equation, excess charge density, Linearization of Boltzmann equation, Linearized Poison Boltzmann equation and its solution, excess charge density and potential as a function of distance from the central ion, Debye Huckel reciprocal length, ionic cloud and its contribution to the total potential), Debye-Hückel limiting law, activity coefficient and ion-ion interactions and its physical significance, mean ionic activity coefficient. Debye – Huckel -Onsager treatment for aqueous solutions and non-aqueous solutions, Debye - Falkenhagen effect, Wein effect.

Suggested Readings:

1. Atkins, P., Paula, Keeler, J. J., Atkins' *Physical Chemistry Thermodynamics and Kinetics,* Oxford University Press, 11th ed. (2017).
2. Rastogi, R. P. & Misra, R. R, *An Introduction to Chemical Thermodynamics*, Vikas Pub. 6th Revised ed. (6/e) (2000)
3. Glasstone, S., *Thermodynamics for Chemists*, Narahari Press (2007)
4. Laidler, K.J., *Chemical Kinetics,* McGraw Hill 2nd ed. (1965).
5. Levine, I. N., *Quantum Chemistry,* Pearson 7th ed. (2016).
6. Chandra, A.K., *Introductory Quantum Chemistry*, Tata Mc Graw Hill, 4th ed. (1998).
7. Prasad, R.K., *Quantum Chemistry through Problems and solutions,* New Age International (1997).
8. Castellan, G.W., *Physical Chemistry, 3/E,* Narosa Publishing House Pvt. Ltd. (2004).
9. Kapoor, K.L., *A Textbook of Physical Chemistry Volume 2,* Macmillan 3rd ed. (2004).
10. Kapoor, K.L., *A Textbook of Physical Chemistry Volume 4*, Tata Mc Graw Hill (2015).
11. Kapoor, K.L., *A Textbook of Physical Chemistry Vol 5 –Dynamics of chemical Reaction*, Tata Mc Graw Hill (2014).
12. Bockris, J.O.M. & Reddy A.K.N., *Modern electrochemistry Vol-I*, 2nd ed. (1970).
13. Rogers, D. W., *Concise Physical Chemistry*, John Wiley & sons (2011).
14. Moudgil, H. K., *Textbook of Physical Chemistry*, PHI Learning Pvt. Ltd. 2nd ed. (2014).

M.Sc.-CHEMISTRY
SEMESTER-I

19CHE-103: Organic Chemistry-I
(Conceptual Organic Chemistry & Stereochemistry)

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Nature of Bonding in Organic molecules: Delocalized chemical bonding –conjugation, cross conjugation. Concept of aromaticity; Huckel's rule, energy level of π-molecular orbitals, annulenes, antiaromaticity, homo-aromaticity. Bonds weaker than covalent, addition compounds.

Reaction Mechanism: Structure and Reactivity: Types of mechanisms, types of reactions, Relationship between thermodynamic stability and rates of reactions - kinetic versus thermodynamic control of product formation – Hammond postulate. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, guide lines for proposing reaction mechanism. The Hammett equation and linear free energy relationship, substituent and reaction constants.

Unit-II

Generation, structure, stability and reactivity of reactive intermediates, carbocations, carbonanions, Free Radicals, Carbenes, Nitrenes.

Aliphatic Nucleophilic and Electrophilic Substitution: The S_N^1, S_N^2, mixed S_N^1 and S_N^2, S_N^i and SET mechanisms. The neighbouring group mechanisms, neighbouring group participation by p and s bonds, anchimeric assistance. Classical and non-classical carbocations, phenonium ions, common carbocation rearrangements. Reactivity- effects of substrate structure, attacking nucleophile, leaving groupand reaction medium.. Ambident nucleophile, regioselectivity. Phase transfer catalysis; The S_E^1 mechanism, Bimolecular mechanisms- S_E^2 and S_E^i., Electrophilic substitution accompained by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Unit-III

Stereochemistry-I: Introduction to molecular symmetry and chirality. D-L, R-S, E-Z and threo-erythro nomenclature, interconversion of Fischer, Newman, Sawhorse and flying wedge formulae. Conformational analysis, enantiomerism and diastereomerism of simple acyclic, cyclic system (chair and boat

configuration), fused and bridged bicyclic systems (decalins) and sugars. Conformation and reactivity some examples. Optical activity in the absence of chiral carbon (biphenyls, allenes, ansa compounds, cyclophanes, hemispiranes and spiranes); Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus.

Unit-IV

Stereochemistry-II: Topicity of ligands and faces, their nomenclature and prostereoisomerism, stereogenecity, chirogenicity, pseudoasymmetry and prochiral centre. stereospecific and stereoselective reaction. Asymmetric synthesis: Enantiomer excess, % enantioselectivity, optical purity, % diastereomeric excess and % diastereoselectivity. Asymmetric synthesis (basic principle, auxiliary, substrate, reagent and catalyst controlled)

Suggested Readings:

1. March, J., *Advanced Organic Chemistry Reactions, Mechanism and Structure,* John Wiley 6th ed. (2007).
2. Carey, F. A. & Sundberg, R. J., *Advanced Organic Chemistry,* Plenum 5th ed. (1977)
3. Sykes, P., *A Guide Book to Mechanism in Organic Chemistry,* Pearson 6th ed. (2003)
4. Ingold, C. K., *Structure and Mechanism in Organic Chemistry,* Cornell University Press (1957)
5. Morrison, R. T. & Boyd, R. N. *Organic Chemistry,* Prentice –Hall 6th ed. (2001)
6. House, H. O., *Modern Synthetic Reactions,* Benjamin (1965)
7. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional 3rd ed. (1993)
8. Prakash, O. & Singh, S. P., *Reaction Mechanism in Organic Chemistry*, Trinity (2017)
9. Eliel, E. L. & Wilen, S. H., *Stereochemistry of Organic Compounds*, John Wiley (1994)
10. Nasipuri, D., *Stereochemistry of Organic Compounds*, New Age International 3rd ed. (2018)
11. Kalsi, P.S., *Stereochemistry of Organic Compounds,* New Age International 10th ed. (2019)
12. Carruthers, W. & Coldham, I., *Modern methods of Organic Synthesis*, Cambridge University Press 1st e. (2005)
13. Robinson, M.J. T., *Organic Stereochemistry*, Oxford University Press (2005)
14. Issacs, N. S., *Reactive Intermediates in Organic chemistry,* John Wiley (1974)

M.Sc.-CHEMISTRY
SEMESTER-I

19CHE-104: Spectroscopy-I

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Electronic Spectroscopy: Introduction and understanding of UV-Visible phenomenon, theory of electronic spectroscopy, instrumentation and sampling, solvents effects, conjugation effects, the chromophore and auxochrome concepts, rules for prediction of wavelength, applications of electronic spectroscopy – dienes, polyenes, carbonyl compounds, benzene and its substituted derivatives, aromatic hydrocarbon other than benzene, heterocyclic systems and stereochemical factors in electronic spectroscopy.

Infrared Spectroscopy: Principle, units of frequency, wavelength and wavenumber; molecular vibrations, factors influencing vibrational frequencies, Instrumentation – dispersive and interferometric instruments; sampling techniques, applications of IR – identity by fingerprinting and functional groups of different organic molecules; quantitative infrared analysis; attenuated total reflectance and multiple internal reflectance.

Unit-II

Nuclear Magnetic Resonance Spectroscopy: Introduction, nuclear spin states, nuclear magnetic moments, resonance, population densities, chemical shift and shielding mechanism; instrumentation, chemical equivalence, integrals and integration, chemical environment & chemical shift, local diamagnetic shielding, magnetic anisotropy, spin-spin splitting, Pascal's triangle, comparison of spectra at low and high field strengths, spin-spin coupling – symbols, mechanism, types, role of magnetic equivalence, concept of non-equivalence within a group, measuring coupling constant from first-order and second-order spectra, coupling in aromatic and heteroaromatic system, spectra of homotopic, enantiotopic and diastereotopic systems, survey of typical proton NMR absorptions of organic compounds - alkanes, alkenes, aromatic compounds, alkynes, alkyl halides, alcohol, ethers, amines, nitriles, aldehydes, ketones, esters, carboxylic acids, amides, nitroalkanes. Discussion on simplification techniques – deuterium exchange, chemical shift reagents, chiral resolving agents, spin decoupling methods, double resonance and NOE difference spectra.

Unit-III

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

Unit-IV

Carbon-13 NMR Spectroscopy and Heteronuclear Coupling: General considerations, carbon-13 nucleus, chemical shift and its calculation, proton-coupled and -decoupled carbon-13 spectra, nuclear overhauser enhancement, cross-polarization, problems with integration, molecular relaxation process, off-resonance decoupling; distortionless enhancement by polarization transfer, heteronuclear coupling of carbon to deuterium, fluorine and phosphorus.

Spectroscopy Problems: IR, NMR, electronic and conjoint IR-UV/VIS-NMR-Mass spectrometry problems.

Suggested Readings:

1. Pavia, D.L., Lampman, G.M. & Kriz, S., *Introduction to Spectroscopy- A Guide for Students of Organic Chemistry*, Fort Worth Harcourt Brace College Publishers, 3nd ed. (2001).
2. Silverstein, R. M., Bassler, G.C. & Morrill, T. C., *Spectrometric Identification of Organic Compounds*, John Wiley 3rd ed. (1991).
3. Dyer, J. R., *Application of Spectroscopy of Organic Compounds,* Prentice Hall (1978).
4. Williams, D. H., Fleming, I., *Spectroscopic Methods in Organic Chemistry,* Tata McGraw-Hill 4th ed. (1989).
5. Kalsi, P.S., *Spectroscopy of Organic Compounds* New Age International 6th ed. (2007).
6. Kemp, W., *Organic Spectroscopy*, Macmillan (1975).
7. Das, K. G., & James, E.P., *Organic Mass Spectrometry* Oxford & IBH Publishing (1976)
8. Mohan, J., *Organic Spectroscopy (Principles & Applications),* CRC Press (2004).
9. Roboz, J., *Introduction to Mass Spectrometry: Instrumentation and Techniques*, Interscience (1968).

M.Sc.-CHEMISTRY
SEMESTER-I

19CHE-105 Practical-I
Inorganic Chemistry

Max. Marks: 50
Time: 8 hrs.

1. Qualitative Analysis:

a) Less common metal ions- Se, Te, Mo, W, Ti, Zr &V

b) Insolubles-Oxides(Al_2O_3, Cr_2O_3, SnO_2, TiO_2); Sulphates (Lead Sulphate, Barium Sulphate, Strontium Sulphate and Calcium Sulphate); Halides (CaF_2, AgCl, AgBr, AgI)

*(2 less common metal ions and 1 insoluble to be given) (30 Marks)

2. Quantitative Analysis:

Cerimetric / Iodometric/ Oxidimetry titrations (10 Marks)

3. Viva-Voce (05 Marks)

4. Note Book (05 Marks)

Suggested Readings:

1. Vogel, A.I., *A Text Book of Macro and Semi-micro Quantitative Analysis*, Longman 4th ed. (1974).
2. Bassett, J., Denney, R.C., Jaffery, G.B. & Menaham, J., *A Vogel's Text Book of Quantitative Inorganic Analysis,* Longman 4th ed. (1985).

M.Sc.-CHEMISTRY
SEMESTER-I

19CHE-106 Practical-II
Physical Chemistry

Max. Marks: 50
Time: 8 hrs.

1. pH metry
   (i) Determine the strength of strong acid by pH-metric titration with strong base.
   (ii) Determine the strength of weak acid by pH-metric titration with strong base.
2. Conductometry
   (i) Determine the strength of strong acid by conductometric titration with strong base.
   (ii) Determine the strength of weak acid by conductometric titration with strong base.
   (iii) Determine the strength of strong acid and weak acid in a mixture by conductometric titration with strong base.
3. Thermochemistry
   (i) Determination of heat of neutralization
   - NaOH vs. HCl
   - NaOH vs. CH_3COOH
4. Chemical Kinetics
   (i) Study kinetics of hydrolysis of an ester in the presence of acid.
   (ii) Saponification of ethyl acetate.
   (iii) Compare the relative strength of acids

Note-Book	05 Marks
Viva-Voce	05 Marks
Experiments	(2x20) = 40 Marks

Suggested Readings:

1. James, A.M. & Prichard, F.E., *Practical Physical Chemistry,* Longman 3rd ed. (1974).
2. Lavitt, B.P., *Findley's Practical Physical Chemistry,* Longman 9th ed. (1973).
3. Das, R.C. & Behera, B., *Experimental Physical Chemistry,* Tata McGraw Hill (1983).
4. Shoemaker, D.P., Gerland, C. W., *Experiments in Physical Chemistry,* Tata McGraw Hill 8th ed. (2009)
5. Jahagirdhar, D.V., *Experiments in Physical Chemistry,* Himalaya Publishing Housing (1994).
6. Khosla, B.D., Garg, V. & Gulati, A. *Senior Practical Physical Chemistry, R. Chand 4th ed. (1985).*
7. Yadav, J.B., *Advanced Practical Physical Chemistry,* Goel Publishing House 16th ed. (2006).

M.Sc.-CHEMISTRY
SEMESTER-I

19CHE-107 Practical-III
Organic Chemistry

Max. Marks: 50
Time: 8 hrs.

1. **General experimental techniques:** (20 Marks)

- Common laboratory glasswares
- Purification of organic solids
    1. Purification of organic compounds by sublimation
    2. Recrystallisation of benzoic acid from water
- Purification of organic liquids by simple distillation.
- Determination of melting point of solid organic compounds.
- Determination of boiling point of liquid organic compounds.
- Separation of organic compounds by paper, TLC, column chromatography.

2**. Organic Synthesis:** Preparation of following organic compounds: (20 Marks)

(i) Preparation of benzanilide from aniline.

(ii) Preparation of p-bromoacetanilide from acetanilide.

(iii) Preparation of tribromoaniline from aniline.

(iv) Preparation of p-nitroacetanilide from Acetanilide.

(v) Preparation of benzene-azo-β-naphthol by diazotization.

(vi) Preparation of adduct of anthracene and maleic anhydride by Diels-Alder reaction.

Any other reaction as per requirement

Note: All the students must submit the recrystallised product along with m.p. for all the stages of preparation.

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3. Viva-Voce (05 marks)
4. Note-Book (05 marks)

Suggested Readings:

1. Clarke, H.T. & revised by Haynee, B. Edward Arnold, *A Hand book of Organic Analysis -Qualitative and Quantitative,* London (1975).
2. Furhen, B.S., *Vogel's Text Book of Practical Organic Chemistry*, Longman ( ).
3. Middleton, H., *Systematic Qualitative Organic Analysis,* Edward Arnold (Publishers) Limited, London (1959).

4. Vogel, A. I., *Elementary Practical Organic Chemistry*, EX CBS Publishers and Distriibutors (1957).
5. Louis, F., Fieser, D.C., *Experiments in Organic Chemistry,* Heath and Company Boston (1955)
6. Vishnoi, N.K., *Advanced Practical Organic Chemistry*, Vikas Publishing 3rd ed. (2009).

M.Sc.-CHEMISTRY
SEMESTER-II

19CHE-201: Inorganic Chemistry-II
(Principle of Inorganic Chemistry)

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

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.

Magnetic 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, application of magneto-chemistry in structure determination, magnetic exchange coupling and spin state crossover.

Unit-II

Electronic Spectra and Magnetic Properties of Transition Metal Complexes: Electronic arrangements of microstates, calculation of the number of microstates, spectroscopic term symbols, determining the ground state terms-Hund's rules, correlation and spin-orbit coupling in free ions for Ist series of transition metals, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1– d^9states), calculation of Dq, B and β parameters, effect of distortion on the d-orbital energy levels. Structural evidence from electronic spectrum, Spectrochemical and nephalauxetic series, charge transfer spectra. anomalous magnetic moments, magnetic exchange coupling and spin crossover.

Unit-III

Metal π- Complexes: Valence electron count (16/18 electron rules), Compliance and violation of the 18 electron rule, Total electron count, Metal Carbonyls- structure and bonding, vibrational spectra of metal

carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding, structure and important reactions of transition metal nitrosyl and tertiary phosphine as ligand.

Unit-IV

Metal Clusters: Structure and bonding in Metal Carbonyl Clusters, Higher boranes, carboranes, metalloboranes and metalloc arboranes, halide clusters.

Crystal Structures: Structures of some binary and ternary compounds such as fluorite, antifluorite, rutile, antirutile, crystobalite, layer lattices- CdI_2, BiI_3; ReO_3, Mn_2O_3, corundum, pervoskite, Ilmenite and Calcite, Normal and Inverse Spinels.

Suggested Readings:

1. Cotton, F.A., Garg, V.C. & Wilkinson, *Advanced Inorganic Chemistry*, John Wiley 4th ed. (1930).
2. Gupta, B.D. & Elias, A.J., *Basic Organometallic Chemistry; Concepts, Synthesis and Applications* University Press 1st ed. (2010).
3. Huheey, J. E., Keiter, E.A. & Keiter R. L., *Inorganic Chemistry: Principles of structure and reactivity*, Harper & Row 4th ed. (1993).
4. Lever, A.B.P., *Inorganic Electronic Spectroscopy,* Elsevier 2nd ed. (1984).
5. Greenwood, N.N. & Earnshaw, A., *Chemistry of the Elements*, Elseiver 2nd ed. (2012)
6. Figgis, B.N., *Introduction to Ligand fields*, Wiley (1966)
7. Emeleus, H.J., Anderson, J.S., *Modern Aspects of Inorganic Chemistry,* Van Nostrand (1938)
8. Ballahyen, C .J., *Introduction to Ligand Field Theory,* Tata McGraw Hill 1st ed. (1962)
9. Mehrotra, R.C.& Singh, A., *Organometallic Chemistry,* New Age International (2007).
10. Douglas, B., McDaniel, D. H. & Alexander, J. J., *Concepts and Models of Inorganic Chemistry*, John Wiley 2nd ed. (1983).
11. Crabtree, R.H., *The Organometallic Chemistry of the Transition Metals*, John Wiley 5th ed. (2011).

M.Sc.-CHEMISTRY
SEMESTER-II

19CHE-202: Physical Chemistry-II
(Principles of Physical Chemistry-II)

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Thermodynamics: Third law of thermodynamics, Nernst heat theorem, concept of absolute entropy.

Heterogeneous equilibrium, Phase rule, Clausius- Clapeyron Equation, Phase diagram for one component system (H_2O & S), two completely miscible components, two component system with congruent and incongruent melting point, Calculation of eutectic point.

Unit-II

Chemical Dynamics: Effect of temperature on reaction rates, Arrhenius equation, Collision theory of reaction rates, thermodynamic formulation of activated complex theory, correlation between various theories of reaction rates.

Enzymatic reaction: Michaelis - Menton treatment, evaluation of Michaelis‘s constant for enzyme - substrate binding by Lineweaver - Burk plot, Concept of inhibition.

Unit-III

Statistical Mechanics: Introduction, microstates and macrostates, Concept of distribution, Thermodynamic probability & most probable distribution for Maxwell Boltzmann statistics, Bose-Einstein & Fermi Dirac statistics, identification of the constant α and β, partition function and its significance, Application of Bose-Einstein statistics for a photon gas, Application of Femi-dirac statistics, Partition function, relation between molar and molecular partition function, multiplication theorem of partition function, Thermodynamic properties in terms of partition function.

Unit-IV

Photochemistry: Laws of photochemistry: (Grothus-Draper law, Stark-Einstein law of photochemical equivalence and Lambert-Beer's law), quantum yield, quantum efficiency and reasons for high and low quantum yields, singlet and triplet state, Jablonskii diagram, photophysical processes: (radiative and non-radiative) fluorescence, phosphorescence and chemiluminescence, Kinetics of photophysical processes, relaxation time, Kinetics of quenching: Stern Volmer equation, photochemical reactions: photoreduction, photo-oxidation, photodimerization, photochemical substitution.

Suggested Readings:

1. Atkins, P., Paula, J., Keeler, J., *Atkins' Physical Chemistry Thermodynamics and Kinetics*, Oxford University Press 11th ed. (2018).
2. Rastogi, R. P. & Misra, R. R, *An Introduction to Chemical Thermodynamics*, Vikas Pub. 6th Revised ed. (6/e) (2000)
3. Glasstone, S., *Thermodynamics for Chemists*, Narahari Press (2007)
4. Laidler, K.J., *Chemical Kinetics,* McGraw Hill 2nd ed. (1965).
5. Kapoor, K.L., *A Textbook of Physical Chemistry Vol 5 –Dynamics of chemical Reaction*, Tata Mc Graw Hill (2014).
6. Rohtagi-Mukherjee, K. K., *Fundamentals of photochemistry*, New Age International (2018)
7. Turro, N. J., Ramamurthy, V., Scaiano, J. C., *Principles of molecular photochemistry An Introduction,* University Science Books 1st ed. (2009)
8. Wardle, B., *Principles and Applications of Photochemistry*, John & Wiley (2009)
9. Hill, T. L., *An Introduction to Statistical Thermodynamics,* Dover Publications (2012)
10. Upadhayay, S. K,, *Chemical Kinetics and Reaction Dynamics*, Springer Science & Business Media (2006).
11. Nash, L. K., *Elements of Statistical Thermodynamics,* Courier Corporation (2006)
12. Puri, B. R., Sharma, L. R., Pathania, M. S., *Principles of Physical Chemistry*, Vishal Publishing Company (2008).

M.Sc.-CHEMISTRY
SEMESTER-II

19CHE-203: Organic Chemistry-II
(Reaction Mechanism & Rearrangements)

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit–I

Aromatic Electrophilic Substitution: The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Diazonium coupling, Gattermann-Koch reaction, Vilsmeir-Haak reaction, Reimer-Tiemann reaction, Fries rearrangement

Aromatic Nucleophilic Substitution: The ArS_N1, ArS_N2, Benzyne and $S_{RN}1$ mechanisms. Reactivity – effect of substrate structure, leaving group and attacking nucleophile. Thevon Richter and Smiles rearrangements.

Unit -II

Elimination Reactions: The E1, E2 and E1cB mechanisms. Orientation Effects in Elimination Reactions, Reactivity –effects of substrate structures, attacking base, the leaving group and the medium. Saytzeff and Hoffman rules, Stereochemistry of E2 elimination reactions and eclipsing effects in E2 eliminations.

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.

Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.

Unit -III

Addition to Carbon-Hetero Multiple Bonds: Reactivity of carbonyl compounds towards addition. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and α, β-unsaturated carbonyl compounds, Wittig reaction. Mechanism of metal hydride reduction ($LiAlH_4$ and $NaBH_4$) of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Mechanism of condensation reactions involving enolates – Aldol, Knoevenagel, Claisen, Mannich, Robinson, Reformatsky, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides.

Unit–IV

Rearrangements: Classification and general mechanistic treatment of nucleophilic, free radical and electrophilic rearrangement, Wagner-Meerwein, Pinacol-pinacolone, Benzil-benzilic acid, Favorskii, Steven, Wittig, Neber, Wolff, Beckmann, Hoffmann, Curtius, Lossen, Schmidt, Bayer-Villger.

Suggested Readings:

1. Sykes, P., *A Guide Book to Mechanism in Organic Chemistry,* Pearson 6th ed. (2003)
2. Morrison, R. T. & Boyd, R. N. *Organic Chemistry,* Prentice –Hall 6th ed. (2001)
3. March, J., *Advanced Organic Chemistry Reactions, Mechanism and Structure,* John Wiley 6th ed. (2007).
4. Clayden, J., Greeves, N., Warren, S. & P. Wothers *Organic Chemistry*, Oxford University Press (2001)
5. Wade, L. G., Siemek, J.W., *Organic Chemistry*, Pearson (2017)
6. Solomons, G. & Fryhle, C., *Organic Chemistry,* John Wiley 7th ed. (1999)
7. McMurry, J., *Organic Chemistry,* Mary Finch 8th ed. (2012)
8. Pine, S.H., *Organic Chemistry,* McGraw Hill 5th ed. (1987)
9. Mukherji, S. M. & Singh, S. P., *Reaction Mechanism in Organic Chemistry,* Macmillan 3rd ed. (1984)

M.Sc.-CHEMISTRY
SEMESTER-II

19CHE-204: Statistics for Chemists

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Measures of Central Tendency: Mean, median and Mode.

Measures of Dispersion: Range, Mean Deviation, Standard Deviation, Coefficient of Variation; Moments, Measures of Skewness and Kurtosis.

Probability Theory: Probability and its applications, Various Definitions of Probability, Addition Theorem, Conditional Probability, independent events, Multiplication Theorem, Baye‘s Theorem.

Unit-II

Random variables: Discrete and Continuous Random Variables; Distribution Functions and properties;

Discrete Probability distributions: Binomial, Poisson and Geometric.

Continuous Probability distributions: Normal, Gamma, Exponential and Log-Normal.

Unit-III

Testing of Hypotheses: Simple and Composite Hypotheses, Null and Alternative Hypotheses, Two Types of Errors, Level of Significance, Power of the Test, Critical Reason, Confidence Intervals.

Sampling Distributions: Student's t, F-distributions and Chi-Square; their Properties and Applications. Tests of Significance based on Chi-square (goodness of fit and independence of attributes), t distribution and F- distribution; Analysis of Variance: one way and two way analysis of variance.

Unit-IV

Correlation: Karl Pearson and Spearman Rank Correlation, Partial and Multiple Correlations.

Curve fitting: Method of Least-squares fitting, Linear, Polynomial, arbitrary functions, R Curve, Linear Polynomial equations.

Regression Analysis: Simple Regression Analysis, Regression Lines, Regression Coefficients and its properties.

Suggested Readings:

1. Miler, J. N. & Miler, J., *Statistics and Chemometrics for analytical Chemistry,* Pearson Prentice Hall 6th ed. (2010)
2. Goon, A.M., Gupta, M.K. & Dasgupta B., *Fundamentals of Statistics,* World Press 8th ed. (2005).
3. Hogg, R. V., Craig, A. T. & Mckean, J. W., *Introduction to Mathematical Statistics,* Pearson Education 6th ed. (2005).
4. Goon, A. M., Gupta, M. K. & Dasgupta, B., *An Outline of Statistical Theory,* World Press 4th ed. Vol. I (2003).
5. Bevington, P. & Keith R., *Data Reduction and Error Analysis for the Physical Sciences,* McGraw Hill 3rd ed. (2003)
6. Barlow R.J. & John, *Statistics: A Guide to the Use of Statistical Methods in the Physical Sciences,* Wiley (1989).
7. Mandel, J.,*The Statistical Analysis of Experimental Data,* Dover Publication (1984)

M.Sc.-CHEMISTRY
SEMESTER-II

19CHE-205
IT Skills

Max. Marks: 50
Time: 2 hrs

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Fundamentals of Computer: Introduction to computer, Classification & Generations of Computer, Block diagram and Anatomy of Computer, Input and Output devices, Basic concept of Data & Information, Software: Types of Software, Operating System, Functions of OS, Types of OS, Features of OS (Based on Windows).

Unit-II

Introduction to Internet & Networking: Data Communication: Types and applications of Data Communications, Concept of Network, Types of Network, Topologies, Computer Protocols, History of Internet, Intranet, Web Browsers, Search Engine, Applications of Internet, E-Commerce: Types, Tools Electronic Payment System .

Unit-III

Business Data Processing: Concept of Database, Architecture of Database, Types of Database Introduction to Data Processing, Data Storage, Data Hierarchy, Methods of Organizing Data Various Data Processing Files, File Organizing, Various Utilities of Files.

Unit-IV

Applications & Packages: File Management: Start Menu and Taskbar, Types of Icons, Viewing, Arranging, and Working with Files and Folders MS Word: Toolbars**,** Menu, Editing a Document, Previewing Document, Printing Documents, Mail Merge MS PowerPoint: Basics, Insert, Tools, Format, Slide Show, Formatting Slides, Create Presentations MS Excel: Entering and Editing Worksheet Data,

Worksheet Operations, Introducing Tables, Graphing and Summarizing Data MS Access: Toolbars, Entering & Editing the Data, Data Operations, Introduction Tables, Data Analysis.

Suggested Readings:

1. Nippani, K. S., Murthy, B. K., *Digital India: Governance Transformation,* Vitasta Publishing Pvt Ltd.
2. Kamal, R. & Saxena, P., *Big Data Analytics*, McGraw Hill Education.
3. Maheshwari, A., *Big Data*, McGraw Hill Education.
4. Bhushan, M., Rathore, R.S. & Jamshed, A., *Fundamentals of Cyber Security*, BPB Publication.
5. Bahga, A. & Madisetti, V., *Internet of Things*, Orient Black Swan

M.Sc.-CHEMISTRY
SEMESTER-II

19CHE-206 Practical-IV
Inorganic Chemistry

Max. Marks: 50
Time: 8 hrs.

1. Determination of some metal ions, such as iron, nickel, chromium, vanadium etc. and fluoride and phosphate etc. by Spectrophotometric Method. (20 Marks)

2. Quantitative Analysis:

Separation and determination of two metal ions such as Ag-Cu, Cu-Ni, Cu-Zn, Ni-Zn, Cu-Fe etc. involving volumetric and gravimetric methods. (20 Marks)

3. Viva-Voce (05 Marks)
4. Note-Book (05 Marks)

Suggested Readings:

1. Vogel, A.I., *A Text Book of Macro and Semi-micro Quantitative Analysis,* Longman 4th ed. (1978).
2. Bassett, J., Denney, R.C., Jaffery, G.B. & Menaham, J., *A Vogel's Text Book of Quantitative Inorganic Analysis,* Longman 4th ed. (1978)
3. Hargis, L.G., *Laboratory manual: Analytical Chemistry-principles and techniques*, Prentice Hall (1988)

M.Sc.-CHEMISTRY
SEMESTER-II

19CHE-207 Practical-V
Physical Chemistry

Max. Marks: 50
Time: 8 hrs.

1. Chemical Kinetics

(i) To determine the temperature coefficient for the 1^{st} order reaction.

(ii) Determination of activation energy for the hydrolysis of ethyl acetate in presence of acid.

2. Ultrasonic Interferrometry

(i) To determine the speed of sound for a given liquid.

(ii) To determine the speed of sound for a given mixture.

3. Potentiometry

(i) Strong acid vs strong base.

(ii) Weak acid vs strong base.

4. Refractometry

(i) Determine the refractive index of the given liquids.

Note-Book	05 Marks
Viva-Voce	05Marks
Experiments	(2x20) = 40 Marks

Suggested Readings:

1. James, A.M. & Prichard, F.E. , *Practical Physical Chemistry,* Longman 3^{rd} ed. (1974)
2. Findlay, A. & Lavitt, B.P., *Findlay's Practical Physical Chemistry,* John Wiley 9^{th} ed. (1981)
3. Viswanathan, B., *Practical Physical Chemistry,* Viva Books (2012)
4. Shoemaker, D.P. , *Experiments in Physical Chemistry,* Tata McGraw Hill 6^{th} ed. (1988)
5. Jahagirdhar, D.V., *Experiments in Physical Chemistry,* Himalaya Publisher (2013)
6. Khosla, B.D., Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R. Chand (2014)
7. Yadav, J.B., *Advanced Practical Physical Chemistry,* Goel Publishing (2014)

M.Sc.-CHEMISTRY
SEMESTER-II

19CHE-208 Practical-VI
Organic Chemistry

Max. Marks: 50
Time: 8 hrs.

1. Qualitative Analysis (20 Marks)
   Separation, purification and identification of compounds of binary mixtures by chemical tests, derivatization. (One set to be given in the examination)
2. Organic Synthesis: Preparation of following organic compound: (20 Marks)
   (i) Sym-tribromophenol from phenol
   (ii) Benzoylacetone from acetophenone and ethyl acetate by Claisen condensation
   (iii) benzilic acid from benzoin
   (iv) p-nitroacetanilide from aniline
   (v) sulphanilic acid from aniline
   (vi) m-dinitrobenzene from nitrobenzene
   (vii) p-aminophenol from nitrobenzene
   Any other reaction as per requirement

   Note : All the students must submit the recrystallised product along with m.p. for all the stages of preparation.
3. Viva-Voce (05 Marks)
4. Note-Book (05 marks)

Suggested Readings:

1. Furniss, B.S., Vogel, A. I., Smith, P. W., *Vogel's Text Book of Practical Organic Chemistry*, Longman-Group Ltd.(1978)
2. Vogel, A. I., *Elementary Practical Organic Chemistry*, Longmans, Green, 2nd Edition (1959).
3. Fieser, F., *Experiments in Organic Chemistry by* D.C. Heath and Company Boston, (1935).
4. Mann F.G., & Saunders. B.C., *Practical Organic Chemistry* Pearson Education India (2009).
5. Campbell, B.N. and Ali M., *Organic chemistry experiments: Microscales and semimicroscales*, McCarty M, Brooks/Cole, (1994).
6. Ault A., *Techniques and experiments for organic chemistry*,University Science Books, (1998).
7. Lehman, *Multiscale operational organic chemistry: A problem solving approach to laboratory course,* Pearson Prentice Hall, 2nd Edition (2009).

8. Clarke, H.T., *A Hand book of Organic Analysis -Qualitative and Quantitative*, Edward Arnold London (1975).
9. Vishnoi N.K., *Advanced Practical Organic Chemistry,* Vikas Publishing (2009).

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-301: Spectroscopy-II

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Rotational Spectra: Introduction, rotational spectra of rigid diatomic molecules, intensities of rotational spectral lines, isotopic effect, non-rigid rotator, spectra of polyatomic linear molecules and symmetric top molecules.

Vibrational and Vibrational-Rotational Spectra: The vibrating diatomic molecule, force constant, zero point energy, simple harmonic vibrator, anharmonicity, Morse potential, overtones, hot bands, P,Q,R branches, normal mode of vibrations, breakdown of Born Oppenheimer approximation, interaction of rotation and vibration, vibration of polyatomic molecules, analysis by infra red technique.

Unit-II

Raman Spectra: Classical and quantum theories, polarization of light and the Raman effect, depolarization of Raman lines, pure rotational Raman spectra of linear molecules, vibrational Raman spectra, mutual exclusion principle, structure determination from Raman and infrared spectroscopy, use of symmetry (Group Theory) to determine selection rules and number of active infra red and raman lines in the spectra.

Electronic Spectra: Electronic spectra of diatomic molecules, vibrational coarse structure and rotational fine structure of electronic band, The Franck Condon Principle, intensity of vibrational electronic band, dissociation energy.

Unit-III

Electron Spin Resonance Spectroscopy: Basic principles of ESR, experimental technique, the g-value hyperfine structure, Instrumentation of ESR and its applications to the study of free radicals and fast reactions, spin densities and Mc Connell relationship.

Mossbauer Spectroscopy: Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of Fe^{2+} and Fe^{3+} compounds including those of

intermediate spin, (2) Sn^{2+} and Sn^{4+} compounds – nature of M-L bond, coordination number, structure and (3) detection of oxidation state.

Unit-IV

Atomic Absorption Spectroscopy: Introduction to Atomic Absorption Spectroscopy, basic principles, resonance line, its natural width, Doppler effect, broadening due to pressure, Hollow cathode lamp. Application to alkali and alkaline earth metals.

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

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

Suggested Readings:

1. Skoog, D.A., West, D. M., Holler, F. J. & Crouch, S.R., *Fundamentals of Analytical Chemistry,* Thomson 8th ed. (2004).
2. Vogel, A.I., Revised by Jeffery, G. H., Bassett, J., Mendham, J. & Denney, R. C., *A text book of Quantitative Analysis*, ELBS 5th ed. (1989).
3. Jose, A. C., *Analytical Atomic Spectrometry with flames and Plasmas,* Wiley-VCH (2002)
4. Parish, R.V., *NMR, NQR, EPR and MB Spectroscopy in inorganic Chemistry,* Ellis Horwood (1991).
5. Kaur, H., *Instrumental Methods of Chemical Analysis,* Pragati Parkashan (2016).
6. Chatwal, G.R., Anand, S.K., *Instrumental Methods of Chemical Analysis,* Himalaya Publishing House (2015).
7. Skoog, D.A., Holler, F.J., Nieman, T.A., *Principles of Instrumental Analysis,* Saunders College Publishing (1992).

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-302: Inorganic Chemistry Special-I
Organotransition Metal Chemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall 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; Fluxional Organometallic compounds: Fluxionality and dynamic equilibria in compound such as η^2-olefin, η^3-allyl and dienyl complexes, Carbonyl scrambling.

Unit-II

Transition Metal π-Complexes: Transition metal π-complexes with unsaturated organic molecules, alkenes, alkynes, allyl, diene, dienyl, arene and trienyl complexes, preparations, properties, nature of bonding and structural features. Important reactions relating to nucleophilic and electrophilic attack on ligands and to organic synthesis.

Unit-III

Compounds of Transition Metal-Carbon Multiple Bonds: Alkylidenes, alkylidynes, low valent carbenes and carbynes- synthesis, nature of bond, structural characteristics, nucleophilic and electrophilic reactions on the ligands, role in organic synthesis; Transition Metal Compounds with Bonds to Hydrogen.

Unit-IV

Homogeneous Catalysis: Stoichiometric reactions for catalysis, homogeneous catalytic hydrogenation , Hydroscyanation, Hydrosilylation, Hydroformylation, Methanol Carbonylation and Olefin Oxidation-Monsanto and Cativa process Zeigler-Natta polymerization of olefins, catalytic reactions involving carbon

monoxide such as hydrocarbonylation of olefins (oxo reaction), oxopalladation reactions, activation of C-H bond.

Suggested Readings:

1. Basolo, F. & Pearson, R.G., *Mechanism of Inorganic Reactions,* John Wiley (1987)
2. Purcell, K.F. & Kotz, J. C., *Inorganic Chemistry*, Saunders (1977)
3. Collman, J.P., Hegsdus, L.S., Norton, J.R. & Finke, R.G., *Principles and Application of Organotransition Metal Chemistry,* University Science Books 2nd ed. (1987)
4. Crabtree, R.H., *The Organometallic Chemistry of the Transition Metals*, John Wiley 5th ed. (2011)
5. Mehrotra, R.C. & Singh, A., *Organometallic Chemistry,* New Age International (2007)
6. Banerjea, D., *Coordination Chemistry,* Pergamon Press (1979)
7. Douglas, B., McDaniel, D.H. & Alexander, J.J., *Concepts and Models of Inorganic Chemistry,* John Wiley 3rd ed. (1994)

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-303: Physical Chemistry Special-I
Advanced Quantum Chemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit – I

Quantum Mechanics: Schrodinger wave equation for three dimensional Rigid rotator and its solution using method of variable separation, Spherical harmonics (physical interpretation, angular momentum), Schrodinger wave equation for linear harmonic oscillator and its solution by polynomial method, Interpretation of its wave functions, zero point energy, 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 – II

Chemical Bonding: 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, Concept of resonance and its role in the stability of hydrogen molecule ion.

Unit – III

Variation Method: Quantum mechanical treatment of Helium atom and the failure of rigorous quantum mechanical method, need of approximate methods, Approximate Methods: The variation theorem, Linear variation Principle, perturbation theory (first order, second order) Applications of variation method and perturbation theory to the Helium atom.

Unit – IV

Molecular Orbital Theory: Huckel molecular orbital (HMO) theory of linear and cyclic conjugated systems, Applications of HMO theory (i) Set up and solve Huckel determinant equation (ii) Calculate resonance energy (iii) Wave functions for molecular orbitals (iv) Molecular diagrams of (a) Ethylene

molecule (b) Allyl system (Allyl radical and related ions) (c) Butadiene (d) Cyclobutadiene (e) Cyclopropenyl system (cyclopropenyl radical and the related ions) (f) Benzene ring.

Suggested Readings:

1. Kapoor, K.L., *A Textbook of Physical Chemistry Volume 4*, Tata Mc Graw Hill (2015).
2. Mcquarrie, D. A., *Quantum Chemistry,* University Science Books 2nd ed. (2008)
3. Chandra, A.K., *Introductory Quantum Chemistry*, Tata Mc Graw Hill, 4th ed. (1998)
4. Levine, I. N., *Quantum Chemistry,* Pearson 7th ed. (2016).
5. Sen, B. K., *Quantum Chemistry Including Spectroscopy,* Tata McGrawHill (1992)
6. Prasad, R.K., *Quantum Chemistry through Problems and solutions,* New Age International (1997)

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-304: Organic Chemistry Special-I
Concerted Reactions and Photochemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit I

Pericyclic Reactions I: Molecular orbital symmetry, frontier orbital of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system classification of pericyclic reactions, Woodward - Hoffmann correlation diagram. FMO & PMO approach, Electrocylic reaction - conrotatory and disrotatory motions. 4n, 4n+2, allyl systems, Ring opening of cyclopropyl halides and tosylates, cycloadditions-antarafacial and suparafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3-dipolar cycloadditions and cheleotropic Reactions.

Unit II

Pericyclic Reactions II: Sigmatropic Rearrangements-suprafacial and entarafacial shifts of H, sigmatropic shifts involving carbon moieties, retention and inversion of configuration, [3,3] and [5,5] sigmatropic rearrangements, detailed treatment of Sommelet-Hauser, Claisen and Cope rearrangements introduction to ene reactions. Simple problems on Pericyclic reactions, Group transfers and eliminations.

Unit III

Photochemistry I: Excitation and excited states, Franck-Condon Principle, Jablonski diagram, energy transfer photsensitization, quenching, quantum efficiency and quantum yield.

Photochemistry of carbonyl compounds (Norrish type I and type II changes, photoreaction of cyclic ketones, Paterno-Buchi reaction and Photoreducation. Photochemistry of olefins and 1,3-Butadiene (cis-trans isomerisation, dimerisation and cycloadditions).

Unit IV

Photochemistry II: Di-π-methane rearrangement, enone and dienone rearrangements, photochemistry of aromatic compounds (substitution, isomerization, cyclization and cycloaddition reactions), Photo-Fries rearrangement, photolysis of nitrile esters and Barton reaction, Hoffman-Loefller-Freytag reaction. Synthesis of vitamin D.

Suggested Readings:

1. Morrison, R. T & Boyd R. N., *Organic Chemistry,* Pearson, 6th Edition (1992).
2. Carruthers, W., *Modern Methods of Organic Synthesis*, Cambridge University Press, (1996).
3. Mukherji S.M., *Pericyclic reactions,* Mcmillan (1979).
4. Albright, T., Burdeet, J. & Whango, M., *Orbital interaction in chemistry*, Wiley VCH 2nd Edition (2013).
5. Fleming, I., *Frontier Orbitals and Organic Chemical Reactions*, Wiley, London (1976).
6. Sankararaman, S., *Pericyclic Reactions- A text Book,* , Wiley VCH, 2005.
7. Turro, N. J., *Modern Molecular Photochemistry*, University Science Books (1991).
8. Coxan , J. M. & Halton, B.,*Organic Photochemistry*, Cambridge University Press(1987).
9. Gilbert, A. & Baggot, J., *Essentials of Molecular Photochemistry*, CRC Press(1991).
10. Griesbeck, A.G., Oelgemoller, M., Ghetti, F.*,CRC Handbook of Organic Photochemistry and Photobiology*, CRC Press (2012).
11. Rohtagi, K. K. & Mukherjee, *Fundamentals of Photochemistry*, New Age International, 2nd Edition (1978).
12. Calvert, J.G. and Pitts, J.N., *Photochemistry*, Wiley (1966).
13. Simons, J .P., *Photochemistry and Spectroscopy*, Wiley Interscience (1971).
14. Wardle,B., *Principles and Applications of Photochemistry*, Wiley (2009).

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-305: Inorganic Chemistry Special-II
Instrumental Techniques –I

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Electanalytical methods of Analysis-I: Electrochemical reactions, General principles, diffusion current, Dropping mercury electrode, IIkovic equation (without proof), Koutecky equation for diffusion current, Half-wave potentials, Polarographic waves (Anodic and Cathodic), Conditions for performing Polarographic determinations, Oxygen interference, maxima, function of supporting electrolyte, determination of stability constants of complexes (reversible systems only) by D. C. polarography, catalytic hydrogen waves.

Unit-II

Electro analytical methods of Analysis-II: Principle of Amperometric Titrations, Types of titration curve, apparatus and techniques, Super imposed a.c. Polarography, voltametry in quiet and stirred solution with electrodeother than mercury, square-wave polarography, normal and differential pulse polarography, chronopotentiometry, chronoamperometry and coulometry. Theory of anodic stripping voltametry, Cathodic stripping voltammetry.

Unit-III

Chromatography: General principles, types of chromatography, absorption chromatography, partition chromatography, vapour phase chromatography, paper and thin layer chromatography. Ion-Exchange: General principles, ion exchangers-natural and synthetic, ion-exchange capacity. Ion selective electrodes: Fundamental types of electrodes, gas sensors, ion sensors and enzyme electrodes, principle involved in measurements with ion selective electrodes with special reference to halide, sulphide and oxygen electrodes.

Unit-IV

Thermal Techniques: Thermogravimetry, differential thermal analysis (DTA) and differential scanning calorimetry (DSC) principles and applications. Nephelometry and Turbidimetry: Theory-light scattering, choice and comparison between nephelometry and turbidimetry, factors affecting measurement, instrumentation, applications.

Suggested Readings:

1. Shriver, D.F., Atkins, P.W. & Langford, C.H., *Inorganic Chemistry,* Oxford Univ. Press (1998).
2. Huheey, J.E., Keiter, E.A. & Keiter, R.L., *Inorganic Chemistry: Principle of Structure and Reactivity,* Pearson (2004).
3. Carey, F.A., Wilkinson, G., Murillo, C.A. & Bochman, M., *Advanced Inorganic Chemistry,* Wiley Interscience (2003)
4. Housecroft, C.E. & Sharpe, A.G., *Inorganic Chemistry,* Prientice Hall (2005).
5. Greenwood, N.N. & Earnshaw, A., *Chemistry of the Elements*, Elseiver 2nd ed. (2012)
6. Porterfield, W.W., *Inorganic Chemistry: A unified Approach,* Academic Press 2nd ed. (2013)
7. Sharpe, A.G., *Inorganic Chemistry,* Pearson Education Ltd 3rd ed. (1981)
8. Miessler, G. L. & Tarr, D.A., *Inorganic Chemistry,* Pearson Publications (2008)
9. Wulfsberg, G., *Inorganic Chemistry,* University Science Books (2000)

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-306: Physical Chemistry Special-II
Advanced Electro Chemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit – I

Electrodics: Rate of charge-transfer reactions under zero field, 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.

Unit – II

Electrified Interface: Introduction, potential difference across electrified interface, concept of polarizable and non-polarizable interface, Thermodynamics of polarizable interface: interfacial tension, electrocapillary curve, Thermodynamics of non-polarizable interface: Lippmann equation, determination of charge density on the electrode, capacitance of interface and surface excess.Metal/Electrolyte interface: Concept of electrical double layer and its structure: Helmholtz-Perrin, Gouy-Chapman, and Stern models.

Unit – III

Corrosion: Electrochemical principles of corrosion, Types of Corrosion: Uniform corrosion, galvanic corrosion, pitting corrosion, crevice corrosion, intergranular corrosion, stress corrosion cracking corrosion, Dfatigue corrosion, fretting corrosion, erosion corrosion,, microbial induced corrosion, filliform corrosion, Polarization of the electrode, Factors affecting polarization, Polarization curve, Methods of prevention of corrosion: Cathodic protection, anodic protection, use of corrosion inhibitors, surface coating, Methods to find corrosion rate: Weight Loss Method, Electrochemical methods (impedance spectroscopy, Cyclic Voltammetry).

Unit – IV

Applied Electrochemistry: Batteries: Characteristics specification, components, Lead storage battery, Dry cell, Silver-Zinc cell, Sodium-Sulphur cell and Ni- Cd Battery, li-ion batteries. Fuel cells: H_2-O_2, hydrocarbon – air and natural gas & CO -air fuel cells, Electro catalysis: Homogeneous and heterogeneous electrocatalysis, Solar cells: Introduction, Dye-sensitized solar cells.

Suggested Readings:

1. Glasstone, S., *Electrochemistry,* Read Books Ltd. (2013)
2. Castellan, G.W., *Physical Chemistry,* Addison Wesley 3rd ed. (1983)
3. Bard, A. J. & Faulkner, L. R., *Electrochemical Methods: Fundamentals and Applications,* John Wiley 2nd ed. (2002)
4. Bockris, J. O' M. & Reddy, A. K. N., *Modern Electrochemistry 1: Ionics* Springer 2nd ed. (1998)
5. Bockris, J. O' M., & Reddy, A. K. N., *Modern Electrochemistry 2B: Electrodics in Chemistry, Engineering, Biology and Environmental Science* Springer 2nd ed. (2001)
6. Crow, D. R., *Principles and Applications of Electrochemistry,* London 4th ed. (1994)
7. Moudgil, H. K., *Textbook of Physical Chemistry*, PHI Learning Pvt. Ltd. 2nd ed. (2014).

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-307: Organic Chemistry Special-II
Reagents for Organic Synthesis

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Oxidation reagents: Principle, reactions and mechanism of following oxidising agents: Manganese oxidants – $KMnO_4$, MnO_2; Chromium oxidants - Chromic acid, PCC, PDC, Collins & Jones reagent; Peracids and Peroxides; Miscellaneous oxidants – Oxygen, Ozone, Lead tetra-acetate, Selenium dioxide, OsO_4, Periodic acid, Silver Carbonate (Fetizons reagent), Thallium nitrate, Woodward and Prevost reagents.

Unit-II

Reduction reagents: Principle, reactions and mechanism of following reducing agents: PtO_2 (Adam's catalyst), $Pd/CaCO_3$ (Lindlar's catalyst), $Pd/BaSO_4$, Raney Ni, $NaBH_4/CeCl_3$ (Luche reagent), $NaBH_3CN$, $NaBH(OAc)_3$, $LiAlH(OR)_3$,$LiBH_4$, DIBAL-H, Sodium-liquid ammonia, Sodium alcohol, Zinc hydrochloric acid, hydrazine, diimide, silanes, stannous chloride, selectrides (K and L).

Unit-III

Organometallic reagents: Preparation, properties and applications of following reagents in organic synthesis with mechanistic details. Lithium cuprates (Gillman's reagent), organocadmium, organosulphur reagent (1,3-dithiane), organosilicon reagent (trimethylsilyliodide TMSI), organoiodines, organotin (tributyltin hydride TBTH), organozirconium (Swartz reagent), Organotitanium (Tebbe olefination).

Unit-IV

Other reagents in organic synthesis: Principle, preparations, properties and applications of the following in organic synthesis with mechanistic detail- DDQ, DCC, IBX, NBS, LDA, DABCO,TEMPO. Metal mediated C-C and C-X coupling reactions: Heck, Stille, Suzuki, Negishi and Sonogashira.

Suggested Readings:

1. Cary, F. A. & Sundberg, R. I., *Advanced Organic Chemistry, Part A and B*, Springer, 5th Edition (2009).
2. March, J., Smith, M. B., *March's Advanced Organic Chemistry Reactions, Mechanisms & Structure*, Wiley, 6th Edition (2007).
3. Warren, S., *Organic Synthesis, The disconnection Approach*, John Wiley & Sons, 2004.
4. Tsuji, J., *Palladium Reagents and Catalysts, New Perspectives for the 21st Century*, John Wiley & Sons (2003).
5. Ojima, I., *Catalytic Asymmetric Synthesis*, Wiley−VCH, New York, 2nd edition (2000).
6. Carruthers, W., *Modern Methods of Organic Synthesis*, Cambridge University Press, (1996).
7. Clayden, J., Greeves, N., Warren, S., & Wothers P., *Organic Chemistry*, Oxford University Press, Oxford (2012).
8. Noyori, R., *Asymmetric Catalysis in Organic Synthesis*, John Wiley & Sons (1994).
9. Kuerti, L. & Czako, B., *Strategic Applications of named Reactions in Organic Synthesis*, Elsevier Academic Press (2005).
10. Warren, S., *Designing Organic Synthesis*, Wiley (1978).
11. House, H. O., Benzamin,W.A., *Modern Synthetic Reactions* (1965).
12. Solomons, G. & Fryhle C., *Organic Chemistry,* John Wiley & Sons, 9th Edition (2008).
13. Greene, T., Wuts, P. G. M., *Protecting group in Organic synthesis*, John Wiley & Sons (1989).
14. Corey, E. J. & Cheng, X-M., *The logic of chemical synthesis*, John-Wiley & Sons, New York (1989).
15. Nicolaou, K. C., Sorensen, E.J., *Classics in Total Synthesis of Natural Products*, Wiley, Vol. I (1996) & Vol. II(2003).
16. Kurti L. & Czako B., *Strategic applications of named reactions in organic synthesis*, Academic Press (2005).

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-308: Inorganic Chemistry Special-III
Modern Concepts of Inorganic Chemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Inorganic Polymers: Classification, types of inorganic polymerization, comparison with organic polymers, boron-nitrogen polymers, silicones, coordination polymers, phosphorus-nitrogen compounds.

Non-aqueous Solvents: Reaction in non-aqueous media with respect to H_2SO_4, BrF_3, N_2O_4 and phosphoryl chloride; Kinetics and mechanism of coordination reactions in non-aqueous media.

Unit-II

Isopoly and Heteropoly Acids and Salts: Isopoly and Heteropoly acids and salts of Mo and W: Structures of isopoly and heteropoly anions.

Basics of Photochemistry : Absorption, excitation, photochemical laws, quantum yield, electronically excited state s lifetime – measurements of times. Flash photolysis, stop flow techniques. Energy dissipation by radiative and non-radiative processes, absorption spectra, Franck condon principle, photochemical stages- primary and secondary processes.

Unit-III

Sewage and fertilizers: Sewage treatment, Biochemistry of sewage, fertilizers - Nitrogen; ammonification, nitrification, denitrification, fixation of nitrogen, biochemistry and ecology of nitrogen fixation, nitrogen and phosphorus fertilizers in agriculture, eutrophication, surfactants - cationic, anionic and non ionic, specific properties, degradation.

Toxicology: Definition of toxicology, its history, scope and its literature, Dose-response relationship. Absorption, distribution and excretion of toxic materials, Toxicity of' metal ions, (Pb, Hg, Al. Ni. As) organic toxicants such as Halogenated hydrocarbons, pesticides and solvents, Chemical Carcinogens.

Unit-IV

Nuclear chemistry: Fundamental particles of nucleus (nucleons): concept of nuclides, representation of nuclides. Isobars and isotopes specific examples, The size concept of nucleus and atom. The possible forces operating between (n-n, p-p, n-p) and the magnitude of nuclear forces (short range); qualitative idea of the stability of nuclear (n/p ratio), sheel and liquid drop models (qualitative ideas); natural and artificial radio-activity disintegration series; Radioactive disintegration rate, half –life, average life.

SuggestedReadings:

1. Banerjea, D., *Coordination Chemistry,* Tata McGraw Hill (1992)
2. Addison, W. E., *Structural Principles in Inorganic Compounds,* (1961)
3. Khopkar, S.M., *Environmental Solution Analysis*, Wiley Eastern (1988)
4. Banerji, S.K., *Environmental Chemistry,* Prentice Hall (1999)
5. Cotton, F. A. & & Willkinson, G., *Advanced Inorganic Chemistry*, 4th ed. (1988)
6. Huhee, J. E., *Inorganic Chemistry*, 3rd ed. (2008)
7. Moeller, T., *Inorganic Chemistry, A Modern Introduction,* John Wiley (1993)
8. Douglas, B., McDaniel, D.H. & Alexander, J.J., *Concepts and Models of Inorganic Chemistry*; John Wiley (1983)

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-309: Physical Chemistry Special-III
Biophysical and Solid State Chemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Role of Photochemistry in Biology: Photosynthesis: introduction, photosynthetic pigments and their absorption spectra, energy transfer and light harvesting complexes, PS I, PS II and their energetics (the Z scheme), EPR studies of photosystems. Photochemistry of vision, Damage of DNA by UV radiation, Photodynamic therapy (PDT)

Unit –II

Membrane potential: Permeability of membrane for different types of molecule. Types of transport: active, passive, facilitated and types of transporters (symporters, antiporters, uniporters). Molecular motion across membranes, mobility of ions, and transport across ion channels (Na^+/K^+). Energetic of transport across membrane for antiporters, symporters and Na^+/K^+ transport.

Molecular imaging: Imaging in cells and bodies, fluorescence resonance energy transfer (FRET), green fluorescent proteins (GFP) and their role in FRET, use of GFP in cell imaging.

Unit –III

Solid State Chemistry: Crystal structure and crystal chemistry:-Introduction:- unit cell its classifications, lattice, lattice planes, Weiss indices, miller indices, d spacing formulae, interfacial angle, crystal densities, packing fraction, some ionic solid structures:- rock salt, zinc blende or sphalerite, fluorite, antifluorite, wurtzite, caesium chloride, rutile structure, perovskite, carbide(CaC_2). Spinels (normal and inverse), silicate structures.

Unit-IV

Crystal Defects: Classification of defects, the Kroger-Vink notation for crystal defects, thermodyanamics of schottky and frenkel defect, formation, X-ray diffraction techniques:- the Laue equation, Bragg's law

and lattice type prediction from θ values, the Powder method, symmetry in crystals (axis, plane and inversion centre of symmetry), scattering factors (atomic, total), geometrical structure factor.

Suggested Readings:

1. Allen, J.P., *Biophysical Chemistry,* Wiley-Blackwell Publication 1st ed.(2008)
2. Atkins, P., Paula, J. D., *Physical Chemistry for the life sciences,* Oxford University Press 2nd ed. (2011)
3. Tinoco, I., Sauer, K., Wang, J. C., Puglisi, J. D., *Physical Chemistry: Principles & Applications in Biological Sciences,* Prentice Hall (2002)
4. Klistermeier, D., Rudolph, M. G., *Biophysical Chemistry,* CRC Press (2017)
5. West, A. R., *Solid state chemistry & its applications,* John Wiley 2nd ed. (2003)
6. Smart, L. E., Moore, E. A., *Solid State Chemistry An Introduction,* Taylor & Francis 3rd ed. (2005)
7. West, A. R., *Basic Solid State Chemistry,* John Wiley 2nd ed. (1999)
8. Azaroff, L. V., *Introduction to Solids,* McGraw Hill Education (2017)

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-310: Organic Chemistry Special-III
Advanced topics in Organic Chemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Green Chemistry I: Principle of Green chemistry and its applications: Basic Principle and need of green chemistry, Different tools for green synthesis (Elementary idea of green reagent, green solvent, green catalyst) atom economy, 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 synthesis of Ibuprofen. Principles of ultrasound and microwave assisted organic synthesis.

Unit II

Green Chemistry II: Renewable energy resources: fossil fuels, biomass, solar power, fuel cell; chemical from renewable feedstocks and fatty acid, polymer from renewable resources, some other chemicals from natural resource. 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

Chromatography: Types. Ion exchange chromatography, planar chromatography - paper and Thin Layer Chromatography, Stationary and mobile phases, Gas chromatography – Theory, instrumentation and applications. Liquid-liquid partition chromatography, High Performance Liquid Chromatography (HPLC), Reverse phase chromatography, Hyphenated techniques- GCMS and LCMS.

Unit IV

Computational Chemistry: Introduction, history, approximations to the Schrödinger equation – basic idea of the Hartree–Fock method, electron correlation – post Hartree–Fock methods, density functional theory, computational approaches to solvation, application of these methods in computation of: spectral properties

and structure identification, fundamentals of organic chemistry, pericyclic reactions, diradicals and carbenes, organic reactions of anions, solution phase chemistry, reaction dynamics and understanding enzymes properties.

Suggested Readings:

1. Kanetker, Y. P., *Let Us C*, BPB Publications (2017).
2. Norris, A.C., *Computational Chemistry: An introduction to Numerical Analysis*, Wiley, Australia (1981).
3. Hunt, R., Shelley, J., *Computers and Common Sense*, Prentice Hall (1987).
4. Rajaraman, V., *Programming in Fortran 90 and 95*, Prentice Hall (2006).
5. Cramer, C. J., *Essentials of Computational Chemistry: Theories and Models*, John Wiley & Sons (2002).
6. Young, D., *Computational Chemistry: A practical Guide for applying Techniques to Real World Problems*, Wiley Interscience (2001).
7. Leach, A. R., *Molecular Modelling: Principles and Applications*, Pearson Education (2001).
8. Foresman, J. B., Frisch, A., *Exploring Chemistry with Electronic Structure Methods,* Gaussian Inc. (1996).
9. Allen, M. P. & Tildesley, D. J., *Computer Simulations of Liquids*, Oxford (1987).
10. Jorgensen, W. L. & Salem, L., *Organic Chemists book of Orbitals*, Wiley-VCH (1973).
11. Killingbeck, J. P., *Microcomputer Quantum Mechanics*, Adam Hilger, 2nd Edition (1985).
12. Rajaraman, V. & RadhaKrishnan, T., *An Introduction to Digital Computer Design*, PHI Learning Pvt. Ltd., 5th Edition (2008).
13. Bachrach, S. M., *Computational organic Chemistry*, Wiley (2014).
14. Hehre, W. J., *A Guide to Molecular Mechanics and Quantum Chemical Calculations*, Wavefunction (2003).
15. Lewars, E. G., *Computational Chemistry*, Springer (2011).
16. Leach, A. R. & Gillet, V. J., *An Introduction to Chemoinformatics*, Springer (2007).
17. Lancaster, M.,*Green Chemistry: An introductory text*, RSC (2007).
18. Sheldon, R. A., Arends, I. & Hanefield, V., *Green Chemistry and Catalysis*, Wiley (2007).
19. Skoog, D.A., Holler, F.J., Crouch, S.R., *Principles of Instrumental analysis*, Cengage Learning, 7th Edition (2017).
20. Skoog, D.A., West, D.M., Holler, F.J. & Crouch, S.R., *Fundamentals of Analytical Chemistry*, Cengage Learning (2013).
21. Willard, H. H., Merrit, L.L., Dean, J.A., *Instrumental Methods of Analysis*, Van Nostrand, 5th Edition (1975).

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-311 Practical-VII
Inorganic Chemistry Special

Max. Marks: 50
Time: 8 hrs

1. Synthesis of inorganic complexes/compounds. Selection can be made from the following or any other from the existed literature. (2x20 Marks)

(i) Metal acetylacetonates-eg. $VO(acac)_2$, $Cr(acac)_3$. *Inorg. Synth. 1957, 5, 130;1963, 1, 183*.

(ii) $[Co(NH_3)_5Cl]Cl_2$; $[Co(NH_3)_5NO_2]Cl_2$

(iii) $Ni(dmg)_2$, $[Ni(en)_3]S_2O_3$, $[Ni(NH_3)_6]Cl_2$

(iv) Metal complexes of dimethylsulfoxide(IR): $CuCl_2$.2DMSO, *Chem.Educ.,*1982, 59, 57.

(v) Preparation of copperglycine complex- cis and transbis(glycinato)Cu(II); *J.Chem.Soc.Dalton* 1979, 1901; *J.Chem Edu.* 1982, 59, 1052.

2. Viva-Voce (05 Marks)
3. Note-Book (05 Marks)

Suggested Readings:

1. Jolly, W. L., *Synthesis and Characterization of Inorganic Compounds,* PrenticeHall (1970)
2. King, A., *Inorganic Preparations: a systematic course of preparations,* T Murby (1936)

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-312 Practical-VII
Physical Chemistry Special

Max. Marks: 50
Time: 8 hrs.

1. pH metry
   (i) HCl vs. NH_4OH
   (ii) CH_3COOH vs. NH_4OH
   (iii) Determine the dissociation constant of weak acid.
2. Dipolemetry
   (i)To determine the dipole moment of given liquids.
3. Polarimetry
   (i) Determination of specific rotation for optically active substance
   (ii) Estimation of concentration of optical active substance in the given solution.
4. Distribution Law
   (i) Determine the distribution coefficient of iodine between carbon tetrachloride and water.
   (ii) Determine distribution coefficient of ammonia between chloroform and water.

Note-Book	05 Marks
Viva-Voce	05Marks
Experiments	(2x20) = 40 Marks

Suggested Readings:

1. James, A.M. & Prichard, F.E. , *Practical Physical Chemistry,* Longman 3rd ed. (1974)
2. Findlay, A. & Lavitt, B.P., *Findlay's Practical Physical Chemistry,* John Wiley 9th ed. (1981)
3. Athawale, V. D., Experimental Physical Chemistry, New Age International (2007)
4. Viswanathan, B., *Practical Physical Chemistry,* Viva Books (2012)
5. Shoemaker, D.P. , *Experiments in Physical Chemistry,* Tata McGraw Hill 6th ed. (1988)
6. Jahagirdhar, D.V., *Experiments in Physical Chemistry,* Himalaya Publisher (2013)
7. Khosla, B.D., Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R. Chand (2014)
8. Yadav, J.B., *Advanced Practical Physical Chemistry,* Goel Publishing (2014)

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-313 Practical-VII
Organic Chemistry Special

Max. Marks: 50
Time: 8 hrs.

1. Separation and identification of organic mixtures of polyfunctional compounds containing two (solid-solid, solid-liquid, liquid-liquid) components by chemical tests and checking purity of individual components using TLC. IR, NMR spectra to be used for functional group identification.
2. Viva-Voce (05 Marks)
3. Note Book (05 Marks)

Suggested Readings:

1. R.M. Roberts, Gilbert, L.B. & Wingrove, A.S.*, An Introduction to Modern Experimental Organic Chemistry*,. Holt, Ranehart and Winston (1969).
2. Vogel, A. I., *Elementary Practical Organic Chemistry*, Longmans, Green, 2nd Edition (1959).
3. Adams, R., Johnson, J. R. & Wilcox, C.F.*, Laboratory Experiments in Organic Chemistry*, The Macmilan Limited, London (1970).
4. Singh, J., Yadav, L. D. S., Singh, R. K. P., Siddiqui, I. R., Singh, J., Srivastava, J.*, Advanced practical chemistry*, Pragati Prakashan Educational Publishers (2015).
5. Advanced Practical Organic Chemistry, N.K. Vishnoi, 2009, Vikas Publishing.

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-314 Practical-VIII
Inorganic Chemistry Special

Max. Marks: 50
Time: 8 hrs.

1. Spectral studies of some inorganic compounds. (2x20 Marks)

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

2. Viva-Voce (05 Marks)
3. Note-Book (05 Marks)

Suggested Readings

1. Jolly, W. L., *Synthesis and Characterization of Inorganic Compounds,* PrenticeHall (1970)
2. King, A., *Inorganic Preparations: a systematic course of preparations,* T Murby (1936)

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-315 Practical-VIII
Physical Chemistry Special

Max. Marks: 50
Time: 8 hrs.

1. Conductometry

(i) Determine the cell constant of the given conductivity cell at room temperature and study the equivalent conductance vs square root of concentration for strong & weak electrolyte.

(ii) Determination of degree of hydrolysis and hydrolysis constant of aniline hydrochloride in aqueous solution.

(iii) Determination of solubility and solubility product of sparingly soluble salt.

2. Refractometry

(i) Study the variation of refractive index with concentration for KCl/NaCl solution and there after determine the unknown concentration of given KCl/NaCl solution.

(ii) Determine the composition of a mixture of given liquids.

3. Ultrasonic Interferrometry

(i) To determine the adiabatic compressibility of given liquids.

4. Phase

(i) Construct the phase diagram for two component system by plotting cooling curves for mixtures of different compositions.

Note-Book	05 Marks
Viva-Voce	05Marks
Experiments	(2x20) = 40 Marks

Suggested Readings:

1. James, A.M. & Prichard, F.E. , *Practical Physical Chemistry,* Longman 3rd ed. (1974)
2. Findlay, A. & Lavitt, B.P., *Findlay's Practical Physical Chemistry,* John Wiley 9th ed. (1981)
3. Athawale, V. D., Experimental Physical Chemistry, New Age International (2007)
4. Viswanathan, B., *Practical Physical Chemistry,* Viva Books (2012)
5. Shoemaker, D.P. , *Experiments in Physical Chemistry,* Tata McGraw Hill 6th ed. (1988)
6. Jahagirdhar, D.V., *Experiments in Physical Chemistry,* Himalaya Publisher (2013)
7. Khosla, B.D., Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R. Chand (2014)
8. Yadav, J.B., *Advanced Practical Physical Chemistry,* Goel Publishing (2014)

M.Sc.-Chemistry
Semester-III

CHE-316 Practical- VIII
Organic Chemistry Practical

Max. Marks: 50
Time: 6hrs.

1. Estimation of glucose
2. Estimation of phenol by brominating mixture
3. Estimation of glysine
4. Estimation of formaldehyde
5. Estimation of cane- sugar
6. Estimation of number of acetyl groups
7. Estimation of saponification value of a fat or oil
8. Estimation of iodine value of a fat or oil

1. Viva-Voce (05 Marks)

2. Note Book (05 Marks)

Suggested Readings:

1. Roberts, R. M., Gilbert, J. C., Rodewald, L. B. & Wingrove, A. S., *An Introduction to Modern Experimental Organic Chemistry*, Holt, Ranehart and Winston Inc., J.C New York (1969).
2. Vogel, A. I., *Elementary Practical Organic Chemistry*, Longmans, Green, 2nd Edition (1959).
3. Adams, R., Johnson, J. R. & Wilcox, C.F*., Laboratory Experiments in Organic Chemistry*, The Macmilan Limited, London (1970).
4. Singh, J., Yadav, L. D. S., Singh, R. K. P., Siddiqui, I. R., Singh, J., Srivastava, J*., Advanced practical chemistry*, Pragati Prakashan Educational Publishers (2015).
5. Vishnoi N.K., *Advanced Practical Organic Chemistry,* Vikas Publishing (2009)

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-317 Practical-IX
Inorganic Chemistry Special

Max. Marks: 50
Time: 8 hrs.

1. Instrumentation (2x20 Marks)

(i) Determination of pK value of an indicator spectrophotometrically.

(ii) Conductometrically–Composition of mixture of weak and strong acids, precipitation and displacement titrations.

(iii) pH–metry– Composition of mixture of strong and weak acids, pK_a value of organic acids.

(iv) Determination of stoichiometry and stability constant of Fe-thiocynate, Fe- Phenanthroline/copper-ethylenediamine complex by Slope-ratio method.

(v) Determination of concentration of sulphate ions in the given solution by Turbidimetry.

Any other techniques introduced time to time.

2. Viva-Voce (05 Marks)

3. Note-Book (05 Marks)

Suggested Readings:

1. Bassett, J., Denney, R. C., Jeffery, G.H. & Mendham, J., *Vogel's Textbook of Quantitative Analysis,* John Wiley 5th ed. (1989)
2. Larry G. Hargis, *Laboratory manual: Analytical Chemistry–principle and techniques,* Prentice Hall (1988)

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-318 Practical-IX
Physical Chemistry Special

Max. Marks: 50
Time: 8 hrs.

1. Potentiometry
   (i) Determine the strength of a given solution of ferrous ammonium sulphate by potentiometric titration with $K_2Cr_2O_7$ solution.
   (ii) Determine the solubility and solubility product of silver chloride in water.
   (iii) Determine the dissociation constant of weak acid.
   (iv) Titrate mixture of acids (HCl+CH_3COOH) vs NaOH.
2. Spectrophotometer
   (i) Verify Lambert Beer's Law
   (ii)Determine the concentration of $KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration spectrophotometrically.
3. Thermochemistry
   (i) Determination of Heat of solution and Heat of hydration of (a) $BaCl_2$ (b) $CuSO_4$.
   (ii)Construction of phenol-water phase diagram and determination of upper critical solution temperature.
4. Viscometry
   (i) Determine the viscosity of methyl acetate and ethyl acetate using Ostwald viscometer.
   (ii) Study the variation of viscosity with concentration for a glycerol solution and determine the concentration of unknown solution of glycerol.
   (iii) Determine the molar mass of a polymer

Note-Book	05 Marks
Viva-Voce	05Marks
Experiments	(2x20) = 40 Marks

Suggested Readings:

1. James, A.M. & Prichard, F.E., *Practical Physical Chemistry,* Longman 3rd ed. (1974)
2. Findlay, A. & Lavitt, B.P., *Findlay's Practical Physical Chemistry,* John Wiley 9th ed. (1981)

3. Athawale, V. D., Experimental Physical Chemistry, New Age International (2007)
4. Viswanathan, B., *Practical Physical Chemistry,* Viva Books (2012)
5. Shoemaker, D.P. , *Experiments in Physical Chemistry,* Tata McGraw Hill 6th ed. (1988)
6. Jahagirdhar, D.V., *Experiments in Physical Chemistry,* Himalaya Publisher (2013)
7. Khosla, B.D., Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R. Chand (2014)
8. Yadav, J.B., *Advanced Practical Physical Chemistry,* Goel Publishing (2014)

M.Sc.-CHEMISTRY
SEMESTER-III

19CHE-319 Practical-IX
Organic Chemistry Special

Max. Marks: 50
Time: 8 hrs.

1. Multi-step synthesis:

(i) Benzanilide from benzene

(ii) Benzophenone – benzopinacole – benzopinacolone

(iii) Benzoin – benzil – benzilic acid

(iv) cyclohexanone – cyclohexanone oxime - caprolactone

(v) p-nitrobenzanilide from Benzophenone

(vi) anthranilic acid from phthalic acid/phthalic Anhydride

Or

Any other suitable multistep synthesis

Note: All the students must submit the recrystallised product along with m.p. for all the stages of preparation.

2. Viva-Voce (05 Marks)

3. Note Book (05 Marks)

Suggested Readings:

1. Roberts, R. M., Gilbert, J. C., Rodewald, L. B. & Wingrove, A. S., *An Introduction to Modern Experimental Organic Chemistry*, Holt, Ranehart and Winston Inc., J.C New York (1969).
2. Vogel, A. I., *Elementary Practical Organic Chemistry*, Longmans, Green, 2nd Edition (1959).
3. Adams, R., Johnson, J. R. & Wilcox, C.F., *Laboratory Experiments in Organic Chemistry*, The Macmilan Limited, London (1970).
4. Singh, J., Yadav, L. D. S., Singh, R. K. P., Siddiqui, I. R., Singh, J., Srivastava, J., *Advanced practical chemistry*, Pragati Prakashan Educational Publishers (2015).
5. Vishnoi N.K., *Advanced Practical Organic Chemistry,* Vikas Publishing (2009).

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-401: Inorganic Chemistry Special-IV
Bioinorganic and Medicinal Chemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Bioinorganic chemistry of Na^+, K^+, Mg^{2+} and Ca^{2+}, Ionophores, active transport of cations across membranes, sodium pump, Calcium pump, Calcium carriers, Biochemistry of calcium as hormonal messenger, muscle contraction blood clotting, neurotransitter, Effect of metal ions on nucleic acids, Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanins and hemerythin.

Unit-II

Electron Transfer in Biological Systems Structure and function of metalloproteins in electron transport processes-cytochromes and iron-sulphur proteins, synthetic models.

Metal Storage Transport and Biomineralization: Ferritin, transferrin, and siderophores, Fixation of dinitrogen biologically and abiologically, biotransformation of non-metallic inorganic compounds, Nitrogenase, model for nitrogenase, metal-N_2 complexes, photosynthesis and chlorophyll.

Unit-III

Metallo-protein and enzymes: Zinc Enzymes – Carboxypeptidase, Carbonic anhydrase, alkaline phosphatase and alcohol dehydrogenase, Iron Enzymes – Catalase, Peroxidase and Cytochrome P- 450, Copper Enzymes – Superoxide dismutase, blue copper electron transfer enzyme, Molybdenum oxatransferase enzymes – Xanthine oxidase Coenzymes – Vitamin B_{12}.

Unit-IV

Biochemical basis of essential metal deficient diseases; Iron, copper and zinc deficiencies and their therapies; Different classes of Inorganic drugs, Drugs in hypo and hyper activity of thyroids, Inorganic drugs in dental carries, Inorganic compounds as antacids, Role of zinc in tumour growth and inhibition, Anticancer activity and mechanism of platinum complexes and Gold complexes, Antibacterial and antiviral properties of metal complexes.

Suggested Readings:

1. Lippard, S. J. & Berg, J. M., *Principles of Bioinorganic Chemistry,* University Science Books (1994).
2. Huges, M. N., *The Inorganic Chemistry of Biological Process,* John Wiley (1972)
3. Bertini, I., Gray, H.B., Lippard, S.J. & Valentine, J.S., *Bioinorganic Chemistry,* University Science Books (1994)

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-402: Physical Chemistry Special-IV
Statistical & Non-Equilibrium Thermodynamics

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit – I

Statistical Thermodynamics: Molecular partition function of an ideal gas, Expressions for translational, rotational, vibrational, nuclear and electronic partition function, Thermodynamic properties of a monoatomic ideal gas: Sackur Tetrode equation, Thermodynamic properties of a diatomic ideal gas: (evaluation of rotational energy, vibrational energy and entropy), Thermodynamic properties of polyatomic gas.

Unit – II

Classical Statistical Mechanics: Heat capacities of monoatomic solids: Einstein theory and Debye theory. Concept of phase space, ensemble and ensemble average, quantization of phase space, Microcanonical ensemble: entropy of a perfect gas, Canonical ensemble: canonical partition function, evaluation of thermodynamic quantities & application, Grand canonical ensemble: partition function and thermodynamic quantities, comparision of various ensembles.

Unit – III

Transport Phenomenon: Diffusion, Fick's first law of Diffusion, Diffusion coefficient, Fick's second law of Diffusion, Einstein-Smoluchowski equation, Ionic movements under the influence of applied electric field, mobility of ions, current density associated with movement of ions, Einstien relation, Stokes-Einstien relation, relationship between flux and viscosity, specific and equivalent conductivities in terms of ionic mobilities, Nernst-Einstein relation.

Unit – IV

Non-Equilibrium Thermodynamics: General theory of non-equilibrium processes, thermodynamic criteria for non-equilibrium states, entropy production and entropy flow; entropy production in heat flow,

mass flow, chemical reactions, electrochemical reactions, Saxen's relation, Phenomenological laws and Onsager's reciprocal relation, thermoelectric effects.

Suggested Readings:

1. Groot, S.R. de. & Mazur, P., *Non-Equilibrium Thermodynamics,* Dover Publications (1984)
2. Zwanzig, R., *Nonequillibrium Statistical Mechanics*, Oxford University Press (2001)
3. *Hill, T. L., An Introduction to Statistical Thermodynamics,* Dover Publication (2012)
4. Glasstone, S., *Theoretical Chemistry,* D. Van Nostrand Company 10th ed. (1958).
5. Kalidas, C., Sangranaraynan, M. V., *Non-equilibrium Thermodynamics,* Macmillan India Ltd. (2002)
6. Callen, H. B., *Thermodynamics & An Introduction to Thermostastics,* John Wiley (1985)
7. Levine, I. N., *Physical Chemistry,* Tata McGraw Hill 5th ed. (2007)
8. Atkins, P.W., Paula, J. D. & Freeman, W.H., *Physical Chemistry,* W.H. Freeman Co. 9th ed. (2010)
9. Glasstone, S., *Thermodynamics for chemists,* Affiliated East West Press Pvt. Ltd. (2008)
10. Denbigh, K.G .,*Principles of Equilibrium Thermodynamics*, Cambridge University Press (1957)
11. McQuarrie, D. A., *Statistical Mechanics,* University Science Books 1st ed. (2000)
12. Moudgil, H. K., *Textbook of Physical Chemistry*, PHI Learning Pvt. Ltd. 2nd ed. (2014)

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-403: Organic Chemistry Special-IV
Bioorganic and Medicinal Chemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit I

Amino Acids, Peptides and Proteins: Introduction, classification and structure, Isoelectric point with numerical problems. General methods of preparation, Ninhydrin reaction. Peptide bond, protein structure, Chemical and enzymatic hydrolysis of proteins to peptides.

Enzymes: Remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's inducedfit hypothesis, concept and identification of active site by the use of inhibitors, affinity labelling. Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition.

Unit II

Coenzyme Chemistry: Biological function of coenzyme A, thiamine pyrophosphate, pyridoxalphosphate, NAD^+, $NADP^+$, FMN, FAD.

Carbohydrates: Introduction, nomenclature, monosacharides & their configuration with the determination of the size of sugar rings, basic elementary idea of structure of starch, cellulse, sucrose, maltose.

Fatty Acids: Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids

Unit III

Drug Design: Introduction, historical development, factors affecting development of new drugs, concept of lead compounds and its modification.

Concepts of prodrugs and soft drugs; Chemical and physicochemical parameters in drug design. Drug metabolism – introduction, biological transformation like oxidation, reduction, hydrolysis and conjugation.

Structure based drug design – introduction and process; Molecular modelling using computers – introduction and uses.

Enzyme Inhibitors – design, competitive inhibitors, active site directed irreversible inhibitors, suicide enzyme inactivators.

Unit IV

Introduction, general mode of action, synthesis and medicinal uses of important drugs in the following categories.

Antipyretic analgesics (paracetamol, aspirin), Antineoplastic (Methotrexate, Fluorouracil), antimalarials (chloroquine, pyrimethamine), antitubercular (Isoniazid, ethambutol), antihelmintic (albendazole, thiabendazole), and sulfa drugs (sulfanilamide, dapsone).

Suggested Readings:

1. Dugas, H., *Bioorganic Chemistry. A Chemical approach to enzyme action*, Springer-Verlag, 2nd Edition (1989).
2. Metzler, D. E., *Biochemistry-The Chemical Reactions of a Living Cell*, Academic Press, (1977).
3. Ed. Dugas, H., *Bioorganic Chemistry Frontiers Vol.2*, Springer-Verlag (1990).
4. Lehninger, A.L. et. al., *Lehninger Principles of Biochemistry*, W.H. Freeman (2005).
5. Voet, D., Voet, J.G., Pratt, C.W., *Principles of Biochemistry,* Wiley, 3rd Edition (2008).
6. Burger, *Medicinal Chemistry*, Vol. I-III, Wiley Interscience Publications, New York (1995).
7. Foye, W. O., *Principles of Medicinal Chemistry*, Lea & Febiger/ Varghese Publishing House, Bombay, 3rd Edition (1989).
8. Lednicer, D. & Mitscher, L. A., *The Organic Chemistry of Drug Synthesis*, Vol. IIII, Wiley Interscience (1977).
9. Kar, A., *Medicinal Chemistry*, Wiley Eastern Ltd., New Delhi (1993).
10. Terrett, N. K., *Combinatorial Chemistry*, Oxford Univ. Press, Oxford (1998).
11. Lednicer, D., *Strategies for organic drug synthesis and design,* John Wiley & Sons, New York (2009).
12. Pandeya, S. N., Dimmock, J. R., *An Introduction to Drug Design*, New Age International (P) Limited, Publishers (1997).
13. Kar, A., *Medicinal Chemistry*, New Age International (P) Limited, Publishers (2005).
14. Bruce, P. Y., *Essential Organic Chemistry*, Pearson Education, New Delhi (2015).
15. Loudon, C. M., *Organic Chemistry*, Oxford University Press, New Delhi (2002).
16. Morrison, R. R., Boyd, R. N. & Bhattacharjee, S. K., *Organic Chemistry* , Dorling Kindersley (India) Pvt. Ltd, New Delhi (2011).
17. Finar, I. L., *Organic Chemistry*, Volume 2, Longmans, Green and Co. Ltd. (1964).

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-404: Inorganic Chemistry Special-V
Instrumental Techniques -II

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Vibrational Spectroscopy: Spectra and symmetry, Selection rules, 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, changes in spectra of donor molecules on coordination, change in symmetry on coordination, bond strength frequency shift relations, Use of symmetry to determine the number of active infrared and Raman lines, Application of resonance Raman Spectroscopy particularly for the study of active sites of metalloproteins as myoglobin and haemoglobin.

Unit-II

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.

Unit-III

Nuclear Quadrupolar Resonance (NQR) Spectroscopy: Quadrupolar moment, energy lends of a quadrupolar nuclease and effect of asymmetry parameters and energy lends. Effect of an external magnetic field, selected examples for elucidation of structural aspects of inorganic compounds using NQR spectroscopy.

Mass Spectroscopy: Presentation and interpretation of mass spectrum, effect of isotopes on appearance of mass spectrum, Applications of mass spectroscopy to inorganic compounds- fingerprint application, molelcular weight determination, evaluation of heat of sublimation of high melting solids.

Unit-IV

Molecular luminescence: Fluorimetry and Phosphorimetry: Introduction, principles of fluorescence and phosphorescence, interpretation of fluorescence spectra, factors, fluorescence intensity and concentration, instrumentation for fluorimetry, applications of fluorimetry. Phosphorimetry, instrumentation, applications, comparison between fluorimetry and phosphorimetry.

Circular Dichroism and Optical Rotatory Dispersion: Polarized light, fundamental symmetry requirements, for optical activity, interaction of polarized light with optically active matter, optical rotation, Cotton effect, configuration of Tris-chelated complexes.

Suggested Readings:

1. Sathyanarayana, D.N., *Vibrational Spectrosocpy: Theory & Applications,* New Age International Publishers 1st ed. (2004)
2. Sathyanarayana, D.N., *Introduction to Magnetic Resonance Spectroscopy ESR, NMR, NQR*, I.K. International Publishing House Pvt. Ltd. (2009)
3. Drago, R. S., *Physical methods in Inorganic Chemistry*, Reinhold Publishing Corporation (1965)
4. Nakamoto, K., *Infrared & Raman Spectra of Inorganic & Co-ordination compounds,* Wiley 6th ed. (2009)
5. Ross, S.D., *Inorganic Infrared & Raman Spectra*, Tata McGraw Hill (1972)
6. Banwell C. N., *Fundamentals of Molecular Spectroscopy,* Tata McGraw Hill (1966)

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-405: Physical Chemistry Special-V
Chemistry of Polymers

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit – I

Basics of polymerization: Introduction: Basic concepts of polymers science, the rise of macromolecular science, molecular forces and chemical bonding in polymers, classification and nomenclature of polymers. Dendrimers, Glass transition temperature (Tg): influencing factors& significance, Biodegradable polymers.

Unit – II

Types of polymerization: Step growth polymerization, chain transfer polymerization,(kinetics & mechanisms), comparison between step growth and chain transfer polymerization, Anionic & Cationic polymerization, Coordination polymerization, Solution & Template polymerization, Bulk & Block polymerization, Radical polymerization and Ring opening polymerization.

Unit – III

Molecular mass &Thermodynamics of Polymer Solutions: Concept of molar mass averages: number average, mass average, z-average, Viscosity average molar mass, Methods of determination of molecular weights: viscometry (Mark-Houwink equation), osmometry ,sedimentation, Light Scattering methods (Zimm Plot). Distribution of molecular sizes in step growth polymerization, identification of number average and mass average molar mass with probability, concept of Poly-dispersity, Molecular mass distribution curves. End - to - End distance in a macromolecular chain: one dimensional random walk, extension to three dimensional chains, Flory Huggins's lattice theory.

Unit – IV

Conducting polymers: Introduction, classification, conduction mechanism, doping of conducting polymers and its significance, factors affecting the conductivity, synthesis and characterization of conducting polymers

Applications in energy storage devices: solar cell, supercapacitors, sensors.

Suggested Readings:

1. Kolasinski, K.W., *Surface Science: Foundations of Catalysis and Nanoscience*, John Wiley (2002)
2. Somorjai, G.A., Li, Y., *Introduction to Surface Chemistry and Catalysis,* John Wiley (2010)
3. Arthur, W., *Physical chemistry of surfaces*, Adamson (1990)
4. Roy, S., *The chemical physics of surfaces* (1990)
5. Allcock, H.R., Lampe, F.W. & Mark, J., *Contemporary Polymer Chemistry*, Prentice Hall (1990)
6. M.P. Stevens, *Polymer Chemistry: An Introduction* Oxford University Press 2nd ed. (1990)
7. Billmeyer, F.W., *Textbook of Polymer Science* Wiley-Inter Science 3rd ed. (1984)
8. Ravve, A., *Principles of Polymer Chemistry* Springer 3rd ed. (2012)
9. Carraher's *Polymer Chemistry*, C. E. Carraher, Jr., CRC Press, 10th ed. (2017)

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-406: Organic Chemistry Special-V
Heterocyclic Chemistry and Disconnection Approach

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Nomenclature of heterocyclic compounds: Replacement and Systematic (Hantzsch-Widman) nomenclature for monocyclic, fused ring and bridged heterocyclic systems.

Aromatic heterocycles: Classification (structural type) Aromaticity, bond lengths, ^{1}H NMR, resonance energy, charge distribution, reactivity, tautomerism.

Non-aromatic heterocycles: Bond angle and torsional strains and their consequences in small ring heterocycles.

Small ring heterocycles: Three-membered and four-membered heterocycles-synthesis and reactions of aziridines, oxiranes, azetidines.

Unit-II

Five membered heterocycles: Methods of synthesis and reactions including mechanism (addition on nitrogen: protonation, N-alkylation, N-acylation; reactions with electrophilic and nucleophilic reagents) of the following five -membered 1,2- and 1,3-heterocycles: pyrazoles, imidazoles, oxazoles, thiazoles; their basic character. Reactions with oxidizing and reducing agents. Synthesis and reaction of quarternary 1,3-azolium and 1,3-azole N-oxide.

Six membered heterocycles: Methods of synthesis and reactions including mechanism of the following six-membered heterocycles: purines and pyrimidines

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.

Suggested Readings:

1. Gilchrist, T. L., *Heterocyclic Chemistry*, Prentice Hall (1997).
2. Paquette, L.A., *Principles of Modern Heterocyclic Chemistry*, W.B. Benjamin, Inc. (1978).
3. Joule, J. A. & Mills, K., *Heterocyclic Chemistry*, Wiley, Fifth Edition (2010).
4. Warren, S., *Organic Synthesis, The disconnection Approach*, John Wiley & Sons, 2004.
5. Gupta, R.R., Gupta, V. & Kumar, M., *Heterocyclic chemistry: Volume II: Five-Membered Heterocycles*, Springer (2013).
6. Bansal, R. K., *Heterocyclic Chemistry, Synthesis, Reactions and Mechanisms*, Wiley Eastern Ltd. (1990).
7. Acheson, R.M., *An Introduction to the Chemistry of Heterocyclic Compounds*, Interscience Publishers, 2nd Edition (1967).
8. Eicher, T. & Hauptmann, S., *The chemistry of Heterocycles*, Wiley-VCH, Weinheim, (2003).

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-407: Inorganic Chemistry Special-VI
Advance Topics in Inorganic Chemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Supramolecular Chemistry : Molecular recognition: Molecular receptors for different types of molecules including anionic substrates, design and synthesis of co-receptor molecules and multiple recognition, Supramolecular reactivity and catalysis, Transport processes and carrier design, Supramolecular devices. Some example of self-assembly in supramolecular chemistry.

Unit-II

Nano materials Technology: Nano materials, Properties of nano structured materials (opticals, magnetic, chemical and photo catalytic properties), Techniques for their synthesis (Hydrothermal, Solvothermal, sol-gel, Precipitation, Reverse Micelle Synthesis, Physical Vapour deposition (PVD), Chemical Vapour Deposition (CVD), Electro deposition and 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. Applications of nanoscience and nanotechnology in various fields.

Unit-III

Solid State-I: Defects and Non-stoichiometry: Intrinsic and extrinsic defects- point defects, line and plane defects, vacancies- Schottky defects and Frenkel defects. Thermodynamics of Schottky and Frenkel defect formation, colour centres, non-stoichiometry and defects.

Metals, insulators and semiconductors, electronic structure of solids- band theory, band structure of metals, insulators and semiconductors. Intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, superconductors, Optical and Magnetic properties.

Unit-IV

Solid State-II: Solid State Lasers (Ruby, YAG and tunable lasers), Inorganic phosphor materials; Synthesis and advantages of optical fibres over conducting fibres. Alloys- interstitial, substitutional and super conducting, Meissner effect, Hume -Rothery rules.

Suggested Readings:

1. Charles, P. P., Frank, J., *Owens : Introduction to Nanotechnology,* John Wiley (2003)
2. Sergeev, G. B., & Klabunde, K. J., *Nanochemistry,* Elsevier 2nd ed. (2013)
4. Fahrner, W.R., *Nano Technology and Nanoelectronics:Materials Devices Measurement Techniues,* Springer (2005)
5. Chattopadhyay, K. K., Banerjee, A. N., *Introducation to Nanoscience and Technology,* PHI Learning Pvt. Ltd. (2009).
6. Lindsay, S. M., *Introduction to Nanosciences,* Oxford University Press (2010)
7. Muralidharan, V. S. & Subramania, A., *Nano Science and Technolony*, Ane Books Pvt. Ltd. (2009)
8. Budhiraja, R.P., *Separation Chemistry,* New age International Ltd (2007)
9. Khopkar, S.M., *Basic Concepts of Analytical Chemistry,* New age International Publishers 2nd ed. (2004)
10. Sharma, B.K., *Instrumental Methods of Chemical analysis,* Goel Publishing House 24th ed. (2005)
11. Steed, J. W. & Atwood, J. L., *Supramolecular chemistry,* Wiley (2000)
12. Evans, R.C., *An Introduction to Crystal Chemistry*, Cambridge University Press 2nd ed. (1976)
13. Kittel, C., *Introduction to solid state Physics*, Wiley 8th ed. (2004)
14. Chakrabarty, D. K , *Solid State Chemistry*, New Academic Science (2010)

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-408: Physical Chemistry Special-VI
Fast Kinetics & Surface Phenomenon

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Adsorption: Introduction, Physical adsorption & Chemisorptions, Freundlich Adsorption isotherm, Langmuir Theory of adsorption, BET theory of multilayer adsorption, BET equation, Determination of surface area of the adsorbent, Correlation of Langmuir & BET equation, Gibb's adsorption equation.

Unit –II

Surface Chemistry: Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), surface films on liquids (electro kinetic phenomenon),Surface active agents: General features, structure & classification, micellisation, mass action model and phase separation model, hydrophobic interactions, critical micellar concentration (CMC), factors affecting CMC of surfactants, thermodynamics of micelle formation, counter ion binding to micelles, reverse micelles.

Unit –III

Chemical Dynamics: Potential energy surfaces, Theories of unimolecular reactions: Rice - Ramsperger–Kassel–Marcus [RRK] and [RRKM] theories, oscillatory reactions (Belousov-Zhabotinsky reaction).

Unit-IV

Fast Reactions: Study of fast reaction, flash photolysis, Flash Spectroscopy, Kinetic Spectrophotometry, Absorption of photoflash energy (adiabatic and isothermal method) Fast flow methods (Absorption spectra, mass spectrometry, Colorimetric probes, ESR, Chemical titrations, Chemiluminescence, Atomic resonance fluorescence) NMR methods.

Suggested Readings:

1. Moroi, V., *Micelles, Theoretical and Applied Aspects*, Springer (1992)
2. Laidler, K.J., *Chemical Kinetics*, Pearson 3rd ed. (1987)
3. Raj, G.,*Chemical Kinetics*, Goel Publishing House 8th ed. (2010)
4. Glasstone, S., Laidler, K.J. & Eyring, H., *The Theory of Rate Processes, The Kinetics of Chemical Reaction, Viscosity, Diffusion and Chemical Phenomenon,* McGraw Hill (1941)
5. Pilling, M. J. & Seakins, P. W., .*Reaction Kinetics,* Clarendon Press (1975)
6. Moudgil, H. K., *Textbook of Physical Chemistry,* PHI 2nd ed. (2015)
7. Moore, J. W., Pearson, R. G., *Kinetics and Mechanism,* John Wiley 3rd ed. (1981)
8. Masel, R. I., *Chemical Kinetics and Catalysis,* Wiley (2001)
9. Chakrabarty, D. K., *Adsorption and Catalysis by Solids*, Wiley Eastern Ltd. (1991)
10. Raj, G., *Advanced Physical Chemistry,* Goel Publishing House 35th ed. (2009)
11. Birdi, K. S., *Handbook of Surface and Colloid Chemistry*, CRC Press 4th ed. (2009)

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-409: Organic Chemistry Special-VI
Chemistry of Natural Products

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Alkaloids: Definition, nomenclature and physiological action, occurrence, isolation Structure elucidation of alkaloids – a general account; degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants. Structure, stereochemistry, synthesis of the following: Ephedrine, (+)-Conine, Nicotine, Quinine, and Reserpine.

Unit -II

Terpenoids: Classification, general aspects of structure determination of terpenoids, biogenetic isoprene rule. Structure, stereochemistry, synthesis of Geraniol, α-terpeneol, α-pinene, camphor.

Carotenoids: General method of structure elucidation and synthesis of β-carotene, Vitamin A and Abietic acid.

Unit-III

Steroids: Isolation, nomenclature basic skeleton, Diel's hydrocarbon, stereochemistry, structural elucidation with special reference to Cholesterol, Bile acid and cardiac glycosides. Synthesis of Testosterone from Cholesterol, Synthesis of Progesterone from Cholesterol, Prostaglandins: Introduction, nomenclature and biological role of prostaglandins. Synthesis of PGE2 and PGF2α

Unit -IV

Natural Pigments: Occurrence nomenclature and general methods of structure determinations, isolation and synthesis of Cyanin, Quercetin, Diadzein, and Chrysin. Biosynthesis of Flavonoids: Acetate path way and shikimic acid pathway.

Suggested readings:

1. Roberts, R. M., Gilbert, J. C., Rodewald, L. B. & Wingrove, A. S., *An Introduction to Modern Experimental Organic Chemistry*, Holt, Ranehart and Winston Inc., J.C New York (1969).
2. Vogel, A. I., *Elementary Practical Organic Chemistry*, Longmans, Green, 2nd Edition (1959).
3. Adams, R., Johnson, J. R. & Wilcox, C.F.*, Laboratory Experiments in Organic Chemistry*, The Macmilan Limited, London (1970).
4. Singh, J., Yadav, L. D. S., Singh, R. K. P., Siddiqui, I. R., Singh, J., Srivastava, J.*, Advanced practical chemistry*, Pragati Prakashan Educational Publishers (2015).
5. Vishnoi N.K., *Advanced Practical Organic Chemistry,* Vikas Publishing (2009).

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-410
Communication Skills

Maximum Marks-40
Internal Assessment-10
Total Credits: 2
Max. Time: 2 hrs

Note*: There shall be nine questions in all. Question no. I shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*
Internal Assessment will be a continuous evaluation process on the basis of the students' expression of effective communication skills through participation in activities like presentations, group-discussions, mock-interviews, etc.

Objective:
To introduce the theory and practice of communicative skills so as to enable the students to communicate effectively and conduct themselves graciously in the business of life.

Unit-I

Human Communication, Verbal and Non Verbal Communication, Barriers to communication; the seven C"s of effective communication. Preparing for interviews, CV/ Biodata, Group Discussion, Public Speaking, Mass Communication.

Unit –II

Greeting and Introducing, Making Requests, Asking for and Giving Permission, Offering Help, Giving Instructions and Directions, Art of Small Talk, Participating in Conversations, Making a Short Formal Speech, Describing People, Places, Events and Things.

Unit-III

Understanding Telephone Communication: Types of Calls, Handling Calls, Leaving a Message, Making Requests, Asking for and Giving Information, Giving Instructions, Agreeing and Disagreeing, Making or Changing Appointments, Reminding, Making Complaints and Handing Complaints, Telephone Etiquette.

Unit-IV

Personality Development Skills: Personal Grooming; Assertiveness; Improving Self-Esteem; Significance of Critical Thinking; Confidence Building; SWOC analysis.

Emotional intelligence: Recognizing and Managing Emotions and Situations; Stress and Anger Management; Positive Thinking; Developing Sense of Humour.

Suggested Readings:

1. Kumar, S.& Lata, P., *English for Effective Communication,* OUP (2016)
2. Mohan, K. & Banerji, M., *Developing Communication Skills*, Trinity Press 2nd ed. (2013)
3. Dutt, P. Kirammai & Rajeevan, G., *A Course in Communication Skills,* Foundation Books, CUP, (2016)

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-411 Practical-X
Inorganic Chemistry Special

Max. Marks: 50
Time: 8 hrs.

1. Preparation of hexaureachromium(III) chloride and estimation of Cl^- ions in the prepared complex.

2. Preparation of pure sample of nitrosylbisdiethylthiocarbamatoiron(I) and estimation of Fe in the prepared complex,

3. Preparation of hexathioureaplumbous nitrate and estimation of Pb in the prepared complex.

4. Preparation of cobalt tetrathiocyanatomercurate (II) $Co[Hg(SCN)_4]$ and estimation of Hg in the prepared complex.

5. Preparation of tetraminecopper (II) sulphate $[Cu(NH_3)_4]SO_4$ and estimation of Cu in the prepared complex.

6. Preparation of dipyridinemercury (II) persulphate $[Hg(C_5H_5N)_2]S_2O_8$ and estimation of Hg in the prepared complex.

7. Preparation of dichlorobis(hydroxylarnine)zinc(II) $[Zn(NH_2OH)_2CI_2l$ and estimation of Zn in the prepared complex.

8. Preparation of aluminiumacetylacetonate $[Al\ (C_5H_7O_2)_3]$ and estimation of Al in the prepared complex.

9. Preparation of pentathioureadicuprous nitrate and estimation of Cu in the prepared complex.

10. Preparation of tetrapyridineferrouschloride and estimation of Fe in the prepared complex.

Suggested Readings:

1. G. Marr and B. W. Rockett. *Practical lnolganic Chemistry*, Van Nostrand Reinhold Cornpany, London (1972)
2. Bull. Chem. Soc., Japan, 29, (1965) 852.
3. Inorg. Chim. Acta., 23,35 (1917).
4. J. Chem. Edu.., 79. 581(1911).
5. Aclvances to lnorganic and Radiochemistry, Vol.7.
6. lnorganic Chemistry. 1966, Vol.5, 6l5.
7. J. Chem. Soc, 1962. 84, 3404.

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-412 Practical-X
Physical Chemistry Special

Max. Marks: 50
Time: 8 hrs.

1. Adsorption
   (i) Verify the Freundlich and Langmuir adsorption isotherms for adsorption of acetic acid on activated charcoal.
   (ii) Verify the Freundlich and Langmuir adsorption isotherms for adsorption of oxalic acid on activated charcoal.
2. Potentiometry
   (i) NaOH vs. H_3PO_4titration
   (ii) Determine the strength of a given solution of ferrous ammonium sulphate by potentiometric titration with $KMnO_4$ solution.
   (iii) Determination of solubility and solubility product of sparingly soluble salts $BaSO_4$.
   (iv) Determination of degree of hydrolysis of aniline hydro chloride.
3. Viscommetry
   (i) Determine percentage composition of a liquid mixture by viscosity measurements.
   (ii) Study the variation of viscosity of a pure liquid with temperature and determine the temperature coefficient of viscosity of the liquid.
   (iii) Determine the relative and absolute viscosities of the given liquid.
4. Spectrophotometer
   (i) Determine the composition of ferric ions-salicylic acid complex by Job's method.
   (ii) Determine the dissociation constant of phenolphthalein indicator.

Note-Book (05 Marks) Viva-Voce (05 Marks) Experiments

(2x20) = 40 Marks

Suggested Readings:

1. James, A.M. & Prichard, F.E. , *Practical Physical Chemistry,* Longman 3rd ed. (1974)
2. Findlay, A. & Lavitt, B.P., *Findlay's Practical Physical Chemistry,* John Wiley 9th ed. (1981)
3. Athawale, V. D., Experimental Physical Chemistry, New Age International (2007)
4. Viswanathan, B., *Practical Physical Chemistry,* Viva Books (2012)

5. Shoemaker, D.P. , *Experiments in Physical Chemistry,* Tata McGraw Hill 6th ed. (1988)
6. Jahagirdhar, D.V., *Experiments in Physical Chemistry,* Himalaya Publisher (2013)
7. Khosla, B.D., Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R. Chand (2014)
8. Yadav, J.B., *Advanced Practical Physical Chemistry,* Goel Publishing (2014)
9. Senior Practical Physical Chemistry by B.D. Khosla, V. Garg and A. Gulati.
10. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing.

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-413 Practical-X
Organic Chemistry Special

Max. Marks: 50
Time: 8 hrs.

1. **Isolation of natural products** (40 Marks)
   (i) Isolation of caffeine from tea leaves
   (ii) Isolation of piperine from black pepper
   (iii)Isolation of β-carotene from carrots
   (iv)Isolation of lycopene from tomatoes
   (v) Isolation of limonene from lemon peel
   (vi)Isolation of euginol from cloves
   (vii) Isolation of nicotine from tobacco.
   (viii) Isolation of casein and lactose from milk

2. Viva-Voce (05 Marks)
3. Note Book (05 Marks)

Suggested readings:

1. Roberts, R. M., Gilbert, J. C., Rodewald, L. B. & Wingrove, A. S., *An Introduction to Modern Experimental Organic Chemistry*, Holt, Ranehart and Winston Inc., J.C New York (1969).
2. Vogel, A. I., *Elementary Practical Organic Chemistry*, Longmans, Green, 2nd Edition (1959).
3. Adams, R., Johnson, J. R. & Wilcox, C.F*., Laboratory Experiments in Organic Chemistry*, The Macmilan Limited, London (1970).
4. Singh, J., Yadav, L. D. S., Singh, R. K. P., Siddiqui, I. R., Singh, J., Srivastava, J*., Advanced practical chemistry*, Pragati Prakashan Educational Publishers (2015).
5. Vishnoi N.K., *Advanced Practical Organic Chemistry,* Vikas Publishing (2009).

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-414 Practical-XI
Inorganic Chemistry Special

Max. Marks: 50
Time: 8 hrs.

1. Estimation and Separation Processes

(i) Any technique using the following instruments such as flame photometer, Atomic Absorption Spectrophotometer, turbidimeter, dipolemeter etc.

(ii) Determination of stoichiometry and stability constant of Fe-thiocynate, Fe-Phenanthroline/copper-ethylenediamine complex by Slope-ratio method. (40 marks)

Viva-Voce (05 Marks)

Note-Book (05 Marks)

Suggested Readings

1. Bassett, J., Denney, R. C., Jeffery, G.H. & Mendham, J., *Vogel's Textbook of Quantitative Analysis,*
John Wiley 5th ed. (1989)
2. Larry G. Hargis, *Laboratory manual: Analytical Chemistry–principle and techniques,*
Prentice Hall (1988)

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-415 Practical-XI
Physical Chemistry Special

Max. Marks: 50
Time: 8 hrs.

1. Corrosion
   (i) Determine corrosion rate of any metal or alloy in given acidic solution.
   (ii) Study the effect of temperature on the corrosion rate.
   (iii) Study the effect of inhibitor on corrosion.
2. Nephelometry
   (i) Estimate chloride ion in a given solution/ water from various resources.
   (ii) Determine the concentration of sulphate ions in given solution and in a sample of tap water byprecipitation with barium chloride.
3. pHmetery
   Buffer solution preparation:
   (i) Acidic buffer of various pH
   (ii) Basic buffer of various pH
   (iii) Neutral Buffer of various pH
4. Refractometry
   (i) Determine the concentration of sugar in a solution.
   (ii) Determine the polarizabilities of liquids.

Note-Book	05 Marks
Viva-Voce	05 Marks
Experiments	(2x20) = 40 Marks

Suggested Readings:

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

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-416 Practical-XI
Organic Chemistry Special

Max. Marks: 50
Time: 8 hrs.

1. Spectrophotometric (UV-vis) Estimations : (20 Marks)

- Amino acids
- Proteins
- Carbohydrates
- Ascorbic acid
- Aspirin
- Caffeine
- Cholesterol

2. Synthesis and characterization of some organic compounds of medicinal interest Paracetamol, aspirin, phenyltoin, phenylbutazone or any other relevant drugs. (20 Marks)

3. Viva-Voce (05 Marks)
4. Note-Book (05 Marks)

Suggested readings:

1. Roberts, R. M., Gilbert, J. C., Rodewald, L. B. & Wingrove, A. S., *An Introduction to Modern Experimental Organic Chemistry*, Holt, Ranehart and Winston Inc., J.C New York (1969).
2. Vogel, A. I., *Elementary Practical Organic Chemistry*, Longmans, Green, 2nd Edition (1959).
3. Adams, R., Johnson, J. R. & Wilcox, C.F., *Laboratory Experiments in Organic Chemistry*, The Macmilan Limited, London (1970).
4. Singh, J., Yadav, L. D. S., Singh, R. K. P., Siddiqui, I. R., Singh, J., Srivastava, J., *Advanced practical chemistry*, Pragati Prakashan Educational Publishers (2015).
5. Vishnoi N.K., *Advanced Practical Organic Chemistry,* Vikas Publishing (2009).

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-417 Practical-XII
Inorganic Chemistry Special

Max. Marks: 50
Time: 8 hrs.

1. Techniques (2x20 Marks)

(i) Chromatographic techniques- Papar/Thin layer chromatography.

(ii) Solvent extraction.

(iii) Complexometry– using EDTA and Sequesteringagent. Masking and Demasking.

(iv) Ion exchange method

Viva-Voce (05 Marks)
Note-Book (05 Marks)

Suggested Readings:

1. Bassett, J., Denney, R. C., Jeffery, G.H. & Mendham, J., *Vogel's Textbook of Quantitative Analysis,*
John Wiley 5th ed. (1989)
2. Larry G. Hargis, *Laboratory manual: Analytical Chemistry–principle and techniques,*
Prentice Hall (1988)

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-418 Practical-XII
Physical Chemistry Special

Max. Marks: 50
Time: 8 hrs.

1. Surface Tension
   (i) Determine the surface tension of given liquids at a given temperature using stalagmometer.
      (a) Drop Number Method
      (b) Drop Weight Method
2. Conductometry
   (i) Determine the concentration of Salicylic acid by
      (a) Salt line method
      (b) Double alkali method
   (ii) Determine the strengths of strong/weak acid by titrating it against weak base.
   (iii) Titrate the solution of ($HCl+CH_3COOH+CuSO_4$) against NaOH.
3. Flame Photometry
   (i) Determine the concentration of Na^+, K^+ and Li^+ in the given solution.
   (ii) Determine the presence of Ca^{2+} and Mg^{2+} in tap water.
4. Chemical Kinetics
   (i) Study of Iodination of acetone.
   (ii) Study the kinetics of iodine-clock reaction.

Note-Book	05 Marks
Viva-Voce	05 Marks
Experiments	(2x20) = 40 Marks

Suggested Readings:

1. James, A.M. & Prichard, F.E., *Practical Physical Chemistry,* Longman 3rd ed. (1974)
2. Findlay, A. & Lavitt, B.P., *Findlay's Practical Physical Chemistry,* John Wiley 9th ed. (1981)
3. Athawale, V. D., Experimental Physical Chemistry, New Age International (2007)
4. Viswanathan, B., *Practical Physical Chemistry,* Viva Books (2012)
5. Shoemaker, D.P. , *Experiments in Physical Chemistry,* Tata McGraw Hill 6th ed. (1988)
6. Jahagirdhar, D.V., *Experiments in Physical Chemistry,* Himalaya Publisher (2013)

7. Khosla, B.D., Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R. Chand (2014)
8. Yadav, J.B., *Advanced Practical Physical Chemistry,* Goel Publishing (2014)

M.Sc.-CHEMISTRY
SEMESTER-IV

19CHE-419 Practical-XII
Organic Chemistry Special

Max. Marks: 50
Time: 8 hrs.

1. Preparation and characterization organic compounds prepared in two and three steps.
   (i) Synthesis of 2,4-dinitro-1-chlorobenzene from chlorobenzene
   (ii) Synthesis of p-chlorobenzoic acid from p-toluidine
   (iii) Synthesis of acridone from anthranilic acid
   (iv) Synthesis of picric acid from cholorobenzene
   (v) Synthesis of anthrone from phthalic anhydride
   (vi) Synthesis of saccharin from toluene
   Or
   Any other relevant experiment (40 Marks)

2. Viva-Voce (05 Marks)
3. Note Book (05 Marks)

Suggested readings:

1. Roberts, R. M., Gilbert, J. C., Rodewald, L. B. & Wingrove, A. S., *An Introduction to Modern Experimental Organic Chemistry*, Holt, Ranehart and Winston Inc., J.C New York (1969).
2. Vogel, A. I., *Elementary Practical Organic Chemistry*, Longmans, Green, 2nd Edition (1959).
3. Adams, R., Johnson, J. R. & Wilcox, C.F., *Laboratory Experiments in Organic Chemistry*, The Macmilan Limited, London (1970).
4. Singh, J., Yadav, L. D. S., Singh, R. K. P., Siddiqui, I. R., Singh, J., Srivastava, J., *Advanced practical chemistry*, Pragati Prakashan Educational Publishers (2015).
5. Vishnoi N.K., *Advanced Practical Organic Chemistry,* Vikas Publishing (2009).