DEPARTMENT OF BASIC AND APPLIED SCIENCES

SYLLABUS

SCHEME OF STUDIES AND EXAMINATIONS

MASTER OF SCIENCE IN CHEMISTRY
(Four-Semester Course)
(Effective from Academic Session 2021-2022)

BHAGAT PHOOL SINGH MAHILAVISHWAVIDYALAYA KHANPUR KALAN-131305 (SONEPAT) HARYANA

M. Sc. Chemistry
Department of Basic and Applied Sciences
Bhagat Phool Singh Mahila Vishwavidyalaya, Khanpur Kalan

Syllabus (w.e.f. 2021-22)

Name of Programme: M. Sc. Chemistry
Duration of Programme: Two Years (Four Semesters);
Choice Based Credit System (CBCS)
Credits requirement for completion of the Programme: 108 Credits

Sr. No.	Course Type	First Year Credits				Second Year Credits				Total Credits
		First Semester		Second Semester		Third Semester		Fourth Semester		
		Theory	P	Theory	P	Theory	P	Theory	P	
1.	Core Courses	16	09	12	09	12	09	12	09	88
2.	Open Elective	-	-	-	-	04	-	04	-	08
3.	Ability Enhancement	-	01	03	01	-	01	03	01	10
4.	Skill Enhancement	02	-	-	-	-	-	-	-	02
Total Credits		28		25		26		29		108
Grand Total Credits										108

B.P.S. Mahila Vishwavidyalaya, Khanpur Kalan, Sonepat (Haryana)
M.Sc. Chemistry (Two year Course) with
Choice Based Credit System (CBCS)
Scheme of Examination
(For university teaching department and affiliated colleges/ Institute)
Effective from Session 2021-22
Semester - I

Code	Nomenclature	Contact Hours			Credits	Duration of Exam	Examination Scheme		
		L	T	P			Internal Marks	External Marks	Total
CHL-501	Inorganic Chemistry-1	4	0	0	04	03 hrs	20	80	100
CHL-503	Physical Chemistry-1	4	0	0	04	03 hrs	20	80	100
CHL-505	Organic Chemistry-1	4	0	0	04	03 hrs	20	80	100
CHL-507	General Spectroscopy	4	0	0	04	03 hrs	20	80	100
CHP-509	Inorganic Chemistry Practical-1	0	0	6	03	06 hrs	15	60	75
CHP-511	Physical Chemistry Practical-1	0	0	6	03	06 hrs	15	60	75
CHP-513	Organic Chemistry Practical-1	0	0	6	03	06 hrs	15	60	75
CHL-515	Computer for Chemist	2	0	0	02	02 hrs	10	40	50
CHP-517	Seminar-1	0	0	2	01	-	25	-	25
Total		18	0	20	28	-	160	540	700

Note:

- All the papers in M.Sc. 1st semester are core and mandatory for M.Sc. 1stsemester students.
- Each theory paper will include 20% marks as internal assessment as per University rules.
- Each practical examination will be of 06 hours and will be conducted in two sessions (Morning & Evening) of 03 hours each.
- Maximum marks of M.Sc. 1st semester will be 700. Theory 540 marks; Practical 160 marks
- Practical marks will include 10% marks for viva-voce and 10% for record files.
- The payment to the internal as well as external examiners will be made on the basis of sessions.
- The assessment of Seminar-I will be done during the semester on the basis of presentation given by the student in front of department seminar committees notified by the Chairperson time to time.
- Total credits: 28.

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M.Sc. Chemistry (Two year Course) with
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Semester - II

Code	Nomenclature	Contact Hours			Credits	Duration of Exam	Examination Scheme		
		L	T	P			Internal Marks	External Marks	Total
CHL-502	Inorganic Chemistry-II	4	0	0	04	03 hrs	20	80	100
CHL-504	Physical Chemistry-II	4	0	0	04	03 hrs	20	80	100
CHL-506	Organic Chemistry-II	4	0	0	04	03 hrs	20	80	100
CHL-508	Environmental Chemistry-I	3	0	0	03	03 hrs	15	60	75
CHP-510	Inorganic Chemistry Practical-II	0	0	6	03	03 hrs	15	60	75
CHP-512	Physical Chemistry Practical-II	0	0	6	03	03 hrs	15	60	75
CHP-514	Organic Chemistry Practical-II	0	0	6	03	03 hrs	15	60	75
CHP-516	Seminar-II	0	0	2	01	-	25	-	25
Total		15	0	20	25		145	480	625

Note:

- Core papers are mandatory for M.Sc. 2nd semester students.
- Maximum marks of M.Sc. 2nd semester will be 625 (Theory 480; Practical 145)
- Each theory paper will include 20% marks as internal assessment as per University rules.
- Each practical examination will be of 06 hours and will be conducted in two sessions (Morning & Evening) of 03 hours each.
- Practical marks will include 10% marks for viva-voce and 10% for record files.
- The payment to the internal as well as external examiners will be made on the basis of Sessions.
- The assessment of Seminar-II will be done during the semester on the basis of presentation given by the student in front of department seminar committees notified by the Chairperson time to time.
- Total Credits = 25.

B.P.S. Mahila Vishwavidyalaya, Khanpur Kalan, Sonepat (Haryana)
M.Sc. Chemistry (Two year Course) with
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Effective from Session 2022-23
Semester - III

Code	Nomenclature	Contact Hours			Credits	Duration of Exam	Examination Scheme		
		L	T	P			Internal Marks	External Marks	Total Marks
CHL-601	Inorganic Special-I	4	0	0	04	3 hrs	20	80	100
CHL-603	Physical Special-I	4	0	0	04	3 hrs	20	80	100
CHL-605	Organic Special-I	4	0	0	04	3 hrs	20	80	100
CHL-607	Inorganic Special-II	4	0	0	04	3 hrs	20	80	100
CHL-609	Physical Special-II	4	0	0	04	3 hrs	20	80	100
CHL-611	Organic Special-II	4	0	0	04	3 hrs	20	80	100
CHL-613	Inorganic Special-III	4	0	0	04	3 hrs	20	80	100
CHL-615	Physical Special-III	4	0	0	04	3 hrs	20	80	100
CHL-617	Organic Special-III	4	0	0	04	3 hrs	20	80	100
CHP-601	Inorganic Special Practical-I	0	0	6	03	3 hrs	15	60	75
CHP-603	Physical Special Practical-I	0	0	6	03	3 hrs	15	60	75
CHP-605	Organic Special Practical-I	0	0	6	03	3 hrs	15	60	75
CHP-607	Inorganic Special Practical-II	0	0	6	03	3 hrs	15	60	75
CHP-609	Physical Special Practical-II	0	0	6	03	3 hrs	15	60	75
CHP-611	Organic Special Practical-II	0	0	6	03	3 hrs	15	60	75
CHP-613	Inorganic Special Practical- III	0	0	6	03	3 hrs	15	60	75
CHP-615	Physical Special Practical-III	0	0	6	03	3 hrs	15	60	75
CHP-617	Organic Special Practical-III	0	0	6	03	3 hrs	15	60	75
CHP-619	Seminar-III	0	0	2	01	-	25	-	25
	Open Elective-I	4	0	0	04	3 hrs	20	80	100
Total		16	0	20	26		150	500	650

Note:

- CHL-601, 603, 605, 607, 609, 611, 613, 615 and CHL-617 are core papers.
- CHP-601, 603, 605, 607, 609, 611, 613, 615 and CHP-617 are Discipline Specific papers.
- Candidate has to opt three core & three Discipline Specific papers from the same series i.e. CHL-601, 607, 613 or CHL-603, 609, 615 or CHL-605, 611, 617; and CHP-601, 607, 613 or CHP-603, 609, 615 or CHP-605, 611, 617.
- Maximum marks of M.Sc. 3rd semester will be 650 (Theory 500; Practical 150)
- Each theory paper will include 20% marks as internal assessment as per University rules.
- Each practical examination will be of 06 hours and will be conducted in two sessions (Morning & Evening) of 03 hours each.
- Practical marks will include 10% marks for viva-voce and 10% for record files.
- The payment to the internal as well as external examiners will be made on the basis of sessions.
- Open Elective-I (OE)/CBCS to be chosen from the list of electives provided by the university.
- The assessment of Seminar-III will be done on the basis of presentation given by the student in front of department seminar committees notified by the chairperson time to time.
- The students will opt. any one specialization which will be continued in IV Semester as well.
- Total Credits = 26

B.P.S. MahilaVishwavidyalaya, KhanpurKalan, Sonepat (Haryana)
M.Sc. Chemistry (Two year Course) with
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Effective from Session 2022-23
Semester - IV

Code	Nomenclature	Contact Hours			Credits	Duration of Exam	Examination Scheme		
		L	T	P			Internal Marks	External Marks	Total Marks
CHL-602	Inorganic Special-IV	4	0	0	04	03 hrs	20	80	100
CHL-604	Physical Special-IV	4	0	0	04	03 hrs	20	80	100
CHL-606	Organic Special-IV	4	0	0	04	03 hrs	20	80	100
CHL-608	Inorganic Special-V	4	0	0	04	03 hrs	20	80	100
CHL-610	Physical Special-V	4	0	0	04	03 hrs	20	80	100
CHL-612	Organic Special-V	4	0	0	04	03 hrs	20	80	100
CHL-614	Inorganic Special-VI	4	0	0	04	03 hrs	20	80	100
CHL-616	Physical Special-VI	4	0	0	04	03 hrs	20	80	100
CHL-618	Organic Special-VI	4	0	0	04	03 hrs	20	80	100
CHP-602	Inorganic Special Practical-IV	0	0	6	03	03 hrs	15	60	75
CHP-604	Physical Special Practical- IV	0	0	6	03	03 hrs	15	60	75
CHP-606	Organic Special Practical- IV	0	0	6	03	03 hrs	15	60	75
CHP-608	Inorganic Special Practical-V	0	0	6	03	03 hrs	15	60	75
CHP-610	Physical Special Practical- V	0	0	6	03	03 hrs	15	60	75
CHP-612	Organic Special Practical- V	0	0	6	03	03 hrs	15	60	75
CHP-614	Inorganic Special Practical-VI	0	0	6	03	03 hrs	15	60	75
CHP-616	Physical Special Practical- VI	0	0	6	03	03 hrs	15	60	75
CHP-618	Organic Special Practical- VI	0	0	6	03	03 hrs	15	60	75
CHL-620	Environmental Chemistry-II	3	0	0	03	03 hrs	15	60	75
CHP-622	Seminar-IV	0	0	2	01	-	25	-	25
	Open Elective-II	4	0	0	04	3 hrs	20	80	100
Total		20	0	20	29	-	165	560	725

Note:

- CHL-602, 604, 606, 608, 610, 612, 614 and CHL-618 are core papers.
- CHP-602, 604, 606, 608, 610, 612, 614 and CHP-618 are Discipline Specific papers.
- Candidate has to opt three core and three Discipline Specific core papers from the same series i.e. CHL-602, 608, 614 or CHL-604, 610, 616 or CHL-606, 612, 618; and CHP-602, 608, 614 or CHPL-604, 610, 616 or CHP-606, 612, 618
- Maximum marks of M.Sc. 4th semester will be 725 (Theory 560; Practical 165)
- Each theory paper will include 20% marks as internal assessment as per University rules.
- Each practical examination will be of 06 hours and will be conducted in two sessions (Morning & Evening) of 03 hours each.
- Practical marks will include 10% marks for viva-voce and 10% for record files.
- Open Elective-II (OE)/CBCS to be chosen from the list of electives provided by the university.
- The assessment of Seminar-IV will be done during the semester on the basis of presentation given by the student in front of department seminar committees notified by the Chairperson time to time.
- The payment to the internal as well as external examiners will be made on the basis of sessions.
- Total Credits: 29.

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M.sc. Chemistry

Programme outcomes

1. The students will obtain good knowledge in Chemical Sciences. They will be trained to compete national level tests like UGC-CSIR NET, JEST, GATE, etc., successfully.
2. They will be prepared to take up challenges as globally competitive chemist /researchers in diverse areas of theoretical and experimental chemistry.
3. They will be technically and analytically skilled enough to pursue their further studies.
4. They will have a sense of academic and social ethics.
5. They will be capable of taking up higher studies of interdisciplinary nature.
6. They will be able to recognize the need for continuous learning and develop throughout for the professional career.

Program specific outcomes

PSO1 Understand nature of bonding and hybridization of compounds.
PSO2 Analyze the reaction mechanism and structure of transition metal complexes.
PSO3 Understand the quantum mechanics, thermodynamics and Electrochemistry.
PSO4 Analyze the bonding and stereochemistry of organic molecules.
PSO5 Understand the various instrumental techniques for structural study of the Compounds.
PSO6 Perform thermodynamic and surface studies of the liquid mixtures.
PSO7 Understand nuclear, radio analytical techniques and corrosion technology.
PSO8 Analyze the bioorganic, bioinorganic chemistry and heterocyclic chemistry and their applications.

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M. sc. Chemistry 1st Semester
Inorganic Chemistry-I

Paper Code: - CHL-501 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Explain bonding in main group compounds
CO2 Predict the shapes and determine the energetic of hybridization of main group compounds
CO3 Explain mechanisms of ligand displacement reactions in octahedral and square planar complexes
CO4 Understand the structures and properties of isopoly and heteropoly acids and salts
CO5 Explain crystal structures of selected binary and ternary compounds

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

Stereochemistry and Bonding in Main Group compounds: VSEPR theory, dπ-pπbonds, Bent rule and energetic of hybridization.

Metal-Ligand Equilibria in solution

Stepwise and overall formation constants and their interactions, trends in stepwise constants, factors affecting stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry.

Unit-2

Reaction Mechanism of Transition Metal Complexes-I

Inert and labile complexes, Mechanisms for ligand replacement reactions, Formation of complexes from aquo ions, Ligand displacement reactions in octahedral complexes- acid hydrolysis, Base hydrolysis, racemization of tris chelate complexes, electrophilic attack on ligands.

Unit-3

Reaction Mechanism of Transition Metal Complexes-II

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

Unit-4

Isopoly and Heteropoly Acids and Salts

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

Crystal Structures

Structures of some binary and ternary compounds such as fluorite, antifluorite, rutile, antirutile, crystobalite, layer lattices- Cd I_2, Bi I_3; Re O_3, Mn_2O_3, corundum, pervoskite, Ilmeniteand Calcite.

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Books Recommended:

1. Concise Inorganic Chemistry – J.D. Lee
2. Inorganic Chemistry – T.Moeller.
3. Modern Aspects of Inorganic Chemistry – H.J. Emeleus& A.G.Sharpe.
4. Introduction to ligand field – B.N. Figgis.
5. Chemical bonding – O.P.Agarwal.
6. Inorganic Reaction Mechanism –Edberg.
7. Inorganic Reactin Mechanism – BasoloPearson.
8. Structural Principles in Inorganic Compounds – W. E.Addison.

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M.sc. Chemistry 1st Semester
Physical Chemistry-I

Paper Code :- CHL-503 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Various concepts of quantum mechanics & wave mechanics

CO2 Detailed application and need of first, second law of thermodynamics

CO3 Detailed discussion on Debye Huckel theory for Solutions.

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit

Unit-1

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

Unit-2

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

Unit-3

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

Unit-4

Electrochemistry:

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

Debye - Huckel -Onsager treatment for aqueous solutions and its limitations. Debye-Huckel- Onsager theory for non-aqueous solutions, the solvent effect on the mobality at infinite dilution, equivalent conductivity vs. concentration $\sqrt{c}$ as a function of the solvent, effect of ion association upon conductivity (Debye- Huckel - Bjerrum equation).

Books Recommended:

1. Thermodynamics for chemists byS.Glasstone.
2. Physical Chemistry by G.M.Barrow
3. Thermodymaics by R.C. Srivastava, S.K. Saha&A.K.Jain
4. Modern electrochemistry Vol.1 by J.O.M. Bockris and A.K.N.Reddy

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5. Chemical Kinetics by K.J.Laidler
6. Kinetics & Mechanism of reaction rates by A.Frost & G.Pearson
7. Modern chemical kinetics by H.Eyring
8. Theories of reaction rates by K.J. laidler, H.Eyring& S.Glasstone.
9. Theoretical Chemistry by S.Glasstone.
10. Introduction to Quantum Mechanics by R.Chandra.

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M. sc. Chemistry 1st Semester
Organic Chemistry-I

Paper Code :- CHL-505 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Differentiate chiral and achiral molecules.
CO2 Know the relationship between enantiomers and their specific rotations.
CO3 Differentiate simple synthesis and asymmetric synthesis of organic molecules.
CO4 Analyze the structure of carbohydrates, natural and Synthetic Dyes.

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

Nature of Bonding in Organic molecules: Delocalized chemical bonding –conjugation, cross conjugation, resonance, hyperconjugation ,tautomerism. Aromaticity in benzenoid and non- benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule, energy level of
-molecular orbitals, annulenes, antiaromaticity, homo-aromaticity, PMO approach. Bonds weaker than covalent, addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, catenanes and rotaxanes

Unit-2

Stereochemistry : Chirality, elements of symmetry, molecules with more than one chiral centre, diastereomerism. Determination of relative and absolute configuration (octant rule excluded) with special reference to lactic acid, alanine & mandelic acid. Methods of resolution, optical purity, prochirality, enantiotopic and diastereotopic atoms, groups and faces, asymmetric synthesis, cram's rule and its modifications, prelog's rule, conformational analysis of cycloalkanes (upto six membered rings), decalins, conformations of sugars, optical activity in absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape, geometrical isomerism in alkenes and oximes, methods of determining the configuration.

Unit-3

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

Unit-4

Carbohydrates: Types of naturally occurring sugars, Deoxy sugars, amino sugars, branch chain sugars, general methods of determination of structure and ring size of sugars with particular reference to maltose, lactose, sucrose, starch and cellulose.
Natural and Synthetic Dyes: Various classes of synthetic dyes including heterocyclic dyes, interaction between dyes and fibers, Structure elucidation of indigo and Alizarin.

Books Recommended:

1. Advanced Organic Chemistry- Reactions Mechanism and Structure by JerryMarch.
2. A guide Book to Mechanism in Organic Chemistry by PeterSykes.
3. Organic Chemistry by R.T. Morrison andR.N.Boyd.

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4. Reaction Mechanism in Organic Chemistry by S.M. Mukherji and S.P.Singh.
5. Stereochemistry of Organic Compounds by D.Nasipuri.
6. Stereochemistry of Organic Compounds by P.S.Kalsi.
7. Carbohydrate by S.P.Bhutani.
8. Organic Chemistry by I.L.Finar.

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M. sc. Chemistry 1st Semester
General Spectroscopy

Paper Code :- CHL-507 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Study the spectra of compounds and propose structure for compounds
CO2 Detailed study of principles and application of UV,IR and NMR spectroscopy.

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

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

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

Unit-2

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

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

Unit-3

Electronic Absorption Spectroscopy: Energy levels in diatomic molecules, introduction to electronic transition, Assignment of transitions, Spectra of transition metal complexes, Orgel diagrams

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

Unit-4

NMR Spectra:- Spin active nuclei, chemical shift, shielding and deshielding, internal standards, spin-spin coupling, equivalent and non- Equivalent Protons, effect of changing solvents and hydrogen bonding on chemical shifts, anisotropic effect. Principles and Applications of UV, IR and NMR Spectra in the structure elucidation of Organic Compounds.

Book Recommended

1. Physical Methods in Inorganic Chemistry- R.S.Drago.
2. Infrared Spectra of Inorganic and Coordination Compound- K.Nakamoto.
3. Fundamentals of MoleculesSpectroscopy-C.N.Banwel.
4. Introduction to Magnetic Resonance Spectroscopy ESR, NMR,NRR-D.N. Sathyanaraya

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M. sc. Chemistry 1st Semester
Inorganic Chemistry Practical -I

Paper Code :- CHP-509 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Determine iodide, Hydrazine and Antimony (III) using Potassium Iodide
CO2 Determine Antimony (III), Aluminum, Magnesium and Zinc using Potassium bromated
CO3 Determine Calcium, Copper and Barium using EDTA (forward and back titrations)
CO4 Determine strengths of metal ions in the presence of masking agents
CO5 Synthesize selected metal acetylacetonato complexes employing green methods

1. Volumetric Analysis

(a) Potassium iodide titrations

Determination of iodide, hydrazine and antimony (III)

(b) Potassium bromate titrations

(i) Determination of antimony (III) (by Direct Method)
(ii) Determination of aluminium, Magnesium and zinc (by Oxine method)

(c) EDTA titrations

(i) Determination of calcium, copper, barium.
(ii) Back titration
(iii) Titration of mixtures using masking

2. Green methods of Preparation of the following

(i) Bis(acetylacetonato)copper(II)
(ii) Tris(acetylacetonato) iron(III)
(iii) Tris(acetylacetonato) managanese(III)

3. Viva-Voce (6 Marks)
4 Note Book (6 Marks)

Note:
1. New experiment(s) related to the theory paper syllabus can also be performed in addition to the above list of experiments.
2. Depending on the availability of chemicals/instruments etc., any similar experiment can also be performed as substitute from the above list.

Books Recommended

a. A text Book of Quantitative Inorganic Analysis: A.I.Vogel.
b. Applied Analytical Chemistry: O.P.Vermani.

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M. sc. Chemistry 1st Semester
Physical Chemistry Practical -I

Paper Code :- CHP-511 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Describe various conduct metric titrations of Strong acid/Strong base, Weak acid /Weak base , Strong acid/Weak base and weak acid/Strong base.
CO2 Describe application of thermo chemistry in determination of heat of neutralization.
CO3 Know the handling of instruments such as refract meter.

1. Condutometry

(i) To determine cell constant of conductivity cell.
(ii) NaOH vs. HCl titration.
(iii) NaOH vs. Oxalic acid titration.
(iv) NaOH vs CH_3 COOH titration
(v) $Ba(NO_3)_2$ vs. Na_2 SO_4 titration

2. Thermochemistry

Determination of heat of neutralization of the followings:-

(i) NaOH vs.Hcl
(ii) NaOH vs. CH_3COOH
(iii) NaOH vs. Oxalicacid.

3. Refractometry

(i) To determine molar refractivity of the givenliquid.
(ii) To determine percentage composition of liquids in the given binarymixture.
(iii) To determine concentration of sugar in a givensolution.

4 Surfacetension

To determine interfacial tension of two immiscible liquids.

5. Adsorption

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

Viva Voce (6 Marks)

Practical Note Book (6 Marks)

Note- Department can opt any other similar experiment depending upon the material available.

Book Recommended

1. Senior practical physical chemistry: B.D. Khosla, V.C. Garg and A.Khosla.
2. Experimental Physical Chemistry: A Thawale and P.Mathur.
3. Practical Physical Chemistry: B. Vishwanatha and P. SRaghav
4. Practical in Physical Chemistry: P.S.Sindhu.

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M. sc. Chemistry 1st Semester
Organic Chemistry Practical -I

Paper Code :- CHP-513 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Demonstrate knowledge of separation of organic compounds from binary mixture
CO2 Recognize different types of procedures for separation , identification and purification of Organic compounds
CO3 Apply basic chemical concepts to write the mechanism of the derivatives.
CO4 Describe different methods for separation of mixtures.

Quantitative Analysis.

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

1. Viva-Voce (6 Marks)
2. Note Book (6 Marks

Note- Department can opt any other similar experiment depending upon the material available.

Books Recommended

1. Experiments and Techniques in Organic Chemistry, by D. Pasto, C. Johnson and M.Miller.
2. Macroscale and Microscale Organic Experiments by K. L. Williamson, & D.C.Heath.
3. Systematic Qualitative Organic Analysis by H. Middleton.
4. Handbook of Organic Analysis-Qualitative and Quantitative by H.Clark.
5. Vogel's Textbook of Practical Organic Chemistry by A. R.Tatchell

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M. sc. Chemistry 1st Semester
Computer for Chemists

Paper Code: - CHL-515 **External marks:- 40**
Duration:- 2 Hours **Internal Marks:- 10**
Total Marks:- 50

CO1 Recognize the different parts of the computer and their functioning,
CO2 Describe the computer applications in different fields.
CO3 The problem identifications and their solutions by flow charts and decision tables.

Note:-Examiner will set eight questions and the candidates will be required to attempt five questions in all. All questions will carry equal marks.

Essentials of Computer: Historical Evolution of Computers, Block diagram of a Computer and functions of various units; Classification of Computers; Input/ Output devices (Display Devices, Printers, etc.) Memories: RAM, ROM, Cache Memory, Virtual memory; Mass-storage Media: Magnetic Disks, Magnetic Tapes and Optical Disks; Batch processing systems, Time sharing systems, Multiprocessor, Parallel Processing Systems.

Introduction to Programming languages: 1 GL to 5 GL languages. Software and its types; Operating System with DOS as an example, Introduction to UNIX and Windows.

Overview of Information Technology (IT): Data Communication, Computer Networks (LAN, WAN and MAN and their applications, Introduction to Internet and Intranet technology.

Computer Applications: Scientific, Business, Research, Sports, Medicine & Health Care, Engineering, Teaching etc.

Problem Solving: Problem Identification, Analysis, flowcharts, Decision Tables, Pseudo codes and algorithms, Program Coding, Program Testing and Execution.

Books Suggested

1 Computers and Common Sense, R. Hunt and J. Shelley, Prentice Hall.
2 Computational Chemistry, A.C. Norris.
3 Microcomputer Quantum Mechanics, J.P. Killngbeck,Adam Hilger.

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M. sc. Chemistry 2nd Semester
Inorganic Chemistry-II

Paper Code :- CHL-502 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Explain bonding in transition metal complexes.
CO2 Spectroscopic states from spectroscopic terms and Interpret Orgel and Tanabe-Sugano diagrams.
CO3 Explain electronic spectra of complexes.
CO4 Apply fundamentals of magneto chemistry in structure determination.
CO5 Explain structure and bonding in selected metal clusters and transition metal complex

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

Metal-Ligand Bonding

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

Unit-2

Electronic Spectra of Transition Metal Complexes

Spectroscopic ground states, correlation and spin-orbit coupling in free ions for Ist series of transition metals, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1 – d^9 states) calculation of Dq, B and β parameters, effect of distortion on the d-orbital energy levels. Structural evidence from electronic spectrum, John-Tellar effect, Spectrochemical and nephalauxetic series, charge transfer spectra, electronic spectra of molecular addition compounds.

Unit-3

Magantic Properties of transition metal complexes :-

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

Metal Clusters:-

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

Unit-4

Metal -∏ Complexes

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

Books Recommended:

1. Advanced Inorganic Chemistry – F.A. Cotton & G.Wilkinson.
2. Inorganic Chemistry: Principles of Structure & reactivity – J.E.Huheey.
3. Chemistry of the Elements – N.N. Greenwood & A.Earnshaw.

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4. Concise Co-ordination Chemistry – R. Gopalan& R.Ramalingam.
5. Magneto Chemistry – R.L.Carlin.
6. Concise Inorganic Chemistry – J.D. Lee.
7. Introduction to Magneto Chemistry – A.Earnshasw

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M. sc. Chemistry 2nd Semester
Physical Chemistry-II

Paper Code :- CHL-504 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Various concepts of quantum mechanics and their applications.

CO2 Detailed application of third law of thermodynamics and systems of one component as well as multi-component systems

CO3 Mechanism and further studies in chain reactions

CO4 Ion transport in solutions

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

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

Unit-2

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

Unit-3

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

Unit-4

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

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Books Recommended:

1. Thermodynamics for chemists byS.Glasstone.
2. Physical Chemistry by G.M.Barrow
3. Thermodymaics by R.C. Srivastava, S.K. Saha&A.K.Jain
4. Modern electrochemistry Vol.1 by J.O.M. Bockris and A.K.N.Reddy
5. Chemical Kinetics by K.J.Laidler
6. Kinetics & Mechanism of reaction rates by A.Frost&G.Pearson
7. Modern chemical kinetics byH.Eyring
8. Theories of reaction rates by K.J. laidler, H.Eyring& S.Glasstone.
9. Theoretical Chemistry by S.Glasstone

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M. sc. Chemistry 2nd Semester
Organic Chemistry-II

Paper Code :- CHL-506 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Identify and differentiate the aromatic and aliphatic nucleophillic substitution reactions
CO2 Be able to understand all different kind of mechanisms given by different compounds
CO3 Know about the regio and chemo selectivity, and different type of elimination and addition reactions
CO4 Develop capacity to solve the organic reaction mechanism related problems.
CO5 Develop a clear understanding about the reactions for addition to the carbon-carbon and carbon-hetero bond.

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

Aliphatic Nucleophilic Substtitution: The SN2, SN1, mixed SN1 and SN2, SNi , SN1', SN2', SNi' and SET mechanisms. The neighbouring group mechanisms, neighbouring group participation by sigm and pi bonds,anchieric assistance.Classical and non-classical carbocations, phenonium ions, common carbocation rearrangements. Applications of NMR spectroscopy in the detection of carbocations. Reactivity- effects of substrate structure, attacking nucleophile, leaving group and reaction medium..Ambident nucleophiles and regioselectivity. Phase transfer catalysis.

Unit-2

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

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

Aromatic Nucleophilic Substitution: The ArSN1, ArSN2, Benzyne and SRN1 mechanisms. Reactivity – effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.

Unit-3

Elimination Reactions: The E2, E1 and E1cB mechanisms . Orientation of the double bond . Reactivity –effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination.

Addition to Carbon-Carbon Multiple Bonds: Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio – and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring.

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

Unit-4

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

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Books Recommended:

1. Advanced Organic Chemistry -Reactions, Mechanism and Structure by JerryMarch.
2. Advanced Organic Chemistry by F.A. Carey and R.J.Sundberg.
3. A Guide Book to Mechanism in Organic Chemistry by PeterSykes.
4. Structure and Mechanism in Organic Chemistry by C.K.Ingold.
5. Organic Chemistry by R.T. Morrison and R.N.Boyd.
6. Modern Organic Reactions by H.O. House.
7. Principles of Organic Synthesis by R.O.C. Norman and J.M.Coxon.
8. Reaction Mechanism in Organic Chemistry by S.M. Mukherji and S.P.Singh.

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M. sc. Chemistry 2nd Semester
Environmental Chemistry-II

Paper Code :- CHL-508 **External marks:- 60**
Duration:- 3 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 To know about the composition and importance of the atmosphere
CO2 To learn about the importance, sources and treatment of water
CO3 To learn about the formation and importance of soil

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

Introduction - Concept and Scope of Environmental Chemistry, Major environmental segments. Natural cycles of the environment - Hydrological cycle, Carbon cycle, Oxygen cycle, Nitrogen cycle, Phosphorous cycle and Sulphur cycle. **Atmosphere:** Atmosphere, composition of the atmosphere, particulates, ions, radicals and their formation, air pollution: oxides of C,N,S and their effects, acid-rain, smog formation, Green house effects (global warming), ozone layer depletion and its consequences. air quality standards.

Unit-2

Hydrosphere: Water resources, global distribution of water, importance of water, water pollution-inorganic, organic pesticides, industrial and radioactive materials, oil spills and oil pollutants and eutrophication, types of waste water treatment, domestic and industrial waste water treatment

Unit-3

Lithosphere: Weathering of rocks- physical, chemical and biological processes. Factors controlling the formation of soil, soil profile, composition of soil, water and air in soil, Micro and macro nutrients, Agricultural practices and soil pollution.

Unit-4

Environmental Toxicology: Toxic chemicals in the environment, solutions to environmental problems, Bhopal gas tragedy, Chernobyl, Three Mile Island, Sewoso and Minamata disasters.

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

Note: The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Books Recommended

1. Environmental Chemistry- A.K.De
2. Environmental Chemistry –Manaham
3. Environmental Pollution Analysis-Khopkar
4. Environmental Chemistry, Sharma &Kaur.
5. Standard Method of Chemical analysis, F.J. Welcher vol.III
6. Environmental Toxicology, Ed.J.Rose.
7. Elemental Analysis of Airborne particles, Ed. S. Landsberger and M-Creatchman.
8. Environmental Chemistry, C. Baird.

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M. sc. Chemistry 2nd Semester
Inorganic Chemistry Practical -II

Paper Code :- CHP-510 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Separate and determine binary mixtures of metal ions using gravimetric and volumetric methods
CO2 Determine strengths of Ferrous, Oxalate and Nitrite ions using Cerimetry

1. Quantitative Inorganic Analysis

Separation and determination of two metal ions such as

i) Silver- Copper,
ii) Copper-Nickel,
iii) Copper-Zinc,
iv) Nickel-Zinc,
v) Copper-Iron Involving volumetric and gravimetric methods.

b) Determination by Cerimetry

i) Ferrous,
ii) Oxalate,
iii) Nitrite

2. Viva-Voce (6 Marks)

3. Note Book (6 Marks)

Note- Department can opt any other similar experiment depending upon the material available.

Books Recommended

1. A text Book of Quantitative Inorganic Analysis: A.I.Vogel.
2. Applied Analytical Chemistry: O.P. Vermani.

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M. sc. Chemistry 2nd Semester
Physical Chemistry Practical -II

Paper Code :- CHP-512 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1	Describe various potentiometric titrations of Strong acid/Strong base and Weak acids /Strong base etc.
CO2	Describe the concept of pH through working of instrument like pH meter.
CO3	Determine partition coefficient and equilibrium constant of various systems.

1. Potentionmetry

(i) NaOH vs. HCl titration.
(ii) NaOH vs. Oxalic acid titration.
(iii) NaOH vs. CH_3 COOH titration.

2. pH metry

(i) NaOH Vs. HCl titration.
(ii) NaOHvs Oxalic acid titration.
(iii) NaOH vs. CH_3COOH titration.

3. Chemical Kinetics

(i) To study kinetics of hydrolysis of ester in the presence of acid.
(ii) To compare the relative strength of acids (HCl and H_2SO_4).

4. Distribution Law

(i) To determine partition coefficient of benzoic acid between benzene and water.
(ii) To determine partition coefficient of Iodine between Carbontetrachloride and water.
(iii) Determination of Equilibrium constant for $I_2 + I^- = I_3$

Viva Voce (6 Marks)

Practical Note Book (6 Marks)

Note- Department can opt any other similar experiment depending upon the material available.

Book Recommended

1. Senior practical physical chemistry: B.D. Khosla, V.C. Garg and A.Khosla.
2. Experimental Physical Chemistry: A Thawale and P.Mathur.
3. Practical Physical Chemistry: B. Vishwanatha and P. SRaghav
4. Practical in Physical Chemistry: P.S.Sindhu.

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M. sc. Chemistry 2nd Semester
Organic Chemistry Practical -II

Paper Code :- CHP-514 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Handle organic chemicals in a safe and competent manner.
CO2 Perform the standard techniques used in practical organic chemistry.
CO3 Carry out multistep synthesis of organic compounds following a prescribed procedure.
CO4 To develop skills to determine the mechanism of the performed practical's.

1. Organic Synthesis and checking purity of samples prepared.
Two Step preparations.

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

2. Viva-Voce (6 marks)

3. Note Book (6 marks)

Note- Department can opt any other similar experiment depending upon the material available.

Books Recommended

1 Experiments and Techniques in Organic Chemistry by D. Pasto, C. Johnson andM. Miller.
2 Macroscale and Microscale Organic Experiments by K. L. Williamson and D.C.Heath.
3 Systematic Qualitative Organic Analysis by H.Middleton.
4 Handbook of Organic Analysis-Qualitative and Quantitative by H.Clark
5 Vogel' s Textbook of Practical Organic Chemistry by A. R.Tatchell.

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M. Sc. Chemistry 3rd Semester
Inorganic Special-I

Paper Code :- CHL-601 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Identify and characterize the molecule on the basis of spectroscopic study.

CO2 Apply vibrational spectroscopy to identify modes of bonding of ambidentate ligand.

CO3 Apply ESR in transitional metals with unpaired electrons.

CO4 Find application of mass, Mossbauer, NMR and NQR spectroscopy in various fields..

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

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

Unit-2

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

Unit-3

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

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

Unit-4

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- $Pt(Pet_3)_2$ Cl_2, Application of ^{31}P NMR for structural determination of Complexes with phosphorus ligands.

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

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

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

Nuclear Quadrupole Transitions- Axially symmetric and Non-symmetric Molecules. Effect of an External magnetic field Application-(i) Chemical bonding and Structure

(ii) Solid state Effects.

(iii) Hydrogen Bonding. Experimental aspects

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Books Recommended:

1. Vibrational Spectrosocpy – D.N.Sathyanarayana.
2. Introduction to Magnetic Resonace Spectroscopy ESR, NMR, NQR - D.N. Sathyanarayana.
3. Physical methods in Inorganic Chemistry – Russel S.Drago.
4. Infrared & Raman Spectra of Inorganic & Co-ordination compounds – K.Nakamoto.
5. Inorganic Infrared & Raman Spectra – S.D. Ross.

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M. Sc. Chemistry 3rdSemester
Physical Special-I

Paper Code :- CHL-603 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Thermodynamics of electrified interfaces
CO2 Models of simple ionic liquids & lattice oriented models
CO3 Gibb's adsorption equation and its applications
CO4 Method for the calculation of energy of activation

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

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

Unit-2

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

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

Unit-3

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

Unit-4

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

Books Recommended:

1. Modern electrochemistry Vol.1& 2 by J.O.M. Bockris and A.K.N.Reddy
2. Chemical Kinetics by K.J.Laidler
3. Kinetics & Mechanism of reaction rates by A.Frost&G.Pearson
4. Theories of reaction rates by K.J. laidler, H.Eyring& S.Glasstone.
5. Electrochemistry byS.Glasstone.

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M. Sc. Chemistry 3rd Semester

Organic Special-I

Paper Code :- CHL-605 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Determine functional groups and write structures.

CO2 Study the spectra of compounds and propose structures for compounds.

CO3 Elucidate the structures of organic molecules from spectral data.

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

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

Unit-2

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

Unit-3

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

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

Unit-4

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Mass Spectroscopy :Introduction – basic theory , instrumentation, process of introducing the sample into mass spectrometer. Methods of generation of positively charged ions, electron ionization method , chemical ionization, FD and fast atom bombardment (FAB) techniques. Mass spectrum, base peak, molecular and parent ion, Mass to charge

ratio (M/Z), relative intensity, fragment ions, even electron rule, nitrogen rule, mata stable ions, McLafferty rearrangement and ortho effect.Determination of molecular weight and molecular formula using mass spectrometry.Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD):Definition, haloketone rule, octant rule for ketones. Cotton effect and Cotton curves, deduction of absolute configuration.

Books Recommended:

1. Spectroscopic Identification of Organic Compounds by R.M. Silverstein, G.C.Bassler and T.C.Morrill.
2. Introduction to NMR Spectroscopy by R.J. Abraham, J.Fisher andP.Loftus.
3. Applications of Spectroscopy of Organic Compounds by J.R.Dyer.
4. Spectroscopic Methods in Organic Chemistry by D.H. Williams andI.Fleming.
5. Organic Spectroscopy by Jagmohan.

Organic Spectroscopy by W.Kemp and Organic Spectroscopy byPavia.

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M. Sc. Chemistry 3rd Semester
Inorganic Special-II (Nuclear and Radiochemistry)

Paper Code :- CHL-607 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Explain origin of nuclear energy and decay of unstable nuclei
CO2 Explain structure of the nucleus based on experimental evidence
CO3 Discuss the impact of radiation on matter
CO4 Describe various methods of detecting nuclear radiation
CO5 Explain types and mechanism of nuclear reactions

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

Nuclear Binding Energy: Justifications and applications; nuclear stability rules and decay of unstable nuclei.
Nuclear Structure: Nuclear forces; liquid drop model, Shell Model and collective model.

Unit-2

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

Radiochemical Techniques: **NAA -Principle, Application and Limitation**
IDA-Principle, Application and Limitation,Radiometric titrations.

Unit-3

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

Unit-4

Nuclear Reactions: Energetics of nuclear reactions; various types of nuclear reactions including photonuclear, thermonuclear and spallation reactions; mechanism of nuclear reaction by compound nucleus model.
Nuclear fission – Fission probability; energy release; theories of fission.

Nuclear Fussion: Brief idea about breeder reactors; accelerators and cyclotron.

Books Recommended:

1. Essentials of Nuclear Chemistry – H. J.Arnikar.
2. Radio Chemistry & Nuclear Chemistry – G.Choppin, J.O. Liljenzin&J.Rydberg.
3. Nuclear Chemistry – M.Sharon.
4. Modern Nuclear Chemistry – W.D. Loveland, D.J. Morrissey & G.T.Seaborg.
5. Handbook of Nuclear Chemistry: Instrumentation, Separation Techniques, Environmental issues – A. Vertes, S. Nagy & Z.Klencsar.

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M. Sc. Chemistry 3rd Semester
Physical Special-II

Paper Code :- CHL-609 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Computing entropy by counting the number of allowed states for simple systems such as the ideal gas.

CO2 Identifying the relationship and correct usage of infinitesimal work, work, energy, heat Capacity, specific heat, latent heat, and enthalpy.

CO3 Explaining quantum mechanical treatment of Helium atom.

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

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

Unit-2

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

Unit-3

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

Unit-4

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

Books Recommended:

1. Theoretical chemistry by S.Glasstone
2. Quantum chemistry byLevinine
3. Quantum chemistry by Pauling, Eyring&Wilson
4. Introduction to Statistical Mechanics by L.K.Nash.

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M. Sc. Chemistry 3rd Semester
Organic Special-II

Paper Code :- CHL-611 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Able to know the determine of structure and synthesis of given vitamins.
CO2 Know the importance and route for the synthesis of given carotene and porphyrins.
CO3 Have a clear understanding about the biological importance and types of enzymes and coenzymes.

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

Vitamins
Structure and synthesis of vitamins A, B_1, B_2, B_6, C, D, E, nicotinic acid, pantothenic acid and Biotin

Unit-2

Carotenoids:
General methods of structure elucidation and synthesis of carotene, -carotene, lycopene, and carotene.
Biosynthesis of carotenoids
Porphyrins:
Structure , spectral properties and synthesis of Porphyrins and Haemin. Structure of chlorophyll (without synthesis)

Unit-3

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

Unit-4

Enzymes and co-enzymes:
Introduction to biological catalysis, nomenclature, classification and specificity.
Kind of reaction catalysed by enzymes: Oxidation – reduction, isomerisation, epimerisation, hydrolysis, phosphorylation, acylation, methylation, decarboxylation and dehydration.
Co-enzymes: Chemistry of Co-enzymes; Co-I, Co-II, Co-A, Co-carboxylase, FMN, FAD and Pyridoxal phosphate
Books Recommended:

1. Bioinorganic Chemistry: A Chemical Approach to Enzyme Action by Herman Duags and C.Penny.
2. Understanding Enzymes by TrevorPalmer
3. Enzyme Chemistry, Impact and Applications by Ed. Collin J.Suckling.
4. Enzyme Mechanisms Ed, M.I. Page and A.Williams
5. Fundamentals of Enzymology by N.C. Price and L.Stevens.
6. The Chemistry of Natural products by P.S.Kalsi.
7. Organic Chemistry by I.L.Finar.

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M. Sc. Chemistry 3rd Semester
Inorganic Special-III
(Bio-Inorganic Chemistry and Environmental Chemistry)

Paper Code :- CHL-613 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Identify essential and trace elements found in nature and describe their function
CO2 Explain how metal ions contribute to functioning of vital biological systems
CO3 Explain the structure and function of vial metalloproteins and metalloenzymes.
CO4 Explain the composition of the atmosphere

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

Metal Ions in Biological Systems: General survey of essential and trace metals, Disturbing factors in metabolic process and causes of diseases, different classes of drugs.
Alkali and alkaline earth metals in biological systems: Ionophores, active transport of cations across membranes, sodium pump, Calcium pump, Calcium carriers, role of carriers in muscle contraction, blood clotting and hormone

Interaction of metal ions with Nucleotides: metal ions in nucleotide systems, effect of metal ions onnucleiacids.

Unit-2

Oxygen carriers: Porphyrins, metalloporphyrins, Hemoproteins, structure and functions of hemoglobin and myoglobin, synthetic oxygen carrier model systems.
Nitrogen fixation: Biological nitrogen fixation, Nitrogenase, model for nitrogenase, metal-N_2complexes, photosynthesis and chlorophyll.
Metal transport and storage: Transferrin, Ferritin, Siderophores

Unit-3

Metalloenzymes:
Zinc Enzymes – Carboxypeptidase & Carbonic anhydrase Iron Enzymes – Catalase, peroxidase & cytochrome P- 450 Copper Enzymes – Superoxide dismutase, blue copper- proteins Coenzymes –Vitamins B_{12}

Unit-4

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

Books Recommended:

1. Inorganic Chemistry: Principles of Structure & Reactivity – J.E.Huheey.
2. Environmental Chemistry – A.K.De.
3. Environmental Pollution Analysis –Khopkar.
4. Environmental Chemistry – V.Subramaniam.

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M. Sc. Chemistry 3rd Semester
Physical Special-III

Paper Code :- CHL-615 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Various techniques studying metal complexes or organic radicals and determining Structure of molecules
CO2 Methodologies for predicting, measuring, and analyzing corrosion performance of materials.
CO3 Identifying practices for the prevention and remediation of corrosion.

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

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

Unit-2

Electron spin resonance spectroscopy; the theory of E.S.R. the position of E.S.R. absorption, the g factor, the fine and hyperfine structures of E.S.R. absorption.Applications of E.S.R. spectroscopy.

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

Unit-3

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

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

Unit-4

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

Protection Methods against Corrosion: Change of metal, design improvement, change of environment, anodic protection, cathodic protection and protective coatings.

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

Books Recommended:

1. Introduction of molecular spectroscopy by G.M.Barrow
2. Fundamental of molecular spectroscopy by C.N.Banwell
3. Corrosion inhibitors Principle & Applications by V.S.Sastri
4. Corrosion by K.R. Trephewey& J.Chamberlain
5. Introduction to Metallic corrosion & its prevention by RajNarain
6. An introduction to the Science of Corrosion and its inhibitonBy S.N.Banerjee.
7. Corrosion engineering by M.G.Fontana

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M. Sc. Chemistry 3rd Semester
Organic Special-III

Paper Code :- CHL-508 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Nomenclature, synthesis and reactivity of different heterocyclic compounds.
CO2 Nucleosides and Nucleotides
CO3 General Methods of formation and reaction mechanisms of Ylides
CO4 Relationship between physiological action and the chemical constitution of different type Of drugs

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

Heterocyclic Compounds: General behaviour, Classification, Criteria of aromaticity, Tautomerism
Five membered Heterocycles: Synthesis and reactions of 1, 3-Azoles: Imidazole, Thiazole and Oxazole

Unit-2

Six membered Heterocyclics with two heteroatoms: Detailed study of Pyrimidines and Purines. Structural elucidation of uric acid and caffeine.

Nucleosides and Nucleotides: Structure of Nucleosides and Nucleotides, General synthesis of Nucleotides and polynucleotides.

Unit-3

Ylides: General methods of formation, General study of reactions with their mechanisms of Nitrogen (Ammonium, Immonium, Diazonium and Nitrile), Phosphorous and Sulphurylides and their applications.

Unit-4

Synthetic Drugs:
Relation between physiological action and chemical constitution
Antimalarials, antipyretics, analgesics, sulpha drugs, Anthelmintics, antifertility and anticancer drugs.

Books Recommended:

1. Heterocyclic Chemistry by R.R. Gupta, M. Kumar and V.Gupta.
2 Heterocyclic Chemistry by T.L.Gilchrist.
3 Heterocyclic Chemistry by V.K.Ahluwalia.
4 Organic Reaction Mechanism by V.K. Ahluwalia& R.K.Parashar.
5 Reaction Mechanism in Organic Synthesis by S.M. Mukherji, S.P. Singh & R.P.Kapoor.
6 Organic Name Reactions- A Unified Approach by GautamBrahmachari.
7 Organic Chemistry by I.L.Finar.
8 An Introduction to Medicinal Chemistry by Graham L.Patrick.
9 Textbook of Organic Medicinal and Pharmaceutical Chemistry by Charles O. Wilson, Ole Gisvold& Robert F.Doerge.
10 Principles of Medicinal Chemistry by William O. Foye, Thomas L. Lemice and David A. Williams.
11 Burgers Medicinal Chemistry and Drug Discovery by M.E.Wolff.

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M. sc. Chemistry 3rdSemester
Inorganic Special Practical-I

Paper Code :- CHP-601 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Synthesize different coordination complexes.
CO2 Observe the various colors associated with the particular complexes.
CO3 Compare the properties of these complexes by preparing similar complexes changing the metal
CO4 Analyze the samples and estimate their yield.

Preparation of selected Inorganic Compounds complexes. Handling of air and moisture sensitive compounds.

a. ChromousAcetate
b. Hg $[Co(SCN)_4]$
c. $[Cu(NH_3)_4] So_4.H_2O$
d. $[Mi(NH_3)_6]Cl_2$
e. $K_3 [Fe(C_2O_4)_3]$
f. $VO(acac)_2$
g. Prussianblue
h. $[Co(NH_3)_5Cl]Cl_2$, $[Co(NH_3)_5NO_2]Cl_2$, $[Co(NH_3)_5ONO]Cl_2$
i. $K_3[Al(C_2O_4)_3]$
j. $[Ni (en)_3] S_2O_3$etc.

Record File (6 Marks)

Viva-Voce (6 Marks)

Note- Department can opt any other similar experiment depending upon the material available.

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M. sc. Chemistry 3rd Semester
Physical Special Practical-I

Paper Code :- CHP-603 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Determine dielectric constant of non aqueous liquid at different concentration and hence determination of Dipole Moment.
CO2 Describe various potentiometric titrations.
CO3 Describe application and functioning of pH meter & Dipole meter

1. Potentiometry

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

(ii) $K_2Cr_2O_7$ vs. Mohr's salt or $FeSO_4$ titration.

(iii) $AgNO_3$ vs. KCl or KI titration

(iv) $AgNO_3$ vs. (KCl + KI) mixture titration

(v) $AgNO_3$ vs. (KCl + KBr +KI) mixture titration

(vi) Fe^{2+} vs Ce^{+4} titration.

2. pH metry

(i) NaOH vs Succinic Acid titration

(ii) NaOH vs Citric Acid titration

(iii) To predict composition of Copper amine complex from CuSO4 vs. NH_4OH titration.
(iv) To determine dissociation constant of weak acid

(v) To determine dissociation constant of acetic acids in acetone by titrating with Potassium hydroxide.
(vi) To determine degree of hydrolysis of aniline hydro chloride.

3. Dipolemetry

To determine the dielectric constant of various organic liquids

Record File (6 Marks)

Viva-Voce (6 Marks)

Note- Department can opt any other similar experiment depending upon the material available

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M. sc. Chemistry 3rd Semester
Organic Special Practical-I

Paper Code :- CHP-605 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Describe various techniques used for synthesis of organic compounds.
CO2 Describe disposal techniques and laboratory emergency procedures.
CO3 Know the handling of instruments.
CO4 Apply purification techniques for the purification of organic compounds

1. Multi-step Synthesis
(i) Benzanilide from benzene
(ii) Benzilic acid from benzaldehyde
(iii) α- Acetyl aminocinnamic acid from glycine
(iv) p-Nitrobenzanilide from benzophenone.

Record File (6 Marks)

Viva-Voce (6 Marks)

Note- Department can opt any other similar experiment depending upon the material available.

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M. sc. Chemistry 3rd Semester
Inorganic Special Practical-II

Paper Code :- CHP-607 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Determine concentrations of selected cations and anions spectrophotometrically

CO2 Determine pK value of an indicator spectrophotometrically

CO3 Determine stoichiometry and stability constants of complexes by Job's method/Slope ratio method

a. Spectrophotometric determination of Fe, Ni, Mn, Cr, V, Ti and fluoride, Nitrate and phosphate etc.
b. Determination of pK value of an indicator spectrophotometrically.
c. Study of complexation (Stoichiometry and stability constant) between Fe- thiocynate, Fe-phenanthroline and Cu-ethylenediamine by Job's method/ Slop ratio method.

Record File (6 Marks)

Viva-Voce (6 Marks)

Note- Department can opt any other similar experiment depending upon the material available.

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M. sc. Chemistry 3rd Semester
Physical Special Practical-II

Paper Code :- CHP-609 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Perform titrations of strong acid-strong base, weak acid- strong base and strong acid- weak base, conduct metrically.

CO2 Perform titration of combination of acids with alkali and find their respective strength conductometrically.

CO3 Identify dextro and laeveo rotatory substances and measure specific rotation Using polarimeter.

1. Conductometry titrations

(i) NaOH vs. Citric acid
(ii) NaOH vs. Succinic Acid
(iii) NH_4OH vs CH_3COOH
(iv) CH_3COONa vs HCl
(v) NaOH vs. (HCl + CH_3COOH) mixture
(vi NaOH vs. (HCl + CH_3COOH + $CuSO_4$) mixture.
(vii) To study the conductometry titration of hydrochloric acid with sodium carbonate. Also determine the concentration of sodium carbonate in a commercial sample of soda ash.

2. Polarimetry

(i) To determine specific rotation for various optically active substances.
(ii) To determine concentration of glucose or fructose or sucrose or tartaric acid in solution

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

Record File (6 Marks)

Viva-Voce (6 Marks)

Note- Department can opt any other similar experiment depending upon the material available.

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M. sc. Chemistry 3rd Semester
Organic Special Practical-II

Paper Code :- CHP-611 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 The application of analytical methods based on titrations, isolation, separations, etc
CO2 The design and application of an analysis related to a question of relevance based on experience in the laboratory and research of the scientific literature
CO3 Solving most important problems of quantitative analysis.

1. Quantitative Analysis

(a) Determination of percentage or number of hydroxyl groups in organic compound by acetylation method.

(b) Estimation of Amines/phenols using bromate-bromide solution or acetylation method.

(c) (c) Determination of iodine and saponification values of oil samples.

(d) Determination of concentration of Glucose or Sucrose in the given solution.

2. Isolation

(i) Caffeine from tealeaves
(ii) Lactose frommilk
(iii) Cystine from human hair.

Record File (6 marks)

Viva-Voce (6 marks)

Note- Department can opt any other similar experiment depending upon the material available.

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M. sc. Chemistry 3rd Semester
Inorganic Special Practical-III CHP-613

Paper Code :- CHP-613 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Spectroscopically analysis of various complex of transition metal.

1. Spectral studies of some inorganic compounds.

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

1. **Viva-Voce (6 marks)**
2. **Record file (6 marks)**

Note- Department can opt any other similar experiment depending upon the material available.

Books Recommended:

1. The Synthesis & Characterization of Inorganic compounds – W.L.Jolly.
2. A Text Book of Quantitative Analysis – A.I.Vogel.
3. A Text Book of Qualitative Analysis – A.I.Vogel.
4. Senior Practical Physical Chemistry – B.D. Khosla, V.C. Garg& A.Gulati

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M. sc. Chemistry 3rd Semester
Physical Special Practical-III

Paper Code :- CHP-615 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Able to measure the sound for various liquids.
CO2 Verify Lambert-Beer's law with different colored solutions and
CO3 Find the unknown concentration of any colored solution.
CO4 Determine the activation energy for hydrolysis of an ester.
CO5 Study reaction kinetics of iodine clock reaction.

1. Ultrasonic Interferometry

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

2. Spectrocolorimetry

(i) To test the validity of Lambert Beer's Law for $KMnO_4$ and$K2Cr2O_7$
(ii) (ii) To determine the concentration of copper sulphate, potassium permanganate and potassium dichromate in the given solution.

3. ChemicalKinetics

(i) To determination the activation energy for the hydrolysis of ethyl or methylacetate
(ii) To determine the temperature coefficient for the hydrolysis of ethyl or methylacetate
(iii) To study the kinetics of reaction between potassium iodide and potassium persulphate solution

4. Viva Voce (6 marks)
5. Practical Note Book (6 marks)

Note- Department can opt any other similar experiment depending upon the material available.

Books Recommended

1. Senior practical physical chemistry: B.D. Khosla, V.C. Garg and A.Khosla.
2. Experimental Physical Chemistry: A Thawale and P.Mathur.
3. Practical Physical Chemistry: B. Vishwanatha and P. SRaghav
4. Practical in Physical Chemistry: P.S.Sindhu.

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M. sc. Chemistry 3rd Semester
Organic Special Practical-III

Paper Code :- CHP-617 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Describe various techniques used for the structural determination of organic compounds.

CO2 Describe disposal techniques and laboratory emergency procedures.

CO3 Know the handling of instruments.

CO4 Apply identification techniques for the structural determination of organic compounds

QualitativeAnalysis

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

1. **Viva- Voce (6 marks)**

2. **Note Book (6 marks)**

Note- Department can opt any other similar experiment depending upon the material available.

Books Recommended

1 Experiments and Techniques in Organic Chemistry by D. Pasto, C. Johnson andM. Miller.
2 Macroscale and Microscale Organic Experiments by K. L. Williamson, D.C.Heath.
3 Systematic Qualitative Organic Analysis by H.Middleton.
4 Handbook of Organic Analysis-Qualitative and Quantitative by H.Clark.
5 Vogel's Textbook of Practical Organic Chemistry by A. R.Tatchell.

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M. Sc. Chemistry 4thSemester
Inorganic Special-IV
(Organotransition metal Chemistry)

Paper Code :- CHL-602 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Define and identify an organometallic compound
CO2 Write their structure, synthesis and reaction mechanism.
CO3 Apply their properties for different applications like polymerization, catalytic Hydrogenation etc
CO4 Comment on their kinetics and stability.

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

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

Alkyls and Aryls of Transition Metals: Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis.

Unit-2

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

Unit-3

Compounds of Transition Metal-Carbon Multiple Bonds: Transition metal- carbene complexes: Fischer type and Schrock type carbene complexes, their synthesis, reactions and structures & bonding; Transition metal-carbyne complexes: their synthesis, reactions and structural features.

Unit-4

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

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

Books Recommended

1. Principles & Applications of Organotransition metal Chemistry by J.P. Collman,L.S. Hegedus, J.R. Norton & R.G.Finke.
2. Organometallic Chemistry – R.C. Mehrotra&A.Singh.
3. Principles of Organometallic Chemistry – G.E. Coates, M.L.H. Green, P. Powel &K. Wade.
4. Transition Metal Organometallic Chemistry – R.B.King.
5. Organotransition Metal Chemistry – V. Ishii &M.Tsutsui
6. The Organometallic Chemistry of the Transition Metals – R.H.Crabetree.

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Khanpur Kalan (Sonipat)

M. Sc. Chemistry 4thSemester
Physical Special-IV

Paper Code :- CHL-604 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Apply the principles of electrochemistry in various electrochemical energy converters.
CO2 Perform Amperometric titrations determination of activation energy for an irreversible electrode process.
CO3 Identify polymerization reactions and their kinetics.
CO4 Calculate the molecular weight of polymers by osmometry, viscometry, light scattering and sedimentation method.

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

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

Unit-2

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

Irreversible electrode processes: An approximate treatment of a slow electrode process and regorous treatment of a slow electrode process, irreversible reduction of complexes, polarography of organic substances, polarographiccoulometry at constant potential, determination of number of electrons by analysis of the decrease in the limiting current.

Unit-3

Polymers: Classification of polymers and polymerisation, condensation and addition polymers, kinetics of condensation (step-wise) polymerisation, size distribution in linear condensation polymers, molecular size control, degree of polymerization; mechanism of vinyl radical polymerisation, molecular weight and its determination, effect of temperature and pressure on chain polymerisation, stereochemistry of polymer chain & stereo regular polymerisation, Ionic polymerisation (similarities and contrast), kinetics of cationic, anionic polymerisation, kinetics of copolymerisation, criteria for polymer solubility; Mass number and Mass average molecular weight, determination of molecular weight of polymers by osmometry, viscometry, light scattering and sedimentation methods.

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Unit-4

Polymers:

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

Books Recommended:

1. Text book of Polymer science by F.W. Billmeyer& Jr.Wiley
2. Contemporary polymer chemistry by H.R. Alcock& F.W.Lambe.
3. Physics & Chemistry of polymer by J.M.C.Cowie
4. Polymer Chemistry by P.J.Flory
5. Modern Electrochemistry Vol.1 & II by J.O.M. Bockris& A.K.N.Reddy
6. Electrochemistry by S.Glasstone
7. Electrochemistry by P.H.Reiger.
8. Polarography byHeyrovsky.
9. Introduction to Polarography & Allied Techniques by ZutshiKannala

M. Sc. Chemistry 4thSemester
Organic Special-IV

Paper Code :- CHL-606 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Be able to understand and be able to apply the Woodward–Hoffmann governing pericycyclic reactions
CO2 Be able to understand the photochemical reactions of Alkenes, Carbonyl and Aromatic compounds.

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

Photochemistry
Photochemical Reactions: Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.
Photochemistry of Alkenes: Intramolecular reactions of the olefinic bond- geometrical isomerism, cyclisation reactions, rearrangement of 1,4 and 1,5 – dienes.
Photochemistry of Carbonyl Compounds: Intramolecular reactions of carbonyl compounds, saturated, cyclic, acyclic, and , unsaturated compounds. Cyclohexadienones.

Unit-2

Intermolecular cycloaddition reactions – dimerisations and oxetane formation.
Photochemistry of Aromatic Compounds: Isomerisations, additions and substitutions.
Miscellaneous Photochemical Reactions: Photo-Fries reactions of anilides. Photo-Fries rearrangement.Barton reaction.Singlet molecular oxygen reactions.Photodegradation of polymers.
Free Radicals: Free radicals stability, generation and detection. Types of free radical reactions, free radicals substitution at an aromatic substrate, Hunsdiecker reaction.

Unit-3

Pericyclic Reactions:
Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward – Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions – conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems.Cycloadditions – antarafacial and suprafacial additions, 4n and 4n+2 systems, Sigmatropic rearrangements – suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties, 3,3-and 5,5-sigmatropic rearrangements. Claisen and Cope rearrangements

Unit-4

Stereochemistry
Conformational analysis of medium and large membered rings, trans annular reactions, conformational analysis of cyclohexanone, effect of conformation on reactivity of acyclic and cyclic compounds.
Stereochemistry of nitrogen containing compounds, strain and their consequences in small ring heterocycles, conformation of six membered heterocyles. Barrier to ring inversion, pyramidal inversion and 1,3-diaxial interactions.

Books Recommended:
1 Molecular Photochemistry by N. J. Turo and W.A.Benjamin.
2 Introductory Photochemistry by A. Cox and T.Camp.

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3 Photochemistry by R.P. Kundall and A.Gilbert.
4 Organic Photochemistry by J. Coxon and B.Halton.
5 Organic Photochemistry by Orville L.Chapman.
6 Pericyclic Reactions by S.M.Mukherji.
7 The Conservation of Orbital Symmetry by R.B. Woodward and R.Hoffman.
8 Orbital Symmetry by R.E. Lehr and A.P.Merchant.
9 Reaction Mechanism in Organic Chemistry by S.M. Mukherji and S.P.Singh.
10 Stereochemistry of Organic Compounds by D.Nasipuri.
11 Stereochemistry of Organic Compounds by P.S.Kalsi.

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M. Sc. Chemistry 4thSemester
Inorganic Special-V
(Electro Analytical Chemistry)

Paper Code :- CHL-608 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Compare the advantages and/or disadvantages of dropping mercury electrode.
CO2 Describe how a coulometric titration is performed and discuss the advantages of a coulometric titration over a conventional redox titration,
CO3 Describe the process of performing an Amperometric titration.
CO4 Discuss the theory of stripping voltametry and ion selective electrode.

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

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

Unit-2

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

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

Unit-3.

Super imposed a.c. Polarography, voltametry in quiet and stirred solution with electrode other than mercury, square-wave polarography, normal and differential pulse polarography, chronopotentiometry, chronoamperometry andcoulometry.

Unit-4

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

Books Recommended:

1. Introduction to Polarography & Allied Techniques – K.Zutshi
2. Basic concepts of Analytical Chemistry – S.M.Khopkar.
3. Principles of Polarography – R.C. Kapoor& B.S.Aggarwal.
4. Fundamentals of Analytical Chemistry – SkoogWest.

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M. Sc. Chemistry 4thSemester
Physical Special-V

Paper Code :- CHL-610 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Learn to recognize, define, and solve problems in equilibrium thermodynamics and statistical physics.

CO2 Understand the fundamentals and thermodynamic criteria for non-equilibrium states, Entropy production and entropy flow .

CO3 Apply the theory of fluctuations and calculate equilibrium fluctuations of extensive Parameters, intensive parameters and densities in systems.

CO4 Use the Hamiltonian operator to derive the quantization rule and also the method of ladder operators

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

Statistical Thermodynamics:

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

Unit-2

Non –Equilibrium Thermodynamics: General theory of non-equilibrium processes, entropy production and entropy flow; thermodynamic criteria for non-equilibrium states, entropy production in heat flow, mass flow, electric current, chemical reactions, Saxen's relation, Onsager's reciprocity relation, , Electro kinetic phenomenon.Theory of fluctuation, energy fluctuations in the canonical ensemble, distribution function and fluctuations, fluctuations of density and energy.

Unit-3

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

Unit-4

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

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

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Khanpur Kalan (Sonipat)

Books Recommended:

1. Non- Equilibrium Thermodynamics by I.Prigogine
2. Non-Equilibrium Thermodynamics by C.Kalidas.
3. Theoretical Chemistry by S.Glaston.
4. Quantum Mechanics by M.S.Pathania.
5. Quantum Chemistry by Pauling ,Eyring andWilson.

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M. Sc. Chemistry 4thSemester
Organic Special-V

Paper Code :- CHL-612 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Identify and characterize various classes of natural products by their structures.
CO2 Have some knowledge of some of the plants around them and their pharmaceutical importance.
CO3 Have some knowledge of bacteria and other life forms from which useful pharmaceuticals are derived.

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

Terpenoids:

Classification , nomenclature, occurrence and general method of structural determination , Isoprene rule, Stucture determination, stereochemistry and synthesis of Citral, Farnesol, Zingibrene, Santonin, α- Cadinene, Camphor and Abietic acid, Biogenetic pathways and biosynthesis

Unit-2

Alkaloids:

Classification, occurrence, general methods of isolation and structure elucidation. Structure, stereochemistry , synthesis and biosynthesis of following : Papaverine, Nicotine, Quinine, Morphine, lysergic acid and Reserpine

Unit-3

Steroids and Harmones

Occurrence and General methods of isolation. Structure elucidation and synthesis of Cholesterol, Bile acids, Oestrogens, Testosterone, Progesterone, Esterone and synthetic non-steroidal estrogens.
Structure elucidation and synthesis of Adrenaline and Thyroxine.

Unit-4

Antibiotics

Structure elucidation of Pencillin, chloramphenicol, Streptomycin and Tetracyclins.

Prostaglandins:
Classification, Physiological effects and synthesis of PGE_2 and PGF2 α.

Books Recommended:

1. Natural Products-Chemistry and Biological Significance by J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B.Harborne.
2 Organic Chemistry by I.L.Finar.
3 Rodds Chemistry of Carbon Compounds by S.Coffey.
4 New Trends in Natural Products Chemistry by Atta-ur-Rehman, M.I.Choudhary.
5 The Chemistry of Natural Products by P.S.Kalsi.
6 Chemistry of Natural Products byNakamshi.
7 Organic Chemistry byI.L.Finar

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Khanpur Kalan (Sonipat)

M. Sc. Chemistry 4thSemester
Inorganic Special-VI
Medicinal Aspects of Inorganic Chemistry

Paper Code :- CHL-614 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Identify the metal deficiency diseases and treat them with proper therapy.
CO2 Become familiar with carcinogens, tumor growth and role of various metals in anticancer activity.
CO3 Discuss role of ligands and their beneficial effects as chelating agents in anti-cancer drugs
CO4 Apply knowledge of nuclear medicine as they study about radioiodine -1 31,technetium – 99m, gallium and indium.

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

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

Unit-2

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

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

Unit-3

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

Unit-4

Vitamins and their functions in general, recommended dietary allowances , deficiencies and supplementations, dietary miners, calcium and vitamin D, antioxidants and their health effects,
biomineralisation
Radiopharmacology, nuclear medicines, radioiodine -1 31, technetium – 99m, galliumand indiumscan.

Books Recommended

1. A Text Book on Medicinal Aspects of Bio-Inorganic Chemistry – A.K.Das.

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BPS Mahila Vishwavidyalaya
Khanpur Kalan (Sonipat)

2. Bioinorganic Medicinal Chemistry – E.Alessio.
3. Bioinorganic Chemistry – K.H.Reddy.
4. Inorganic Chemistry: Principle of Structure Reactivity – J.E. Huheey, E.A. Keiter&R.L.Keiter.
5. HandbookofRadiopharmaceuticals:RadioChemistry&Applications–M.J.Welch& C.S. Redvanly.
6. Perspectives on Bioinorganic Chemistry – R.W. Hay, J.R. Dilworth & K.B.Nolan.

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Khanpur Kalan (Sonipat)

M. Sc. Chemistry 4thSemester
Physical Special-VI

Paper Code :- CHL-616 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Identify symmetry elements and recognize symmetry operations generated by each symmetry element for a given molecule.
CO2 Combine symmetry operations and set up multiplication table for simple point groups.
CO3 Perform vector transformation and generate reducible representation of common molecules.
CO4 Find the number of infrared and Raman active vibrations in a molecule.
CO5 Identify the causes, conditions and prevention of corrosion.

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-A

Symmetry and Group Theory in Chemistry: Symmetry elements and symmetry operation group and its properties, Multiplication table, point symmetry groups. Schonflies symbol, representations of groups by matrices (representation for the C_n, C_{nv}, C_{nh}, D_{nh} etc. groups to be worked out explicity) Irreduceable representation of groups.The great orthogonality theorem (without proof) and its importance.Character tables and their use in spectroscopy.

Unit-B

Electronic Spectroscopy of Polyatomic Molecules : Free electron model, spectra of carbonyl group, spectra of ethene, n-II and II-II transitions, spectra of benzene , spectra of transition metals, charge-transfer transition, fluorescence phosphorescence.

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

Unit-C

Forms of Corrosion: Uniform corrosion, galvanic corrosion, pitting corrosion, crevice corrosion, intergranular corrosion, stress corrosion cracking, corrosion Dfatigue, fretting corrosion, dealloying, hydrogen embrittlement, erosion corrosion, microbial induced corrosion, filliform corrosion andexfoliation.

Unit-D

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

Books Recommended:

1. Molecular symmetry and group theory byA.Vincent
2. Applied group theory by A. NassBauim
3. Group theory in Chemistry by S.Swarnlakshmi, T.Saroja& R.M.Ezhilarasi.
4. Introduction of molecular spectroscopy by G.M.Barrow
5. Fundamental of molecular spectroscopy by C.N.Banwell
6. Corrosion inhibitors Principle & Applications by V.S.Sastri
7. Corrosion by K.R. Trephewey& J.Chamberlain
8. Introduction to Metallic corrosion & its prevention by RajNarain
9. An introduction to the Science of Corrosion and its inhibitonBy S.N.Banerjee
10. Corrosion engineering by M.G.Fontana

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Khanpur Kalan (Sonipat)

M. Sc. Chemistry 4thSemester
Organic Special-VI

Paper Code :- CHL-618 **External marks:- 80**
Duration:- 3 Hours **Internal Marks:- 20**
Total Marks:- 100

CO1 Apply different reagents in the organic transformations.
CO2 Understand the need to study molecular rearrangements.
CO3 Construct efficient, simple mechanistic pathways for the synthesis of a given compound

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

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

Organometallic Reagents:

n-Butyllithium, Grignard reagent, Organo chromium(III) compounds, Dialkyl copperlithium, Pentacarbonyl iron, Tetracarbonyl nickel, octacarbonyldicobalt, Alkene Palladium (II) complexes, Wilkinsons catalyst, Methyl triisopropoxy titanium, Tri-n-butyl tin hydride, Trimethylsilyl iodide,Diborane.

Unit-2

General Reagents:

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

Unit-3

Oxidation:

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

Reduction:

Catalytic hydrogenation, lithium aluminium hydride, Sodium borohydride, Sodamide, Zinc dust, Sodium liquid ammonia

Unit-4

Rearrangements:

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

Books Recommended:

1. Designing Organic Synthesis by S. Warren.
2. Organic Synthesis Concept, Methods and Starting Materials by J.Fuhrhop andG. Penzillin.
3. Some Modern Methods of Organic Synthesis byW.Carruthers.
4. Modern Synthesis Reactions by H.O. House & W.A.Benjamin.
5. Advanced Organic Chemistry -Reactions Mechanism and Structure by JerryMarch.
6. Principles of Organic Synthesis by R. Norman and J.M.Coxon.
7. Advanced Organic Ohemistry Part-B by F.A. Carey and R.J.Sundburg.
8. Organometallic Chemistry-A Unified Approach by R.C. Mehrotra& A.Singh.
9. Concise Coordination Chemistry by R. Gopalan& V.Ramalingam
10. Organometallic Chemistry by G.S.Sondhi

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BPS Mahila Vishwavidyalaya
Khanpur Kalan (Sonipat)

M. Sc. Chemistry 4thSemester
Environmental Chemistry-II

Paper Code :- CHL-504 **External marks:- 60**
Duration:- 3 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Understand the concept of various water quality standard
CO2 Identifying various types of industry and their impact
CO3 Apply the principle of green chemistry and green technology

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit.

Unit-1

Water Quality: Concept of DO, BOD, COD and their measurement, water quality standards, water quality parameters. Heavy metal: toxicity of heavy metals, bioaccumulation of heavy metals, harmful effects of different heavy metals e.g. As, Cd, Hg, Pb, Zn Cu, and Cr, pesticides and their classification.

Unit-2

Industrial Pollution: Cement, Sugar, distillery, paper and pulp, thermal power plants, nuclear power plants, metallurgy, drugs etc. Impacts of radiations on human health and environmental, Disposal and management of wastes.

Unit-3

Green Chemistry: Importance, basic principles of green chemistry, green chemistry and its environmental importance, green reagents, green solvents, green technology: new trends in green chemistry. Green technology: microwave heating and pollution, ultrasound technique.

Unit-4

Climate change: Causes and consequences, predications and adapting to climate change. International response to climate change: Montreal protocol, Rio de Janeiro summit, World summit, Kyoto protocol and Paris Agreement
Persistant Organic Pollutants: Aldrin, chlordane, Dieldrin, Dioxins, DDT, Endrin, Furans, Helptachlor, Hexachlorobenzene, Mirex, Polychlorinated biphenyls, Toxaphene.

Books Recommended

1. Environmental Chemistry – A.K.De
2. Environmental Chemistry- Manaham.
3. Environmental Pollution Analysis-Khopkar.
4. Environmental Chemistry- V. Subramaniam.
5. Chemistry of Atmosphere-Murray J. Mc Ewan and Leon F.Philips.
6. Atmospheric Chemistry – J.Heichlen.

Chairperson
Department of Basic & Applied Sciences
BPS Mahila Vishwavidyalaya
Khanpur Kalan (Sonipat)

M. sc. Chemistry 4th Semester
Inorganic Special Practical-IV

Paper Code :- CHP-602 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Interprete the structure and bonding of inorganic compounds from IR spectra.
CO2 Interprete the structure and bonding of coordination compounds from IR spectra.
CO3 Differentiate the isomers from spectra.

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

(i) Ammonium salts [NH_4Cl, $(NH_4)_2 SO_4$, $NH_4 SCN$, NH_4NO_3]
(ii) Sulphate ions in different bonding mode: ionic – K_2SO_4, $CaSO_4$ etc., unidentate, bidentate, bridgedetc.
(iii) Thiocynate and Isothiocynate complexes.
(iv) Oxalato complexes
(v) Cyano complexes – $K_4 Fe(CN)_6$, Na_2 [$Fe(CN)_5NO$]
(vi) Ammine complexes
(vii) Spectra of isomers – Nitro – and Nitrito

Record File (6 marks)

Viva-Voce (6 marks)

Note- Department can opt any other similar experiment depending upon the material available.

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M. sc. Chemistry 4th Semester
Physical Special Practical-IV

Paper Code :- CHP-604 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Determine dipole moment of organic liquids at different concentration.
CO2 Describe various potentiometric titrations.
CO3 Describe application and functioning of ph meter & dipole meter

Potentiometry

(i) NaOH vs.H_3PO_4 titration.
(ii) NaOH vs. (HCl + CH_3COOH)mixture
(iii) NaOH vs. Boric Acid
(iv) $ZnSO_4$vs $K_4[Fe(CN)_6]$
(v) $Na_2S_2O_3$ vs Iodine
(vi) To determine solubility and solubility product of sparingly soluble salts $BaSO_4$, AgCl and $PbSO_4$
(vii) To determine degree of hydrolysis of aniline hydrochloride
(viii) To determine dissociation constant of weak acid.

1. pH metry Titrations

(i) NaOH vs. H_3PO_4
(ii) NaOH vs. (HCl + CH_3COOH)mixture
(iii) NH_4OH vs.HCl
(iv) NH_4OH vs. CH_3COOH
(v) NaOH vs. Boric Acid
(vi)

2. Dipolemetry

To determine dipole moment of various organic liquids

Record File (6 marks)

Viva-Voce (6 marks)

Note- Department can opt any other similar experiment depending upon the material available.

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M. sc. Chemistry 4th Semester
Organic Special Practical-IV

Paper Code :- CHP-606 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Describe various techniques used for synthesis of organic compounds.
CO2 Describe disposal techniques and laboratory emergency procedures.
CO3 Know the handling of instruments.

1. Multi-step Synthesis
(i) m-Nitroaniline from benzene.
(ii) 5-Acetoxy-1,3-benzoxathiol-2-one from hydroquinone.
(iii) 2'-Hydroxy-4-methoxyphenylstyryl ketone from resorcinol.
(iv) Acridone from anthranilic acid.

Record File (6 marks)

Viva-Voce (6 marks)

Note- Department can opt any other similar experiment depending upon the material available.

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M. sc. Chemistry 4th Semester
Inorganic Special Practical-V

Paper Code :- CHP-608 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Perform titrations of strong acid-strong base, weak acid- strong base and strong acid-weak base, conductometrically.
CO2 Perform titrations of precipitation and displacement reactions conductometrically.
CO3 Describe various potentiometric titrations.
CO4 Perform titrations of organic acids by pH metery

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

Record File (6 marks)

Viva-Voce (6 marks)

Note- Department can opt any other similar experiment depending upon the material available.

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M. sc. Chemistry 4th Semester
Physical Special Practical-V

Paper Code :- CHP-610 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Perform various titrations conductometrically.
CO2 Determine the percentage composition of optical substances of the binary mixture by polarimeter.
CO3 Determine the heat capacity of organic liquids.

1. Conductometry Titrations

(i) $AgNO_3$ vs KCl or KI
(ii) $AgNO_3$ vs KCl + KI
iii) To determine concentration of Salicylic acid by
(a) Salt line method and (b) Double alkali method
(iv) To determine solubility and solubility product of sparingly soluble salts (AgCl, $PbSO_4$,$BaSO_4$)
(v) To study the kinetics of sponification of ester conductometrically
(vi) Verification of D.H.O. equation for strong electrolytes.
(vii) To estimate the concentration of each component in a mixture of $AgNO_3$ andHNO_3.

2. Polarometry

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

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

3. Determination of Heat capacity

To determine the heat capacity of organic liquids

Record File (6 marks)

Viva-Voce (6 marks)

Note- Department can opt any other similar experiment depending upon the material available.

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M. sc. Chemistry 4th Semester
Organic Special Practical-V

Paper Code :- CHP-612 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Apply basic chemical concepts to estimate different types of organic compounds.
CO2 Describe different methods for isolation

1. **Spectrophotometric (UV/VISIBLE) Estimations:**

   (a) Aminoacids
   (b) Proteins
   (c) Carbohydrates
   (d) Ascorbicacid
   (e) Aspirin
   (f) Caffeine
   (g) Cholesterol

2. **Isolation**
   (i) Casein from milk
   (ii) D (+) Glucose from cane sugar
   (iii) Hippuric acid from urine

Record File (6 Marks)

Viva-Voce (6 marks)

Note- Department can opt any other similar experiment depending upon the material available.

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M. sc. Chemistry 4th Semester
Inorganic Special Practical-VI

Paper Code :- CHP-614 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Determine the capacity of a cation – exchange resin
CO2 Determine of the capacity of an anion exchange resin
CO3 Identify the ions by Ion-exchangers.

Ion Exchange methods in Column Chromatographic Analysis:-

(i) Determination of the capacity of a cation – exchange resin i.e. Amberlite IR –120.
(ii) Determination of the capacity of an anion exchange resin i.e. Amberlite IRA – 400 or De – Acidite FF.
(iii) Separation of Ions by Ion–exchangers.

Viva-Voce (6 marks)

Record file (6 marks)

Note- Department can opt any other similar experiment depending upon the material available.

Books Recommended:

1. A Text Book of Quantitative Analysis – A. I. Vogel.
2. A Text Book of Qualitative Analysis – A. I. Vogel.
3. Senior Practical Physical Chemistry – B.D. Khosla, V.C. Garg& A. Gulati
4. Infrared and Raman Spectra of Inorganic & Co-ordination compounds – K. Nakamoto.
5. Inorganic Infrared & Raman Spectra – S.D. Ross.
6. Basic Concepts of Analytical Chemistry – S. M. Khopkar.

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M. sc. Chemistry 4th Semester
Physical Special Practical-VI

Paper Code :- CHP-616 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Able to measure the sound for various liquids.
CO2 Verify Lambert-Beer's law with different colored solutions and
CO3 Find the unknown concentration of any colored solution.
CO4 Determine the activation energy for hydrolysis of an ester

1. **Ultrasonic Interferrometry:**

   (i) To determine the isentropic compressibility of liquids.
   (ii) To determine excess isentropic compressibility of given binary liquid mixture.

2. **Spectrocolorimetry:**

   (i) Determine the composition of $KMnO_4$ and $K_2Cr_2O_7$ in the given mixture.
   (ii) Determine the pK value of the methyl red and phenolphthalein indicator.
   (iii) To study complex formation between ferric and thiocyanate ions.

3. **Chemical Kinetics:**

   (i) To study of kinetics of iodination of acetone.
   (ii) To study the kinetics of sponification of ethyl or methylacetate.
   (iii) To study the kinetics of acid catalyzed inversion of cane sugar.
   (iv) To study of kinetics of bromination of Gallic acid by bromide-bromate mixture in acid medium. (Clock reaction).

4. **Viva-Voce (6 marks)**
5. **Practical Note Book (6 marks)**

Note- Department can opt any other similar experiment depending upon the material available.

Books Recommended:

1. Senior practical physical chemistry: B.D. Khosla, V.C. Garg and A.Khosla.
2. Experimental Physical Chemistry: A Thawale and P.Mathur.
3. Practical Physical Chemistry: B. Vishwanatha and P. SRaghav
4. Practical in Physical Chemistry: P.S.Sindhu.

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M. sc. Chemistry 4th Semester
Organic Special Practical-VI

Paper Code :- CHP-618 **External marks:- 60**
Duration:- 6 Hours **Internal Marks:- 15**
Total Marks:- 75

CO1 Describe various techniques used for the structural determination of organic compound

CO2 Describe disposal techniques and laboratory emergency procedures.

CO3 Know the handling of instruments.

CO4 Apply identification techniques for the structural determination of organic compounds

1. Qualitative Analysis:

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

2 Viva-Voce (6 marks)

3. Note Book (6 marks)

Note- Department can opt any other similar experiment depending upon the material available.

Books Recommended:

1 Experiments and Techniques in Organic Chemistry by D. Pasto, C. Johnson and M. Miller.
2 Macroscale and Microscale Organic Experiments by K. L. Williamson, D.C.Heath.
3 Systematic Qualitative Organic Analysis by H. Middleton.
4 Handbook of Organic Analysis-Qualitative and Quantitative by H.Clark.
5 Vogel's Textbook of Practical Organic chemistry by A. R.Tatchell.

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