KARNATAK UNIVERSITY

M.Sc. Chemistry
(Inorganic, Organic, Physical and Analytical)

Choice Based Credit System

(CBCS)

Revised Syllabus

(w.e.f. 2019-20)

The Department of Chemistry was one of the earliest Centers of post–graduate teaching and research under the Bombay University (1953). Later, the newly formed Karnatak University has trodden the path of more than five decades. Presently, the Department offers four semester Masters (M.Sc.) programme in the three branches of Chemistry viz., Inorganic, Organic & Physical with a unique blend of high quality teaching and rigorous student training.

Infrastructure:

Department is housed in a 30,000 sq.ft two storeyed building, offers an excellent environment for learning. This includes well-furnished classrooms, spacious laboratories, sophisticated instruments, departmental library, journal section and a computer laboratory. These are also supported by specially equipped research laboratories.

Faculty:

The Department has an experienced & dedicated group of faculty members with decades of teaching experience at various levels, who are equally competent in frontier areas of chemical research. This rich and vibrant intellectual pool will transform the budding and ambitious post–graduates into professional chemists, research scholars and inspiring teachers. Many of them have the financial support for research from agencies like DST, UGC, CSIR, AICTE etc.

Students Aid-in Programmes:

Financial aid to students: Every year 5 students get financial aid from the scholarships instituted in the names of former professors namely, Prof. S. Siddappa, Prof. N. S. Biradar and Prof. V. V. Badiger. On an average 10 students get government merit scholarships. In addition to departmental scholarships, private education trusts, namely, Jindal Pvt. Ltd., Mumbai and Dempo Pvt. Ltd., Goa also provide financial assistance to the students. Some research students also get University fellowships, every year.

Gold Medals:

Gold medals are instituted in the names of Prof. S. Siddappa, Prof. V. V. Badiger, Prof. E. S. Jayadevappa, Prof. G. K. N. Reddy, Prof. A. R. Murthy, Prof. S. T. Nandibewoor and Prof. M. V. Kulkarni.

Centrally Aided Programmes:

The Department of Chemistry has been recognized for its potential research output and was selected for additional financial support by the University Grants Commission (UGC), New Delhi and Department of Science & Technology (DST), New Delhi. The details of these special distinctions achieved by the Department are as follows: SAP (DRS)-UGC:1992–1997; SAP II (DRS)–UGC:1998-2003; COSIST-UGC:1999–2004; FIST–DST:2001-2006; SAP III–UGC:2005-2010; FIST II–DST:2007-2012

Facilities in the Department:

The Department has sophisticated instrumental facilities like UV–Visible–, Fluorescence–, FTIR– and NMR–spectrometers, Single Crystal X–ray diffraction instrument,

Confocal microscope, Electrochemical analyser, Potentiostat, Fuel cell work station, Polarimeter, Zeta sizer, Electrospinning machine, Water contact angle instrument, HPLC, CO_2 incubator, –40 to –80 free dryer, Faraday balance and stopped flow accessory. Recently, the UGC–INFLIBNET through the University library has provided access to majority of the international journals and the University library has also provided access to the SciFinder^{TM} database of chemical and bibliographic information. The Department also houses its own departmental library and has procured a large number of text books under the centrally aided programmes which are useful to the post-graduate students, research students and staff and also has a separate periodical section which has chemical abstracts and many national and international journals up to the year 2000.

Special Features:

The Department has established its own employment cell and several national and multinational companies hold campus interviews for our post graduate and research students. It is a matter of pride to note that more than 50% of our students find their placement before completion of the course. The department is proud to have Karnatak University Alumni Association (R) to foster fellowship and to provide a forum to bring together members of KUCAA for their progress and development in chemical sciences.

Basis for Internal Assessment:

Internal assessment marks in theory papers shall be based on tests. The tests may be conducted 8 to 12 weeks after the start of a semester. Internal assessment marks in practicals shall be based on tests. The practical test may be conducted 10 weeks after the start of a semester.

Theory question paper format for CBCS Semester Examinations:

Q: 1 (Compulsory)
Seven sub questions carry two marks each and one sub question to be answered of one mark (2 questions from each unit) **15 marks**

Q: 2 to Q: 7

Six questions from four units will be given. Each question carries 15 marks. Any four questions are to be answered. There may be mixing of questions from different units. **15x4 =60 marks**

Total: 75 marks

The other general academic regulations will be same as laid by University

KARNATAK UNIVERSITY, DHARWAD

POST-GRADUATE DEPARTMENT OF STUDIES IN CHEMISTRY

M.Sc. DEGREE PROGRAMME IN CHEMISTRY

(With effect from 2019-20)

(CBCS)

Course Structure and Scheme of Examination:

FIRST SEMESTER

Description of Papers	Credits	No. of Hrs/ week Theory/ Practical	Duration of exam. in Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the exams.	Total Marks
A. Core Subjects						
PG75T101A: Inorganic Chemistry–I	4	4	3	25	75	100
PG75T102B: Organic Chemistry–I	4	4	3	25	75	100
PG75T103C: Physical Chemistry– I	4	4	3	25	75	100
PG75T104D: Analytical Chemistry	4	4	3	25	75	100
B. Practical						
PG75P101A: Lab Course in Inorganic Chemistry	2	4	4	10	40	50
PG75P102B: Lab Course in Organic Chemistry	2	4	4	10	40	50
PG75P103C: Lab Course in Physical Chemistry	2	4	4	10	40	50
PG75P104D: Lab Course in Analytical Chemistry	2	4	4	10	40	50
Total	24	32	28	140	460	600

SECOND SEMESTER

Description of Papers	Credits	No. of Hrs/ week Theory/ Practical	Duration of exam. in Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the exams.	Total Marks
A. Core Subjects						
PG75T201A:Inorganic Chemistry–II	4	4	3	25	75	100
PG75T202B: Organic Chemistry–II	4	4	3	25	75	100
PG75T203C: Physical Chemistry–II	4	4	3	25	75	100
B. Elective						
PG75O201A: Applied Inorganic Chemistry	4	4	3	25	75	100
C. Practical						
PG75P201A: Lab Course in Inorganic Chemistry	2	4	4	10	40	50
PG75P202B: Lab Course in Organic Chemistry	2	4	4	10	40	50
PG75P203C: Lab Course in Physical Chemistry	2	4	4	10	40	50
Total	22	28	24	130	420	550

THIRD SEMESTER
(INORGANIC CHEMISTRY SPECIALIZATION)

Description of Papers	Credits	No. of Hrs/ week Theory/ Practical	Duration of exam. in Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the exams.	Total Marks
A. Core Subjects						
PG75T301A: Advanced Coordination & Bioinorganic Chemistry	4	4	3	25	75	100
PG75T302A: Molecular Spectroscopy	4	4	3	25	75	100
PG75T303A: Selected topics in Inorganic Chemistry	4	4	3	25	75	100
B. Elective						
PG75O302B: Applied Organic Chemistry OR **PG75O302C**: Applied Physical Chemistry	4	4	3	25	75	100
C. Practical						
PG75P301A: Lab Course in Inorganic Chemistry	2	4	4	10	40	50
PG75P302A: Lab Course in Inorganic Chemistry	2	4	4	10	40	50
PG75P303A: Lab Course in Inorganic Chemistry	2	4	4	10	40	50
Total	22	28	24	130	420	550

THIRD SEMESTER

(ORGANIC CHEMISTRY SPECIALIZATION)

Description of Papers	Credits	No. of Hrs/ week Theory/ Practical	Duration of exam. in Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the exams .	Total Marks
A. Core Subjects						
PG75T301B:Organic spectroscopy	4	4	3	25	75	100
PG75T302B: Stereochemistry and Reaction Mechanism	4	4	3	25	75	100
PG75T303B: Chemistry of Natural Products	4	4	3	25	75	100
B. Elective						
PG75O302B: Applied Organic Chemistry OR **PG75O302C**: Applied Physical Chemistry	4	4	3	25	75	100
C. Practical						
PG75P301B: Lab Course in Organic Chemistry	2	4	4	10	40	50
PG75P302B: Lab Course in Organic Chemistry	2	4	4	10	40	50
PG75P303B: Lab Course in Organic Chemistry	2	4	4	10	40	50
Total	22	28	24	130	420	550

THIRD SEMESTER
(PHYSICAL CHEMISTRY SPECIALIZATION)

Description of Papers	Credits	No. of Hrs/ week Theory/ Practical	Duration of exam. in Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the exams.	Total Marks
A. Core Subjects						
PG75T301C: Quantum Mechanics, Group Theory & Diffraction.	4	4	3	25	75	100
PG75T302C: Spectroscopy & Voltammetry.	4	4	3	25	75	100
PG75T303C: Statistical Mechanics & Polymer Chemistry.	4	4	3	25	75	100
B. Elective						
PG75O302B: Applied Organic Chemistry OR **PG75O302C**: Applied Physical Chemistry	4	4	3	25	75	100
C. Practical						
PG75P301C: Lab Course in Physical Chemistry	2	4	4	10	40	50
PG75P302C: Lab Course in Physical Chemistry	2	4	4	10	40	50
PG75P303C: Lab Course in Physical Chemistry	2	4	4	10	40	50
Total	22	28	24	130	420	550

THIRD SEMESTER

(ANALYTICAL CHEMISTRY SPECIALIZATION)

Description of Papers	Credits	No. of Hrs/ week Theory/ Practical	Duration of exam. in Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the exams.	Total Marks
A. Core Subjects						
PG75T301D: Instrumental Methods of Analysis	4	4	3	25	75	100
PG75T302D: Molecular Spectroscopy	4	4	3	25	75	100
PG75T303D: Selected Topics in Analytical Chemistry–I	4	4	3	25	75	100
B. Elective						
PG75O302B: Applied Organic Chemistry OR **PG75O302C**: Applied Physical Chemistry	4	4	3	25	75	100
C. Practical						
PG75P301D: Lab Course in Analytical Chemistry–I	2	4	4	10	40	50
PG75P302D: Lab course in Analytical Chemistry–II	2	4	4	10	40	50
PG75P303D: Lab course in Analytical Chemistry–III	2	4	4	10	40	50
Total	22	28	24	130	420	550

FOURTH SEMESTER

(INORGANIC CHEMISTRY SPECIALIZATION)

Description of Papers	Credits	No. of Hrs/ week Theory/ Practical	Duration of exam. in Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the exams.	Total Marks
A. Core Subjects						
PG75T401A: Instrumental Methods of Analysis.	4	4	3	25	75	100
PG75T402A: Material, Nuclear and Environmental Chemistry	4	4	3	25	75	100
PG75T403A: Organometallic and Solid State Chemistry	4	4	3	25	75	100
PG75D404A: Project Work*	6	4	8	25	125*	150
Practical						
PG75P401A: Lab Course in Inorganic Chemistry	2	4	4	10	40	50
PG75P402A: Lab Course in Inorganic Chemistry	2	4	4	10	40	50
PG75P403A: Lab Course in Inorganic Chemistry	2	4	4	10	40	50
Total	24	28	21	130	395	600

* Project Evaluation:

Dissertation – 75 Marks

Presentation/ Viva-Voce – 50 Marks

FOURTH SEMESTER

(ORGANIC CHEMISTRY SPECIALIZATION)

Description of Papers	Credits	No. of Hrs/ week Theory/ Practical	Duration of exam. in Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the exams	Total Marks
PG75T401B: Organic Synthesis	4	4	3	25	75	100
PG75T402B: Photochemistry and Pericyclic Reactions	4	4	3	25	75	100
PG75T403B: Heterocyclic and Medicinal Chemistry	4	4	3	25	75	100
PG75D404B: Project Work*	6	4	8	25	125*	150
Practical						
PG75P401B: Lab Course in Organic Chemistry	2	4	3	10	40	50
PG75P402B: Lab Course in Organic Chemistry	2	4	3	10	40	50
PG75P403B: Lab Course in Organic Chemistry	2	4	3	10	40	50
Total	24	28	21	130	395	600

* Project Evaluation:

Dissertation – 75 Marks

Presentation/ Viva-Voce – 50 Marks

FOURTH SEMESTER

(PHYSICAL CHEMISTRY SPECIALIZATION)

Description of Papers	Credits	No. of Hrs/ week Theory/ Practical	Duration of exam. in Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the exams	Total Marks
PG75T401C: Quantum Mechanics and Solid State Chemistry.	4	4	3	25	75	100
PG75T402C: Catalysis and Polymer Chemistry.	4	4	3	25	75	100
PG75T403C: Spectroscopy and Microscopy.	4	4	3	25	75	100
PG75D404C: Project Work*	6	4	8	25	125*	150
C. Practical						
PG75P401C: Lab Course in Physical Chemistry	2	4	3	10	40	50
PG75P402C: Lab Course in Physical Chemistry	2	4	3	10	40	50
PG75P403C: Lab Course in Physical Chemistry	2	4	3	10	40	50
Total	24	28	21	130	395	600

* Project Evaluation:

Dissertation – 75 Marks

Presentation/ Viva-Voce – 50 Marks

FOURTH SEMESTER
(ANALYTICAL CHEMISTRY SPECIALIZATION)

Description of Papers	Credits	No. of Hrs/ week Theory/ Practical	Duration of exam. in Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the exams .	Total Marks
A. Core Subjects						
PG75T401D: Pollution and Analysis	4	4	3	25	75	100
PG75T402D: Quality Control, Analysis of Food, Beverages and Pharmaceuticals.	4	4	3	25	75	100
PG75T403D: Selected Topics in Analytical Chemistry–II	4	4	3	25	75	100
PG75D404D: Project work*	6	4	8	25	125*	150
C. Practical						
PG75P401D: Lab course in Analytical Chemistry.	2	4	4	10	40	50
PG75P402D: Lab course in Analytical Chemistry.	2	4	4	10	40	50
PG75P403D: Lab course in Analytical Chemistry	2	4	4	10	40	50
Total	22	28	24	130	420	550

* Project Evaluation:
Dissertation – 75 Marks
Presentation/ Viva-Voce – 50 Marks

FIRST SEMSTER

Course Code and Name	M.Sc. Inorganic Chemistry Syllabus 2011-2012	M.Sc. Inorganic Chemistry Syllabus 2019-2020
PG75T101A Inorganic Chemistry–I	**Unit-I: Inorganic Chemistry: Structure, Bonding And Coordination Chemistry** Ionic bonding: Properties of ionic compounds, lattice energy, Born-Lande's equation, Born-Haber cycle and its applications, Kapustinskii equation, Solvation energy, dissolution of ionic compounds in polar solvents and its energetics. The predictive power of thermochemical calculations of ionic compounds, covalent character in ionic compounds. Radius ratio and structure of ionic compounds and efficiency of packing of crystal lattices. Covalent bonding: Valence bond theory, orbital overlap, molecular orbital theory, symmetry and overlap, molecular orbital diagrams of diatomic molecules (homo- and hetero- nuclear), triatomic molecules-linear (CO_2 , N_2O) and angular (NO_2), Walsh diagrams, Bent's rules, some reactions of covalently bonded molecules, Resonance, hybridisation, VSEPR theory, molecular geometries.	**Unit-I: Structures and Energetics of Ionic Crystals and Covalent Bonds:** Ionic Bond: Properties of ionic compounds, crystal lattices, closed packed structures, coordination number of an ion, radius ratio rule, structures of crystal lattices- NaCl, CsCl, ZnS and rutile. Lattice energy: Born Lande equation, Born-Haber cycle, uses of Born-Haber type of calculations. Covalent character in ionic bonds, Fajan's rules, hydration energy and solubility of ionic solids. Covalent Bond: Valence bond theory, resonance, hybridization and energetics of hybridization. VSEPR theory: Deduction of molecular shapes. MOT of homo and heteronuclear molecules and MO treatment for the molecules involving delocalized π-bonding (CO_3^{2-}, NO_3^- and CO_2). Walsh diagrams and Bent's rule.
	UNIT-II: Metallic bonding: Characterization of metallic states, VB approach, band theory, conductors, insulators, semiconductors, defects in solids. **Organometallic chemistry:** Classification of organo-transition metal complexes, The 18-electron and 16-electron rules. Synthesis, structure, bonding and reactions of metal alkyls, aryls and olefin complexes. **Metal clusters**: Halide clusters, compounds with metal-metal multiple bonds. **Metal Π-complexes:** Preparation, structure, bonding and important reactions of metal carbonyls, metal nitrosyls, dinitrogen and dioxygen complexes.	**UNIT–IV: Solid State Chemistry:** Crystal lattice: Unit Cell, Miller indices and planes, X–ray diffraction method, molecular solids, hydrogen bonding, metallic, covalent and ionic solids; structural classification of binary and tertiary compounds, determination simple structure, spinel and perosvskite structures. Band theory, conductors, semiconductors and insulators, energy bands, intrinsic and extrinsic semiconductors. Perfect and imperfect crystals, intrinsic and extrinsic defects, point–, line– and plane– defects. Vacancy, Schottky and Frenkel defects. Schottky and Frenkel defect

		formation, colour centres, non–stoichiometry.
	UNIT-III: Stereochemistry of coordination compounds: coordination geometry, types of isomerism (geometrical & optical) Review of bonding theories, Molecular orbital theory/Ligand field theory (octahedral, tetrahedral and square planar complexes), MO theory applied to complexes with Π-bonding. Evidences for metal-ligand orbital overlap, spectrochemical seires and Jahn –Teller distortion in coordination compounds. **Electronic Spectra**: Spectroscopic gound terms, Orgel diagrams for transition metal complexes. **Magnetism**: Types, spin moment, spin-orbit coupling.	**UNIT–II: Coordination Chemistry:** Coordination numbers 2–10 and their geometries. Crystal field theory of coordination compounds: octahedral, square planar, tetrahedral, trigonal bipyramidal and square pyramidal fields, measurement of 10 Dq and factors affecting it, CFSE, Spectrochemical series and Jahn–Teller effect. Structural evidences for ligand field splitting: hydration, ligation and lattice energies. Evidences for covalency in M–L bonding. MO theory of coordination compounds: MO energy level diagrams for octahedral and tetrahedral complexes without and with pi–bonding. Electronic Spectra: Spectroscopic ground terms, Orgel diagrams for transition metal complexes(T_d&O_h). Magnetism: Types, spin moment, spin–orbit coupling.
	UNIT-IV: Metal-ligand equilibria: Stepwise and overall formation constants, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand. Chelate effect and its thermodynamic origin, determination of formation constants by polarography and spectrophotometry. **Concepts of Acids and Bases:** Theories of acids and bases, pH and pK_a, acid-base concept in non-aqueous media, HSAB concept and buffers.	**Unit-III: Stability of Metal Complexes, Concepts of Acids and Bases and Non-aqueous Solvents:** Stability of complexes: Step-wise and overall formation constants, factors affecting stability of metal complexes, determination of stability constants of metal complexes by spectrophotometric and polarographic methods. Concept of acids and bases: Theories of acids and bases, Bronsted and Lewis acids and bases, Lux–Flood theory, leveling effect of solvents, hardness and softness, HSAB concept and its applications. Non-aqueous solvents: Classification of solvents, properties of non-aqueous solvents. Reactions in non-aqueous media: Liquid ammonia, anhydrous sulphuric acid, anhydrous HF, liquid sulphur dioxide. Super acids.

PG75P101A Lab Course in Inorganic Chemistry	1) Separation and determination of two metal ions involving volumetric and gravimetric methods from the following: Fe+Ni, Zn+Cu, Cu+Fe, Zn+Ni 2) Preparation of complexes: Hg [Co $(SCN)_4$], K_3[Al $(C_2O_4)_3$].$3H_2O$ and $[Cu(tu)_3]_2SO_4$.H2O 3) Determination of composition of a complex (colorimetric method)- Demonstration	1) Determination of iron in hematite ore using cerium(IV) solution (0.02M) as the titrant and gravimetric determination of insoluble residue. 2) Determination of calcium and magnesium carbonates in dolomite ore using EDTA titration and gravimetric analysis of insoluble residue. 2) Quantitative analysis of copper-nickel in alloy/mixture: i) Copper volumetrically using KIO_3 ii) Nickel gravimetrically using DMG 3) Determination of lead and tin in a mixture: Analysis of solder using EDTA. 4) Determination of Cr(III) and Fe(III) in a mixture: Kinetic masking. 5) Quantitative determination of iron(III) gravimetrically and calcium(II) volumetrically in a mixture. 6) Determination of iron(II) and nickel (II) in a mixture: i) Iron(II) volumetrically using $K_2Cr_2O_7$ solution ii) Nickel gravimetrically using DMG solution 7) Quantitative analysis of chloride and iodide in a mixture: i) Iodide volumetrically using KIO_3 ii) Total halide gravimetrically 8) Preparation of complexes: i) Tris (thiourea) copper(I)sulphate monohydrate and ii) Tris (oxalato) aluminate (III)
PG75T102B: Organic Chemistry–I	**UNIT-I: Bonding in Organic Molecules:** Localised chemical bonding: Hybridisation index, Bonding in cyclopropane, Bond distances, Bond angles, Bond energies, Calculation of Heats of reactions, Bond order. Delocalised chemical bonding: Conjugation, Cross conjugation, Steric inhibition of resonance, Hyperconjugation, tautomerism, valence tautomerism. Bonding in Fullerenes. Bonding weaker than	**UNIT-I: Bonding in Organic Molecules:** Localized chemical bonding: Bond distances, bond angles, bond energies, bond polarity, dipole moment and calculation of heat of reactions. Delocalised chemical bonding: Conjugation, cross conjugation, steric inhibition of resonance, hyperconjugation, tautomerism, valence tautomerism. Structure and reactivity: Brönsted-Lowry concept of organic acids,

	covalent: Hydrogen bonding, EDA complexes, Inclusion compounds, Complexes of Crown ethers, Catenanes, Rotaxanes. Structure and reactivity: Bronsted-Lowry concept of organic acids, Conjugate acids and bases, pH, pKa values. Electronic, steric, and solvent effects on their strengths. General and Specific acid base catalysis, Running scale of acidity. Lewis acids and bases. HSAB concept.	conjugate acids and bases, pH, pKa values. Electronic, steric, and solvent effects on their strengths. General and specific acid base catalysis, running scale of acidity. Lewis acids and bases. HSAB concept.
	UNIT-II: Organic Reaction Mechanisms: Classification of organic reactions – Meaning and Importance of reaction mechanism. Methods of Determination of reaction mechanisms. Kinetic Methods: Order and Molecularity. Non-kinetic Methods: Product identification, Cross over experiments, Study of intermediates, Isotopic labeling, Kinetic isotope effects, Stereochemical studies. Mechanisms of Aliphatic nucleophilic substitutions, S_N2, $S_N1$and S_Ni, $S_{RN}1$ pathways Rearrangements in S_N1 reactions, Nucleophilic substitutions in cyclopropyl systems, Nucleofugacity, Nucleophilicity and Basicity, Effects of structure, leaving groups, ambident nucleophiles. Substitution v/s Elimination. Structure, Stability and reactions of the following reactive intermediates: Carbocations (classical and non-classical), carbanions and carbenes,	**UNIT–II: Organic Reaction Mechanisms:** Classification of organic reactions: Meaning and importance of reaction mechanism. Non–kinetic methods of Determination of Reaction Mechanism: Product identification, cross over experiments, study of intermediates, isotopic labeling, kinetic isotope effects and stereochemical studies. Nucleophilic substitutions (aliphatic): Mechanisms of S_N2, S_N1 (rearrangements in S_N1 reactions) and S_Ni, $S_{RN}1$ pathways. Effects of structure, leaving groups and ambident nucleophiles. Elimination Reactions: E_2, E_1, E_1CB pathways. Stereochemistry, product proportions in dehydration of alcohols, alkyl halides (chiral and achiral), Hoffmann and Saytzeff rules. Substitution v/s elimination and pyrolytic eliminations.
	UNIT-III **Stereochemistry and Conformational analysis:** Elements of symmetry and Symmetry Operations and Point groups in small molecules. Optical Isomerism: Optical activity and Chirality. Specific rotation. Molecules with one asymmetric center. Fischer, Wedge and 3D representations, DL and RS systems of indicating configuration. Ring compounds, Molecules with two chiral centers:	**UNIT-III: Stereochemistry and Conformational Analysis:** Elements of symmetry and chirality, optical isomerism, optical activity, specific rotation. molecules with one asymmetric center. Fischer, Wedge and 3D representations, DL and RS systems indicating configuration. Ring compounds, molecules with two chiral centers: Fischer, Saw–Horse, Newmann projections and their transformations.

	Fischer-Saw Horse-Newmann projections and their transformations. Enantiomers, Diastereomers, Epimers, Racemisation, Resolution. Stereochemical correlation. Pseudo-asymmetric compounds. Geometrical Isomerism: E-Z nomenclature, configuration of Geometrical isomers, Syn and Anti isomers. Conformational analysis: Conformational study of n-Butane, ethylene, Chlorohydrin, 1,2-dichloroethane, 2-aminoethanol, Curtin-Hammett principle.	Enantiomers, diastereomers, epimers, racemization, resolution. Stereochemical correlation. Geometrical isomerism: E–Z nomenclature, configuration of geometrical isomers and *syn*– & *anti*– isomers. Conformational analysis: Conformational study of n-Butane, ethylene, glycol, chlorohydrin.**Hours)**
	UNIT-IV **Aromaticity:** Aromaticity and Huckel's rule- HMO theory, Energy level diagrams, Mobius systems Benzenoid and Non-benzenoid aromatic compounds. Tropones, Tropolones, Borazine, Azulene, Pyrilium cation, Ferrocene. Alternant and non-alternant hydrocarbons. Aromaticity of charged rings (3-8 membered) Non aromatic, Anti-aromatic and homo aromatic systems. Physical methods for the determination: X-ray, UV, and NMR methods. Ring current as criteria for aromaticity. Annulenes and heteroannulenes [10-18].	**UNIT–IV: Aromaticity:** Aromaticity and Huckel's rule: HMO theory, energy level diagrams, möbius systems, benzenoid and non–benzenoid aromatic compounds. Tropones, tropolones, borazine and azulene. Heterocyclic Systems: Systems of the type pyrrole, pyridines, pyrilium cation, ferrocene. alternant and non-alternant hydrocarbons. Aromaticity of charged rings (3-8 membered), non aromatic, anti–aromatic and homo aromatic systems. Ring current as criteria for aromaticity. Annulenes and heteroannulenes [10-18].
PG75P102B: Lab Course in Organic Chemistry	Preparation of the following organic compounds: 1. Benzoic acid and Benzyl alcohol from Benzaldehyde (Cannizarro reaction). 2. p-Chlorobenzoic acid from p-toluidine. 3. Aniline from Benzene. 4. 2,4-Dinitrophenol from chlorobezene. 5. Benzil from Benzaldehyde. 6. m-Nitroaniline from Nitrobenzene. 7. Methyl orange. 8. m-Nitro benzoic acid from Ethyl benzoate. 9. Benzanilide from	**Preparation of the following organic compounds:** 1. Benzoic acid and benzyl alcohol from benzaldehyde (Cannizarro reaction). 2. Cyclohexanone from cyclohexanol. 3. Reduction of *p*-nitrobenzaldehyde to *p*-nitrobenzylalcohol. 4. 2,4-Dinitrophenol from chlorobezene. 5. Benzil from benzaldehyde. 6. m–Nitroaniline from nitrobenzene.

	Benzophenone (Beckmann rearrangement). 10. 2-Hydroxy-5-methyl benzophenone from p-cresol (Fries rearrangement). 11. p-Bromoaniline from acetanilide. 12. p-Nitroaniline from acetanilide.	7. m–Nitro benzoic acid from ethyl benzoate. 8. Benzanilide from benzophenone (Beckmann rearrangement). 9. p–Bromoaniline from acetanilide. 10. p–Nitroaniline from acetanilide.
PG75T103C Physicalchemistry: Quantum Chemistry, Reaction Kinetics, Thermodynamics &Electrochemistry and Introduction to Polymers	**UNIT- I: Quantum Chemistry – I:** Black body radiation, Planck's theory, Photoelectric effect, Compton effect. Bohr theory of hydrogen atom, Sommerfeld theory. Wave- particle duality: de Broglie hypothesis, uncertainty principle, the wave nature of electron. Schrodinger equation. Wave function and its interpretation. Normalization and orthogonality, eigen functions and eigen values.	**UNIT–I: Quantum Mechanics:** Review of classical mechanics: Equation of motion for a particle, Newtonian, Lagrangian and Hamiltonian equations of motion, elementary wave motion. Operators, eigen values and expectation values, commuting operators, linear operator and Hermitian operators. Solutions of Schrödinger equations of a free particle, particle in a box problem: in one and three dimensions, degeneracy, reflection and penetration of a particle in a one dimensional box of semi-infinite barrier, a particle in a box of finite walls. Rigid rotator, derivation of selection rules for transitions in rotating molecule, linear harmonic oscillator, Hermite polynomials. Equation for the hydrogen atom in spherical polar coordinates and an indication of the method of its solution, the quantum numbers and
	UNIT-II: Quantum Chemistry – II: Solutions of equations of a free particle, particle in a box problem: in one and three dimensions. Rigid rotator and the harmonic oscillator. Equation for the hydrogen atom in spherical polar coordinates and an indication of the method of its solution, the quantum numbers and their significance.Hydrogen-like atoms, properties of the H-atom wave functions. Electronic energy states of	their significance**.** Hydrogen-like atoms, properties of the H–atom wave functions. Electronic energy states of H–atom. Many electron systems and the self-consistent field method. Electronic configurations in the periodic table. Pauli exclusion principle. **UNIT–II: Reaction Kinetics:** A critical account of collision and transition state theories. Kinetics and mechanism: Steady state

	H-atom. Many electron systems and the self-consistent field method. Electronic configurations in the periodic table. Pauli exclusion principle. Spectroscopic term symbols.	approximation and simple examples relating kinetics to mechanism.Theories of Unimolecular reactions: RRKM theory. Isomerisation of methyl isocyanide. Chain Reactions, examples of chain reactions, general aspects of chain reactions. Chain-length, chain transfer reactions, chain inhibition, kinetics of branching chain reactions and explosion limits.
	UNIT-III: Reaction Kinetics: A critical account of collision and transition state theories. Kinetics and Mechanism: Steady state approximation and simple examples relating kinetics to mechanism.Theories of unimolecualr reactions: RRKM theory. Isomerisation of methyl isocyanide. Chain Reactions: examples of chain reactions, general aspects of chain reactions. Chain-length, Chain transfer reactions, Chain inhibition, Kinetics of branching chain reactions, explosion limits.	**UNIT–III: Thermodynamics:** Thermodynamic criteria for spontaneous chemical changes. Systems at (i) constant volume and temperature and (ii) constant pressure and temperature (derivation of $dA \leq 0$ &$dG \leq 0$). Dependence of free energy on pressure and temperature. Standard free energies and their determination. Relation between free energy change and equilibrium constant. Gibbs–Helmholtz equation and their different forms. The pressure dependence of free energy of non–ideal gases and fugacity. Standard state for non-ideal gas. Equilibrium constant for system of non–ideal gases. Lewis and Randall rule. Temperature dependence of free energy and equilibrium constants.Partial miscibility, activity and activity coefficients of components of solutions, partial molar quantities and their determinations. Gibbs–Duhem equation and the calculation of activity of a component in solutions. Duhem–Margules equation. Ternary systems and phase diagram of ternary systems.
	UNIT-IV: Thermodynamics& Electrochemistry: Thermodynamic criteria for spontaneous chemical changes. Standard free energies and their determination. Relation between free energy change and equilibrium constant. The pressure dependence of free energy of non-ideal gases; fugacity. Standard state for non-ideal gas. Equilibrium constants in non-ideal systems. Temperature dependence of free energy and equilibrium constants. Debye-Huckel theory of activity	**UNIT–IV:Polymers:**

	coefficients and Debye-Huckel-Onsagar theory of conductance of strong electrolytes.	Review on basic concepts of polymers and their classifications. Homopolymers, copolymers, terpolymers, addition polymers and condensation polymers with examples. Comparison between addition polymers and condensation polymers. Tacticity with examples of polystyrene and PMMA. Elastomers, difference between elastomer and thermoplastic, approaches to increase processability. Techniques of free–radical polymerization: Bulk, solution, suspension, emulsion and precipitation polymerization.Reactions of vinyl polymers**:** Functional group reactions, ring-forming reactions and block & graft copolymer formation. Crosslinking reactions:peroxide crosslinking, sulphur vulcanization, radiation crosslinking, photo crosslinking, electron beam crosslinking and miscellaneous crosslinking reactions. Polymer degradation: Chemical, thermal and radiation degradations.
PG75P106C: Lab Course in Physical Chemistry	1. **Calibration:** Calibration of glassware and weight box 2. **Density:** Determination of partial molar volume (eg. Salts in water and	1. **General Information and Chemical mathematics**: Calibration of glasswares, concentration measures of solutions- concept of normality, molarity, molality and mole fraction, preparation of standard solution. Treatment of Experimental data – Errors, type of errors, Accuracy and precision. Mean deviation, standard deviation,

	liquids in water, systems)	significant figures, Methods of average and least squares.
	3. Viscosity: Molecular radius of glycerol molecule and molecular weight of a polymer by viscosity measurements	**2. Spectrophotometry:** To obtain the absorption curve of $KMnO_4$ solution on a colorimeter and hence verify Beer–Lamberts law.
	4. Distribution law: Distribution of benzoic acid (or succinic acid, etc.) between water and benzene.	**3. Potentiometry:** Determination of the dissociation constant of dibasic acids (minimum two acids and titration with NaOH)
	5. Thermochemistry: i. Step -wise heat of neutralization of a polybasic acid ii. Integral heats of solution and heats of dilution of salts. (e.g., KNO_3, NaCl etc.)	**4. Conductance:** Simultaneous estimation of $H_2C_2O_4$ and HCl in the mixture conductometrically by titrating with NaOH.
	6. Refractometry: Molar refraction of a solid substance by measuring the refractive indices of its solutions. **7. Spectrophotometry:** i. Mixture analysis by absorptiometry/Spectrophotometry. ii. Applicability range (for an absorbing substance in solution) and evaluation of the molar absorbency index, finding unknown concentration.	**5. Distribution law**: Studying the distribution of benzoic acid between water and benzene and hence determine the degree of association of benzoic acid in benzene. **6. Viscosity**: Determination of viscosity average molecular weight of polystyrene in toluene by Ubbelohde Viscometer
	8. Reaction Kinetics: Acid hydrolysis, catalytic strengths and determinationof Ea.	**7. Thermochemistry:** Determine the relative strength of CH_3COOH and $ClCH_3COOH$ by calorimetric method.
	9. Potentiometry: Dissociation constant of weak monobasic acids and titration of $HCl+CH_3COOH$ with NaOH.	
	10. Electrical conductance: i. Titration of a weak acid with a weak base and a strong acid with a	**8. Reaction Kinetics:** Determination of activation parameters of the reaction of

	weak base. ii. Titration of acid mixture with NaOH. e.g. CH_3COOH + HCl; CH_3COOH + $H_2C_2O_4$; HNO_3 + H_2SO_4; $H_2C_2O_4$ + HCl	acid hydrolysis of methyl acetate at two different temperatures. 9. **Cryoscopy:** Determination of cryoscopic constant of benzene and nitrobenzene 10. **Refractometry**: Analysis of a binary mixture (glycerol and water) by refractive indices measurement.
PG75T104D : General Chemistry	**UNIT-I** **Volumetric methods**: Classification of reactions in volumetry. Theories of indicators: Acid-base, redox, metallochromic, fluorescent and chemiluminescent indicators. Complexation titrations: Titrations using EDTA. Selective masking and demasking techniques, industrial applications of masking. Precipitation titrations. Redox titrations. **Gravimetric methods**: Mechanism of precipitate formation. Factors influencing completion of precipitation. Washing, drying and ignition of precipitates. Precipitation from homogeneous solutions. Coprecipitation and postprecipitation. Organic reagents used in gravimetry (Oxine and dimethylglyoxime). **UNIT-II** **Nomenclature of Inorganic Compounds**: General aspects and affixes. Naming of ions, radicals, iso and heteropoly anions, acids, salts, salt-like compounds and addition compounds. **Chemistry of Lanthanides**: Electronic structure, Oxidation states, ionic radii, and Lanthanide contraction. Complex formation. and compounds of Lanthanides **Chemistry of Actinides**: General features, methods of separation of Np, Pu, Am from	**UNIT–I** **Language of Analytical Chemistry, Data Treatment and Gravimetric Analysis:** Language of analytical chemistry: Definition of analysis, determination, measurement, techniques and methods. Classification of analytical techniques. Selection of an analytical method: Accuracy, precision, sensitivity, selectivity, robustness and ruggedness. Figures of merit of analytical methods: Sensitivity, detection limit and linear dynamic range. Errors and Treatment of analytical Data: Limitations of analytical methods–Errors: determinate and indeterminate errors, minimization of errors. Statistical treatment of finite samples, measures of central tendency and variability, mean, median, range, standard deviation and variance. Student's t-test, confidence interval of mean. Testing for significance and comparison of two means and two standard deviations. Comparison of an experimental mean and a true mean. Criteria for the rejection of an observation, Q–test. External standard calibration, the least squares methods, regression equation and correlation coefficient. Gravimetric analysis: Mechansim of

	Uranium. Similarities between Later actinides and Later Lanthanides. **UNIT-III** **Reactions**: Friedel-Crafts, Claisen-ester, Claisen-Schmidt, Baylis-Hillman, Houben-Hoesch, Arndt-Eistert, Wurtz, Wurtz-Fittig, Sonogoshira, Buchwald-Hartwig reactions **Rearrangements**: Amadori, Orton, Wallach, Demjanov, Claisen, Wagner-Meerwein and Nametkin, rearrangements. **Transformations:** Organic functional group Interconversions involving substitution, addition, elimination, diazocoupling, oxidation, reduction, hydrolysis, and rearrangement reactions associated with aromatic compounds. **UNIT-IV** **Corrosion and its Control:** Introduction. Definition. Chemical and electrochemical theories of corrosion. Galvanic series. Factors affecting corrosion rate (nature of the metal, relative areas of anode and cathode, nature of the corrosion product, nature of the medium-conductivity, pH and temperature). Types of corrosion- galvanic, differential aeration (waterline), intergranular, pitting and stress. Corrosion control- design and selection of material, protective coatings- metal coatings, anodic and cathodic, inorganic coatings (anodizes and phosphate), cathodic protection (sacrificial and impressed current methods) and anodic protection. **Surfactants:** Introduction. Properties, Type of surfactants, Anionic surfactants, Cationic surfactants, Nonionic surfactants, Amphoteric surfactants. Applications of the surfactants. Harmful effects of surfactants. **Fuel Cells:** Introduction, difference between conventional cell and a fuel cell, limitations, advantages; types of fuel cells. Construction and working of hydrogen-oxygen and methanol-oxygen fuel cells.	precipitation, factors influencing precipitation, coprecipitation, postprecipitation and organic reagents used in gravimetry (oxime and dmg). **UNIT–II** **Titrimetric Methods:** Titrimetric Analysis: Principles of titrimetric analysis. Classification of reactions in titrimetry. Titrations based on acid-base reactions: Titration curves for strong acid and strong base, weak acid and strong base and weak base and strong acid titrations. Titration curves, quantitative applications, selecting and standardizing a titrant, inorganic analysis, alkalinity, acidity and ammonium salts. Complexometric titrations: Indicators for EDTA titrations, theory of common indicators, titration methods employing EDTA, direct, back and displacement titrations, indirect determinations, titration of mixtures using masking and demasking agents. Redox Titrations: Balancing redox equations, calculation of the equilibrium constant of redox reactions, titration curves, theory of redox indicators, calculation of standard potentials, determination of chemical oxygen demand (COD) in natural and waste waters. Precipitation titrations: Titration curves, titrants and standards, indicators for precipitation titrations involving silver nitrate, the Volhard, the Mohr and the fajan's methods **UNIT–III** **Separation Methods–I:** Fundamentals of chromatography: General description, definition, terms and parameters used in chromatography, classification of chromatographic methods, criteria for selection of stationary and mobile phase and nature of adsorbents.

		Column chromatography: Theories, plate theory, rate theory, band broadening-eddy diffusion, longitudinal diffusion and resistance to mass transfer, column efficiency, Van Deemter's equation and its modern version, interrelationships, capacity factor, selectivity factor, column resolution, distribution constant and applications of conventional column chromatography, advantages and limitations. Thin layer chromatography (TLC): Definition, mechanism, efficiency of TLC plates, methodology, selection of stationary and mobile phases, development, spray reagents, identification and detection, reproducibility of R_f values, qualitative and quantitative analysis. High performance liquid chromatography (HPLC): Instrumentation, pumps, column packing, characteristics of liquid chromatographic detectors, UV and fluorescence detectors, advantages and applications. **UNIT–IV** **Separation methods–II** Gas chromatography (GC): Principle, instrumentation, columns, study of detectors, thermal conductivity, flame ionization and mass spectrometry, factors affecting separation, retention volume, retention time and applications. Ion exchange chromatography (IEC): Definition, principle, requirements for ion-exchange resin, types of ion-exchange resins, resin properties-ion-exchange capacity and its determination, resin selectivity and factors affecting the selectivity, applications of IEC in purification and

		recovery processes. Solvent extraction: Nernst partition law, efficiency and selectivity of extraction. Extraction systems: Extraction of covalent neutral molecules, extraction of uncharged metal chelates and synergic extraction, extraction of ion-association complexes-non chelated complexes and chelated complexes. Use of salting out agents. Methods of extraction–batch and continuous extractions. Applications (special emphasis on extraction of iron and copper).
PG75P104D: Lab Course in Analytical Chemistry	1. Separation of Binary mixture of Organic compounds without solvent ether, containing Carboxylic acids, Phenols, Bases and Neutral compounds 2. Identification of individual compounds by qualitative analysis 3. Preparation of functional group derivatives 4. Determination of nitrite by KMnO4. 5. Determination of Ni^{2+} using EDTA. 6. Use of masking of agents in volumetric analysis. 7. Determine the radius of glycerol molecule by viscosity method. 8. Comparison of the strengths of two acids by finding the rate of the hydrolysis of methyl acetate at room temperature. 9. Determine the relative strength of chloroacetic acid and acetic by conductivity measurements.	**I. Organic Chemistry Practical** Quantitative analysis Titrimetric Estimation of amino acids. Estimation of glucose by Bertrand's method. Estimation of keto group. Iodine value of oil (Chloramine - T method) Estimation of Nitro group by reduction using $SnCl_2$. Qualitative Analysis Separation of binary mixture of organic compounds using ether and identification of separated compounds by systematic qualitative organic analysis. Please Note: 1) Individual organic compounds are to be given after the candidate reports the nature of the mixture. 2) Ether insoluble acids and ether insoluble Neutral organic

		compounds may be given. 3) Low boiling liquids and Amino acids need not be given. The following mixtures may be given: Acid + Base Acid + Neutral Base + Neutral Phenol + Acid Base + Phenol **II-Physical Chemistry Practicals** Determination of molecular radius of glycerol molecule by viscosity method. Estimation of metal ions of ferric-thiocyante and cupric-ammonia complexes by spectrophotometrically. Determination of relative strength of acids (HCl and H_2SO_4) by studying the hydrolysis of methyl actetate. Determination of dissociation constants of weak monobasic acids potentiometrically by titrating against NaOH. Comparison of strengths of chloroacetic acid and acetic acid using conductometric method. Determine the dissociation constant of acetic acid pH-metrically by titrating against NaOH.
SECOND SEMESTER		
PG75T201A Inorganic Chemistry:	**UNIT-I: Chemistry of non-transition elements:** Syntheses, properties and structures of	**UNIT–I: Chemistry of Non-Transition Elements**: Alkali and alkaline earth metal

Chemistry of Non-Transition Elements, Separation Techniques And Group Theory	boranes, borazines, silicates, phosphazenes, S-N compounds, silicones and carboranes. Peroxo compounds of boron, carbon and sulphur. Oxyacids of nitrogen, phosphorus, sulphur and halogens. Interhalogen compounds and pseudohalogens. Noble gas compounds: Preparation and structure of noble gas compounds (oxides and fluorides).	complexes of crown ethers, cryptands and calixarenes and their biological importance. Synthesis, properties and structures of boron, carbon and silicon compounds: Chemistry of higher boranes, classification, structures and MO description of bonding, framework electron counting, Wade's rules, chemistry of B_5H_9, $B_{10}H_{14}$ and $B_nH_n^{2-}$, boron nitride, borazines, carboranes, metalloboranes, metallocarboranes; silicates, silicones, graphite, graphene, carbon nanotubes and zeolites. Hydrogen bonding and its influence on properties.
	UNIT-II: Separation techniques: Ion exchange: Types of ion exchange resins, ion exchange capacity, ion exchange equilibria and selectivity coefficient, techniques of ion exchange process. Applications of ion exchangers: Preparation and purification of reagents, removal of interfering ions, concentration and recovery of traces, determination of total salts (stoichiometric substitution) and in the separation of lanthanides and actinides. Solvent extraction: Basic principles of solvent extraction, relationship between percentage extraction and distribution ratio and distribution selectivity of an extraction. Techniques of extraction and choice of solvents, stripping, back washing, treatment of emulsion, variation of oxidation states, use of masking out and salting out agents. Classification of solvent extraction methods. Synergistic extractions. Applications of solvent extraction	**UNIT–II: Chemistry of Main Group Elements**: Nitrogen, phosphorous and sulphur compounds: Hydrides, oxides and oxy acids of nitrogen, phosphorous, sulphur and halogens. Phosphazines, phosphazene polymers, sulphur–nitrogen compounds: Binary sulphur nitrides: S_4N_4, S_2N_2 and $(SN)_x$. P–O and P–S cage compounds. Chemistry of halogens and xenon: Interhalogens, psuedohalogens, polyhalide ions, oxyhalogen species. Xenon oxides and fluorides.
	UNIT-III: Chromatography: General principles and classification of chromatographic methods: Paper, Thin-layer, column and liquid chromatography. Gas chromatography : Principles, instrumentation, stationary phases and	**UNIT–IV: Organometallic Chemistry:** Organometallic compounds: Introduction, classification of organometallic compounds by bond type, nomenclature, classification of ligands σ and π ligands, hapticity of

	types of carrier gas used in GC. Methods of sample injection, types of detectors used, programmed temperature GC, plate and plate height in GC. Applications of GC, use of GC-MS in detection of samples. HPLC and its applications. **Data analysis:** Errors: Types of errors, propagation of errors, accuracy and precision, significant figures. Standard deviation, Significance of t- and F-tests and least squares analysis	ligands, 18 and 16 electron rules, electron counting schemes. Ferrocene and ruthenocene: Preparation, structure and bonding. Complexes containing alkene and alkyne ligands: Preparation, structure and bonding. Carbene (Fischer and Schrock type) complexes: Synthesis, structure and bonding. The isolobal principles. Use of organometallic reagents in hydrogenation, hydroformylation, isomerisation and polymerization reactions.
	UNIT-IV: Symmetry and Group theory: Molecular symmetry, Representation of symmetry operation as matrices. Definition of groups, set of symmetry operations of molecules satisfying the condition of point groups. Representation, basis of representation, reducible and irreducible representation. The great orthogonality theorem, character tables and their applications to chemical bonding	**UNIT–III: Symmetry and Group Theory:** Molecular symmetry, representation of symmetry operation as matrices. Definition of groups, set of symmetry operations of molecules satisfying the condition of point groups. Representation, basis of representation, reducible and irreducible representation. The great orthogonality theorem, character tables. The direct product. Applications of group theory: Molecular vibrations; molecular vibration in symmetrical AB_2. Hybridisation (tetrahedral and trigonal planar geometries)
PG75P201A Lab Course in Inorganic Chemistry	1. Semi-micro qualitative analyses of mixtures containing two each of common cations and anions and one of the following less familiar elements (W,Mo,Ce,Th,Ti,Zr,V and U) 2. Analysis of solder alloy 3. Analysis of haematite ore	1. Semimicro qualitative inorganic analysis of a mixture containing three cations (including one less common cation such as W, Mo, Ti, Zr, Ce, V and Li) and two anions (one of them may or may not be interfering anion such as PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$, F^- and CH_3COO^-). 2. Separation and determination of Zn and Mg on an anion exchanger. 3. Demonstration experiment: Determination of iron as the 8–hydroxy quinolate by solvent extraction.
PG75O201A Applied Inorganic Chemistry (Elective)	**UNIT-I: Data analysis:**Types of errors, accuracy and precision, methods of minimization of systematic errors, mean and standard deviation,	**UNIT–I: Data Analysis:** Types of errors, accuracy and precision, methods of minimization of systematic errors, mean and standard

	distribution of random errors, reliability of results, comparison of results-Student t-test, F-test and chi-square test, significant figures, confidence intervals, method of least squares, calibration curve and standard addition method	deviation, distribution of random errors, reliability of results, comparison of results-Student t-test, F-test and chi–square test, significant figures, confidence intervals, method of least squares, calibration curve and standard addition method.
	UNIT-II: Thermal methods of analysis: Thermobalance, Factors influencing thermogravimetric results, Differntial thermal analysis-Instrumentation for differential thermal analysis(DTA) and differential scanning calorimetry (DSC). Applications of TG, DTA and DSC. **7 hrs** **Inorganic polymers:** Silicones, Polyphosphazenes, Synthesis, structure and applications.	**UNIT–II: Thermal Methods of Analysis and Inorganic Polymers:** Thermal methods of analysis: Thermobalance, factors influencing thermogravimetric results, differntial thermal analysis: Instrumentation for differential thermal analysis (DTA) and differential scanning calorimetry (DSC). Applications of TG, DTA and DSC. Inorganic Polymers:Silicones, polyphosphazenes, synthesis, structure and applications
	UNIT-III: Bioinorganic Chemistry: Metal ions in biological systems, deficiency of trace metal ions (Fe, Zn, Cu and Mn),Metal ions and chelating agents in medicine: treatment of toxicity due to inorganics (chelation therapy), metal complexes as therapeutic agents. Proteins and their functions**:** Heme proteins, Oxygen uptake proteins-hemoglobin and myoglobin,	**UNIT–III: Bioinorganic Chemistry:** Metal ions in biological systems, deficiency of trace metal ions (Fe, Zn, Cu and Mn), metal ions and chelating agents in medicine: Treatment of toxicity due to inorganics (chelation therapy) and metal complexes as therapeutic agents. Proteins and their functions**:** Heme proteins, oxygen uptake proteins-hemoglobin and myoglobin,
	UNIT-IV: Chromatography: Gas chromatography**-** Principles, instrumentation, stationary phases and types of carrier gases used in GC. Methods of sample injection, types of detectors, programmed temperature GC, plate and plate height theory in GC. Applications of GC, use of GC-MS in detection of samples.	**UNIT–IV: Chromatography:** Gas chromatography**:** Principles, instrumentation, stationary phases and types of carrier gases used in GC. Methods of sample injection, types of detectors, programmed temperature GC, plate and plate height theory in GC. Applications of GC and use of GC-MS in detection of samples.
PG75T202B: Organic Chemistry–II	**UNIT–I** **Reaction Mechanism:** Aliphatic Electrophillic Substitutions : Bimolecular pathways. S_E2, S_E1 and S_Ei mechanisms. Reactions involving double bond shifts. Aromatic	**UNIT–I** **Reaction Mechanism:** Aliphatic electrophillic substitutions: S_E2, S_E1 and S_Ei mechanisms. Reactions involving double bond

	Electrophillic Substitutions : Mechanisms of aromatic, Nitration, Sulphonation, Halogenation, isotope effects, energy profile diagrams. Kinetic and thermodynamic control., Hammond's Postulate, o/p ratio. ipso substitution, Vilsmeir Haack, Pechmann, Fries rearrangement. Aromatic Nucleophilic Substitutions : S_NAr, S_N1 and aryne pathways. Meisenheimer complexes, Vicarious nucleophilic displacement, Von-Richter and Smiles rearrangement.	shifts, α-halogenation of carbonyl compunds, nitrosation at carbon bearing active hydrogen, mercury exchange reactions. Aromatic electrophillic substitutions: Mechanisms of aromatic, nitration, sulphonation, halogenation, isotope effects, energy profile diagrams. Kinetic and thermodynamic control, sulphonation, Hammond's Postulate, o/p ratio, ipso–substitution, Vilsmeir Haack and Fries rearrangement. Aromatic nucleophilic substitutions: S_NAr, S_N1 and aryne pathways. Meisenheimer complexes, mechanism and synthetic applications of vicarious nucleophilic substitution (VNS), Von-Richter, Goldberg, Bucherer, Shiemann reactions and Smiles rearrangement
	UNIT-II **Advanced Stereochemistry:** Prochirality: Homotopic, Enantiotopic and Diastereotopic atoms, groups and faces. Stereochemical Descriptors : Application to reduction of carbonyl compounds, cyanohydrin formation, addition of water to alkenes. Optical activity due to molecular dissymmetry : Allenes, Spiranes, Biphenyls, Atropisomerism, Molecular Crowding. Conformational analysis of cyclohexane, mono substituted and disubstituted (1,2, 1,3, 1,4) cyclohexanes. Cis and Trans Decalins. Chirality of cyclohexanes.	**UNIT–II** **Advanced Stereochemistry:** Prochirality: Homotopic, enantiotopic and diastereotopic atoms, groups and faces. Stereochemical descriptors: Application to reduction of carbonyl compounds, cyanohydrin formation, addition of water to alkenes. Optical activity due to molecular dissymmetry: Allenes, spiranes, biphenyls, atropisomerism, molecular crowding. Conformational analysis of cyclohexane, mono substituted cyclohexanes. Chirality of cyclohexanes.
	UNIT-III **Carbohydrates:** Conformational representation of monosaccharides. Mechanism of Mutarotation- Base catalysed Isomerisation of Aldoses and ketoses. Epimerisation, Anomeric effect. Glycosides, Ether and Ester derivatives of carbohydrates. Acetone, amino and Deoxysugars. Oxidation and reduction reactions of carbohydrates.	**UNIT–III** **Carbohydrates:** Monosaccharides: Conformational representation of monosaccharides and their transformations. Determination of configuration of the monosaccharides, mechanism of mutarotation–base catalyzed isomerisation of aldoses and ketoses. Epimerisation, anomeric effect, glycosides, ether and ester derivatives

	Disaccharides: Lactose, Maltose and Sucrose. Polysaccharides: Structure and degradation of starch, cellulose and glycogen.	of carbohydrates. Acetone, amino and deoxysugars. Oxidation and reduction reactions of carbohydrates. Disaccharides: Structure elucidation of maltose, lactose, sucrose. Polysaccharides: Structure and degradation of starch, cellulose and glycogen.
	UNIT-IV **Chemistry of Heterocycles:** Nomenclature, structure, reactivity, synthesis, and chemical reactions of : Indole, Quinoline, Isoquinoline, Thiazole, Imidazole, Benzimidazole, Coumarin, Chromones, Flavones and Isoflavones.	**UNIT–IV** **Chemistry of heterocycles:** Nomenclature of heterocyclic compounds including fused heterocycles. Synthesis and chemical reactions of indole, quinoline, isoquinoline, thiazole, imidazole, benzimidazole, coumarin, flavones and isoflavones.
PG75P202B: Lab Course in Organic Chemistry	1. Quantitative Estimation of the following Organic compounds: a. Acid. b. Acid + Amide. c. Acid + Ester. d. Glucose. e. Molecular weight determination by base hydrochloride method. 2. Preparations of derivatives of heterocycles like Coumarins, Quinolines, Benzimidazoles, Benzoxazines, Pyrazoles etc. 3. Preparations based on functional group reactions of organic compounds like Aldehydes, Ketones, Esters, Phenols etc. Note: Any two of the above experiments will be prescribed for the examination.	1. Quantitative Estimation of the following Organic compounds: (i) Acid (ii)Acid + Amide (iii) Acid + Ester (iv) Molecular weight determination by base hydrochloride method (v) Phenol (Bromometric method). 2. Preparations of derivatives of heterocycles like coumarins, quinolines, benzimidazoles, benzoxazines, pyrazoles by convention, microwave and by sonication. 3. Preparations based on functional group reactions of organic compounds like aldehydes, ketones, esters, phenols etc. Note: Any two of the above experiments will be prescribed for the examination.
PG75T203C: Physical Chemistry–II	**UNIT- I: Molecular Spectroscopy:** Electromagnetic radiation and its interaction with matter. Atomic and molecular spectra. Rotational spectra of a rigid and non-rigid planar simple	**UNIT–I: Microwave Spectroscopy and X–ray Diffraction:** Microwave spectroscopy: Gaseous microwave spectra and rotational transitions: Study of inversion of

	molecules. Vibrational spectra of harmonically vibrating diatomic molecules, anharmonic case. Morse potential function and dissociation energy. The diatomic vibrating rotator, the vibrations of polyatomic molecules, specific group vibrations. Applications of infrared spectroscopy. Raman spectra: Raman effect, Rotational Raman and vibrational Raman spectra of simple molecules. Complementarity of IR and Raman.	ammonia and hindered rotations in molecules. Instrumentation. Stark effect in molecular spectra, first and second order Stark effects. X–ray diffraction: Origin and production of X-rays, interaction of X–rays with matter: Absorption, scattering and diffraction. Reciprocal lattice: Brag's law in reciprocal space. Instrumentation: Sources, filters, monochromatic detectors. Crystal structure: Unit cell, lattices, planes and miller indices. Debye-Scherrer powder methods and Weissenberg camera. Numerical problems.
	UNIT- II:Electronic Spectroscopy: Electronic spectroscopy of diatomic molecules. Born-Oppenheimer approximation. Vibrational course structure of electronic transitions: The v' and v" progressions. Deslandres table. Intensity: the Franck-Condon principle. Pre dissociation. **Thermodynamics:** A review of the thermodynamics of ideal solutions. Non-ideal liquid systems. Partial miscibility. Activity and activity coefficients of components of solutions, partial molar quantities and their determinations. Gibbs-Duhem equation and the calculation of activity of a component in solutions. Duhem-Margules equation. Ternary systems: phase diagram of ternary systems. **UNIT- III: Reaction Kinetics:** Kinetics in solution: Primary and secondary salt effects, ion-ion neutral molecule type reactions. Effect of solvent, cage effect.Mechanism of	**UNIT–II: Reaction Kinetics** Kinetics in Solution:Effect of solvent, pressure and ionic strength for ion–ion, ion–neutral molecule type reactions and cage effects. Potential energy surfaces, methods employed in the construct of potential surfaces, calculating reactions. Fast Reactions:Techniques for fast reactions, flow methods, stopped flow technique, relaxation methods and flash photolysis. Numerical problems. **UNIT–III: Electrochemistry:** Introduction to electrochemistry, Debye-Huckel and Bjerrum models and the corresponding theoretical expression for activity coefficient and Debye–Huckel–Onsagar theory of conductance of strong electrolytes. Electrochemistry of Solution: Activity of ions in solution, solvation number

	heterogeneous catalysis. BET theory, Gibbs adsorption equation. Flash photolysis and applications. Chemiluminescence.	and their determination, ion-solvent interactions, ion-ion interactions and free energy of ions in solution and triple ion formation, conductance minima and free energy of ions in solution. Born model for calculating the free energy of ion-solvent interaction and its modifications. The enthalpy and entropy of ion–solvent interaction. Electrical double layer: Electrocapillarity, Lippman equation (surface excess), theories of electrical double layer: Helmholtz–Perrin, Gouy–Chapman and Stern theories. Effect of ions on zeta potential. Over potentials, exchange current density, derivation of Butler–volmer equation and Tafel plot.
	UNIT- IV: Introduction to Polymers: Basic concepts: Monomers, repeat units, polymers and degree of polymerization. General classification of polymers, homopolymers, copolymers, terpolymers, addition polymers and condensation polymers with examples, tacticity, comparison between thermoplastics and thermosetting polymers.Techniques of freeradical polymerization: Bulk, solution, suspension, emulsion and precipitation polymerization.Polymer molecular weight:Number average and weight average molecular weights, polydispersity and molecular weight distribution in polymers.Reactions of polymers: Functional group reactions, ring-forming reactions and block & graft copolymer formation. Crosslinking reactions:peroxide crosslinking, sulphur vulcanization, radiation crosslinking, photo crosslinking, electron beam	**UNIT–IV: Polymer chemistry:** Transitions in polymers: Definition of glass transition temperature (T_g) and flow temperature (T_f) and melting temperature (T_m), thermal behaviour of amorphous and crystalline polymers, factors affecting the T_g.Plasticizers, properties and their effect on $T_g$of PVC and diethylhexylsuccinate, efficiency of plasticizers, comparison of T_g and T_m. T_g of copolymers and polymer blends, relation between $T_g$and T_m. Polymer molecular weight: Number average and weight average molecular weights, polydispersity and molecular weight distribution in polymers. Numerical problems on determination of molecular weights.Kinetics of polymerization: Kinetics of free-radical addition polymerization, cationic polymerization, anionic polymerization, copolymerization and determination of reactivity ratios.

	crosslinking and miscellaneous crosslinking reactions. Elastomers	Polymer synthesis: Ziegler–Natta polymerization (isotactic and syndiotactic) and its limitations. Metallocene catalysis polymerization (isotactic). Metathesis polymerization: Acyclic diene metathesis polymerization (ADMET) and ring opening metathesis polymerization (ROMP). Group transfer polymerization (GTP) and advantages of GTP.
PG75P203C: Lab Course in Physical Chemistry	**1. Surface Tension**: a. Variation of surface tension of aqueous solutions of n-propyl alcohol with concentration and determination of the limiting cross-sectional area of the molecule. b. Effect of added salt on surface tension of water (and/or comparison of the cleansing powers of the two detergent samples). **2. Solubility**: Heat of solution of an organic compound by solubility experiments and the effect of addition of an electrolyte on the solubility. **3. Phase Equilibria:** Equilibrium constant of the reaction: $KI+I_2 \quad KI_3$ **4. Thermochemistry:** Heat of neutralization of a weak acid and calculation of its heat of ionization. **5. Spectrophotometry:** Investigation of complex formation. (eg., Fe^{+3} + Salicyclic acid system:formula, stability, ΔG value	**1. Solubility:** Determine the heat of solution of a solute (eg. oxalic acid or benzoic acid) by solubility method. **2. Coulometric titration:** Titration of I_2 against $Na_2S_2O_3$. **3. Cryoscopy:** Determination of the degree of dissociation of a given strong electrolyte and the determination of the number of ions present in the solute using cryoscopy method. **4. Spectrophotometry:** To obtain the absorption spectra of coloured complexes (Ferric-thiocyanate and Cupric–ammonia complexes) and hence verify the Beer–Lambert's law and estimation of metal ions in solution by spectrophotometry. **5. Conductance:** (i) Determination of equivalent conductance of a weak electrolyte at different concentrations and the applicability of Ostwald's law. (ii) Determination of equivalent conductance of a weak electrolyte from Kohlrausch's law.

	calculation and pH effects). **6. Electric conductance:** Equivalent conductance of a weak electrolyte at differentconcentrations and the applicability of Ostwald's law. **a.** Verification of the Onsager equation for strong electrolytes. **b.** Equivalent conductance of a weak electrolyte from Kohlrausch's law. **7. Reaction Kinetics:** a. Salt effect on the persulphate-iodide reaction. b. Iodination of acetone. c. Autocatalysis: Mn (VII)-Oxalic acid case in the presence of H_2SO_4. **8. EMF of Cells:** a. Solubility of sparingly soluble salts. b. Titration of Fe^{2+} with Ce^{4+} or Cr^{6+} and determination of the formal redox potentials of the complexes of Fe^{3+}/Fe^{2+} and Ce^{4+}/ Ce^{3+} or Cr^{6+}/ Cr^{3+}. c. Titration of Zn^{2+} with $Fe(CN)_6^{4-}$ and determination of the empirical formula of the complex formed. **9. Cryoscopy:** a. Determination of the degree of dissociation of a given strong electrolyte and the determination of the number of ions present in the solute. b. Determination of the molecular weight of the given solute by the vacuum flask method.	**6. Potentiometry:** Potentiometric determination of formal redox potential of Fe^{2+}/Fe^{3+} and Ce^{4+}/ Ce^{3+} or Cr^{6+}/ Cr^{3+} couples by titrating Fe^{2+} solution with Ce^{4+} or Cr^{6+}. **7. Reaction Kinetics**: Investigation of autocatalytic reaction between potassium permanganate and oxalic acid in the presence of H_2SO_4. **8. Viscosity:** Determination of limiting viscosity number (Staudinger index) of polystyrene. **9. pH metry:**Titration of acetic acid against NaOH and hence determine the acid dissociation constant (K_a).

THIRD SEMSEST (INORGANIC CHEMISTRY)		
PG75T301A Coordination And Bioinorganic Chemistry	**UNIT-I: Spectral and Magnetic properties of complexes:** Term symbols for d^n ions, spectroscopic ground states, selection rules, nature of spectral bands- band shapes, band intensities, band widths, effect of spin-orbit coupling, Orgel diagrams, Tanabe-Sugano diagrams, Racah parameters, interpretation of spectra of octahedral, distorted octahedral, tetrahedral and square planar complexes, calculation of nephelauxetic parameter, Charge transfer bands, intervalence charge-transfer bands. Type of magnetic behaviour, classical magnetism, orbital contribution, orbital contribution reduction factor, spin orbit coupling, measurement of magnetic susceptibility – Gouy and Faraday methods, diamagnetic corrections, magnetically non-dilute compounds-ferro, antiferro and ferri magnetic, spin cross-over systems, correlation of magnetic and structural properties	**UNIT–I: Electronic spectra and magnetic properties:** Spectral properties of complexes: Term symbols for d^n ions, spectroscopic ground states, selection rules, nature of spectral bands- band shapes, band intensities, band widths, spin-orbit coupling, Orgel diagrams, Tanabe–Sugano diagrams, Racah parameters, interpretation of spectra of octahedral, distorted octahedral, tetrahedral and square planar complexes, determination of 10Dq, B′ and nephelauxetic parameterfrom absorption spectra of octahedral and tetrahedral complexes, charge transfer bands: Origin, types, and characteristics, intervalence charge–transfer bands. Magnetism: Determination of magnetic susceptibility (Gouy and Faraday methods), diamagnetic corrections,orbital contribution, ferro–ferri– and anti–ferro magnetism, Curie law, Curie–Weiss law, effect of temperature on dia–, para–, ferro– and anti–ferromagnetic compounds, temperature independent paramagnetism, effect of spin orbit coupling on spectral and magnetic properties and spin cross–over systems.
	UNIT-II: Reaction Mechanisms in Transition Metal Complexes: Energy profile of a reaction, inert and labile complexes, kinetics of octahedral substitution and mechanistic aspects. Acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism and evidences in its favour. Anation reactions, Substitution reactions in square planar complexes, trans effect, mechanisms of substitution. Electron transfer reactions-inner sphere and outer sphere reactions,	**UNIT II: Inorganic reaction mechanisms** Basic principles, lability, inertness, substitution reactions of octahedral complexes. Nature of substitution reactions: Theoretical approach to substitution mechanisms, mechanism of substitution reaction of complexes of cobalt: Acid hydrolysis and base hydrolysis of Co(III) complexes, substitution reactions of square planar complexes, reaction of Pt(II) complexes, trans–effect, theories of

	complimentary and non-complimentary reactions. Photochemistry of metal complexes-Types of photochemical reactions, photosubstitution and photoredox reactions and solar energy conversion	trans–effect, mechanism and kinetics of substitution of Pt(II) complexes. Electron tunneling hypothesis: Marcus–Hush theory, atom transfer reaction, one– and two–electron transfer. Inner sphere and outer sphere mechanisms.
	UNIT-III:Metal ions in biological systems: Essential and trace metals, active transport of cations (Na and K), ionophores, Metalloproteins as enzymes – carboxy peptidase, catalases, peroxidases, cytochrome P450, superoxide dismutase, copper oxidases, vitamin B_{12} coenzyme. Synthetic model compounds. Metals in medicine- metal deficiency (Fe,Mn,Cu and Zn), chelation therapy and metal complexes as drugs.	**UNIT–III: Bioinorganic chemistry–I** Metal ions in biological systems, essential and trace metals, disease due to metal deficiency and treatment: Iron, zinc, copper, manganese, sodium, potassium, magnesium and calcium. Metal complexes as therapeutic agents: Metal complexes in cancer therapy, metal complexes for the treatment of rheumatoid arthritis, vanadium in diabetes, metal complexes as radio diagnostic agents. Treatment of toxicity due to inorganics: Chelation therapy and requirements of a chelate/antidote. Mechanism of antidotes with poison rendering it inert: Arsenic, lead, mercury, iron, copper, plutonium, cyanide and carbon monoxide poisoning. Ion transport across membranes and active transport of ions across biological membranes, ionophores. Metal complexes in transmission of energy: Chlorophyll, photosystems–Iand II in cleavage of water and model systems.
	UNIT-IV: Heme and non-heme systems: Chlorophyll and its role in photosynthesis,transport and storage of dioxygen- heme proteins, oxygen uptake, functions of haemoglobin, myoglobin, hemerythrin and hemocyanins, synthetic oxygen carriers. Metal storage and transport – ferritin, transferrin and ceruloplasmin. Electron transfer proteins-cytochromes and iron-sulphur proteins. Biological nitrogen fixation, *In vivo* and *in vitro* nitrogen fixation, Interactions of transition metal complexes with	**UNIT–IV: Bioinorganic chemistry–II:** Transport and storage of dioxygen, heme proteins, oxygen uptake, functions of haemoglobin, myoglobin, hemerythrin and hemocyanins, synthetic oxygen carriers. Metal storage and transport: Ferritin, transferrin and ceruloplasmin. Electron transfer proteins: Cytochromes, iron–sulphur proteins. Metalloproteins as enzymes: Carboxy peptidase, carbonic anhydrase,

	DNA.	catalases, peroxidases, cytochrome P–450, cytochrome c–oxidase, superoxide dismutase, copper oxidases and vitamin B_{12} coenzyme. Biological nitrogen fixation, in *vivo*–andin *vitro*– nitrogen fixation.
PG75T302A : Molecular Spectroscopy	**UNIT-II: Vibrational spectroscopy:** Infrared spectroscopy-Vibrational energy levels, infrared spectra of diatomic and polyatomic molecules, Normal modes of vibration, force constant, selection rules, anhormonicity, the vibration-rotation spectroscopy. Infrared spectra of simple molecules and coordination compounds, changes in infrared spectra of donor molecules upon coordination (N,N-dimethylacetamide, urea, DMSO, pyridine N-oxide, ammine, cyano, cyanato and thiocyanato complexes), mono and multinuclear carbonyl complexes, nitrosyls, phosphine and arsine complexes. Change in spectra accompanying change in symmetry upon coordination (NO_3^-, SO_4^{2-} NO_2^-, and ClO_4^-), hydrogen bonding, instrumentation including FTIR. **Raman spectroscopy:** Theory, relation with IR spectroscopy, resonance Raman stimulated hyper and inverse Raman effects. Experimental techniques, structure determination from IR and Raman spectra	**UNIT–I: Introduction and Vibrational Spectroscopy:** Basic concepts and Introduction:Properties of electromagnetic radiation, Wave property: Interference and diffraction.Particle property: Photoelectric effect. Regions of the electromagnetic spectrum, energies corresponding to various kinds of radiation. Interaction of electromagnetic radiation with matter (absorption, emission, transmission, reflection, dispersion, polarisation and scattering). General application. Vibrational spectroscopy:Infrared spectroscopy: Vibrational energy levels, infrared spectra of diatomic and polyatomic molecules, normal modes of vibration, force constant, selection rules, anhormonicity, the vibration–rotation spectroscopy. Infrared spectra of simple molecules and coordination compounds, changes in infrared spectra of donor molecules upon coordination (N,N–dimethylacetamide, urea, DMSO, pyridine N–oxide, ammine, cyano, cyanato and thiocyanato complexes), mono and multinuclear carbonyl complexes, nitrosyls, phosphine and arsine complexes. Change in spectra accompanying change in symmetry upon coordination (NO_3^-, SO_4^{2-}, NO_2^-, and ClO_4^-), hydrogen bonding. Instrumentation including FTIR. Raman spectroscopy:Theory, relation with IR spectroscopy, resonance Raman stimulated hyper and inverse Raman effects. Experimental techniques, structure determination from IR and Raman spectra.

	UNIT-III: Magnetic Resonance spectroscopy: Nuclear Magnetic Resonance spectroscopy. Magnetic properties of nuclei, population of energy levels, the Larmar precession, relaxation processes, Chemical shift, shielding mechanism, spin-spin interactions, rules governing the interpretation of first order spectra, effect of chemical exchange on spectra. Analysis of complex NMR spectra, ^{1}H nmr spectra of organic molecules and complex metal ligands, NMR studies of nuclei other than proton, ^{13}C (including heteronuclear coupling with other nuclei viz ^{19}F and ^{31}P) ,^{19}F, ^{31}P, ^{11}B, ^{15}N. Spectra of paramagnetic complexes, contact shift, double resonance technique, shift reagents, Instrumentation including FT nmr.	**UNIT–II: Magnetic Resonance spectroscopy–I:** Nuclear magnetic resonance spectroscopy: Magnetic properties of nuclei, population of energy levels, the Larmor precession, relaxation processes, chemical shift, shielding mechanism, spin–spin interactions, rules governing the interpretation of first order spectra, effect of chemical exchange on spectra. Analysis of complex NMR spectra, ^{1}H–NMR spectra of organic molecules and complex metal ligands. Spin–systems: First order and second order patterns. Long range coupling : Spin decoupling, CIDNP and NOE. NMR shift reagents. NMR studies of nuclei other than proton, ^{13}C–NMR (including heteronuclear coupling with other nuclei viz., ^{19}F and ^{31}P): Broad band and off resonance, decopouling methods, use of ^{13}C–NMR in structural determination of organic and inorganic molecules. ^{19}F, ^{31}P, ^{11}B, ^{15}N. Spectra of paramagnetic complexes, contact shift, double resonance technique. Instrumentation including FT–NMR. Correlation NMR spectroscopy: ^{1}H–^{1}H (COSY) and ^{13}C–^{1}H (HETEROCOSY) methods.
	UNIT-IV: Electron Paramagnetic Resonance (EPR) Spectroscopy: Basic principles, Selection rules, intensity, width, position of spectral line, multiplet structure of EPR spectra, hyperfine interaction, spin-orbit coupling, zerofield splitting and Kramer's degeneracy, rules for interpreting spectra, factros affecting the magnitude of values. Instrumentation. Applications to the study of free radicals, Coordination compounds, biological studies, rate of electron exchange reactions. **Nuclear Quadrupole Resonance (NQR) Spectroscopy-**Quadrupole	**UNIT-III: Magnetic Resonance spectroscopy–II and Mössbauer Spectroscopy:** Electron Paramagnetic Resonance (EPR) Spectroscopy: Basic principles, selection rules, intensity, width, position of spectral line, multiplet structure of EPR spectra, hyperfine interaction, spin–orbit coupling, zerofield splitting and Kramer's degeneracy, rules for interpreting spectra, factros affecting the magnitude of values. Instrumentation. Applications to the study of free radicals, coordination compounds,

	nuclei, Quadrapole movement, electric field gradient, The NQR experiment, structural information from NQR spectra. **Mössbauer Spectroscopy:** Introduction, Principles, conditions for Mössbauer spectroscopy, parameters from Mossbauer spectra, isomer shifts, electric quadrupole interaction, magnetic interactions, Mossbauer spectrometer, applications, $Fe_3(CO)_{12}$, Prussion blue, Oxyhemerythrin, Hexacyanoferrates, Nitropruside, Tin halides.	biological studies and rate of electron exchange reactions. Nuclear Quadrupole Resonance (NQR) Spectroscopy**:** Quadrupole nuclei, quadrapole movement, electric field gradient, the NQR experiment, structural information from NQR spectra Mössbauer Spectroscopy: Introduction, principles, conditions for Mössbauer spectroscopy, parameters from Mossbauer spectra, isomer shifts, electric quadrupole interaction, magnetic interactions, Mossbauer spectrometer. Applications in structure determination of $Fe_3(CO)_{12}$, Prussian blue, oxyhemerythrin, hexacyanoferrates, nitropruside, tin halides.
	UNIT-I: Basic concepts and Introduction: Properties of electromagnetic radiation: Wave property- interference, diffraction. Particle property- Photoelectric effect. Regions of the electromagnetic spectrum, energies corresponding to various kinds of radiation. Interaction of electromagnetic radiation with matter (absorption,emission, transmission, reflection, dispersion, polarisation and scattering.),General application. **Electronic spectroscopy:** Molecular electronic absorption spectroscopy.(UV-Visible), Electronic spectra of diatomic molecules, electronic transitions, selection rules, assignment of transition, band intersities, substituent and solvent effect, change transfer transitions, Application to organic and inorganic molecules. **Photoelectron spectroscopy:** Basic principles; Photo-electric effect. ionisation process, Koopman's theorem. Photoelectron spectra of simple molecules, ESCA, chemical information from ESCA. Instrumentation.	**UNIT–IV: Electronic Spectroscopy and Mass Spectrometry:** Electronic spectroscopy:Molecular electronic absorption spectroscopy (UV–Visible), electronic spectra of diatomic molecules, electronic transitions, selection rules, assignment of transition, band intersities, substituent and solvent effect and change transfer transitions. Application to organic and inorganic molecules. Photoelectron spectroscopy:Basic principles: Photo–electric effect, ionisation process, Koopman's theorem. Photoelectron spectra of simple molecules, ESCA and chemical information from ESCA. Instrumentation. Auger electron spectroscopy, basic ideas. Mass Spectrometry:Ionization and mass analysis. Instrumentation. Methods of ionization: EI, CI, DI, SI methods. Fragmentation: Principles, odd electron (OE^{+})and even electron (EE^{+}) ions, molecular ion and base peak, nitrogen rule, metastable ions. Isotope effects in chloro and bromo compounds. Fragmentation of inorganic and oraganic compounds: (i)

	Auger electron spectroscopy, basic ideas.	normal and branched alkanes. (ii) alkenes. (iii) benzene and its derivatives. (iv) alcohols. (v) aldehydes. (vi) ketones. (vii) acids. (viii) esters. (ix) ethers. (x) amines. (xi) nitro compounds. (xii) halo compounds.
PG75T303A: Selected Topics In Inorganic Chemistry	**UNIT–I: Non-Aqueous Solvents:** Introduction, importance of non aqueous solvents, classification and properties of solvents, types of reactions, important reactions in liquid ammonia, anhydrous H_2SO_4, liquid SO_2, liquid N_2O_4, BrF_3 and glacial acetic acid.	**UNIT–I: Metal Clusters:** Metal π-acceptor complexes: Metal carbonyls, preparative methods, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, magnetic and X-ray evidences of structures, MO representation of bi– and tri–nuclear carbonyls, reactions of metal carbonyls. Metal carbonylates and carbonyl halides: Preparation and important reactions. Chemistry of metal nitrosyls: Preparation, structure and bonding, dinitrogen and dioxygen complexes. Metal–metal bonding in carbonyls and halides, evidences for M–M bonding, factors favouring M–M bond formation. Metal clusters: Bi–, tri–, tetra–, penta– and hexanuclear metal clusters and bonding in metal clusters.
	UNIT–II: Ceramics, Composites and Nanomaterials: Ceramic materials- Introduction, structures, classification-clay, glasses, refractories-characteristics, classification and applications. Composite materials-introduction, classification-1. Dispersion strengthened, particulate strengthened and fibre reinforced composites. Matrix materials, characteristics of fibres. Nanometrials.	**UNIT–II: Lanthanides and acinides:** Correlation of general properties of d–block elements with those of 4f and 5f elements. Lanthanide series: Introduction, electronic structure, oxidation states, lanthanide contraction, abundance and extraction (solvent extraction and ion–exchange methods), lanthanides as shift reagents, chemical properties of compounds of lanthanides in II, III, and IV oxidation states. Magnetic properties, colour and spectra. Actinides: Electronic structure and position in the periodic table, oxidation states, occurrence and synthesis of elements. Spectral and magnetic properties of compounds of actinides in comparison with those of lanthanides and d–block elements. Chemistry of separation of Np, Pu &

		Am from U & fission products. Uranium: Isotope separation/enrichment and chemistry of uranium salts.
	UNIT–III: Analysis of Coal: Proximate and ultimate analysis of coal. Analysis of food Moisture, ash, crude proteins, fat, crude fiber, carbohydrates, calcium, potassium, sodium and phosphate. Food management, food additives, chemical preservatives in foods, food adulteration-common adulterants in food, detection of food adulteration and contaminations of food stuffs. Adulteration and law.	**Unit–III: Fuel analysis and agricultural chemistry:** Fuels: Solid, liquid and gaseous fuels, ultimate and proximate analysis, calorific values, grading of coal. Liquid fuels: Flash point, aniline point, octane number and carbon residues. Gaseous fuels: Producer gas and water gas. Analysis of soil: Inorganic and organic components of soil, collection and preparation of soil samples for analysis. Measurement of soil moisture, pH, total nitrogen, phosphorous, silica, lime, magnesia, manganese, sulphur and alkali salts. Fertilizers: Fertilizer industries in India, manufacture of ammonia, ammonium salts, urea, nitrates, phosphates and superphosphates and mixed fertilizers.
	UNIT–IV: Analysis of Drugs in Pharmaceutical Formulations: Vitamins:Thiamine hydrochloride, riboflavin, pyridoxine hydrochloride, nicotinamide, cynocobalamine, ascorbic acid and folic acid. Antibiotics**:** Structure, properties, identification and analysisof **c**hloramphenicol, erythromycin, neomycin, penicillins, nystatin, streptomycins and tetracyclines.	**UNIT–IV: Photoinorganic chemistry:** Photochemical Reactions: Prompt and delayed reactions, quantum yield, laws of photochemistry, recapitulation of fluorescence and phosphorescence, d–d and charge transfer reactions. Excited states of metal complexes, energy transfer under conditions of weak interaction and strong interaction, exciplex formation. Conditions of the excited states to be useful as redox reactants: Photosubstitution, photooxidation, photoreduction and photochemical reactions of transition metal complexes including $[Ru(bipy)_3]^{2+}$ and $[Fe(bipy)_3]^{2+}$. Application to photovoltaics: Water photolysis and carbon dioxide reduction. Solar energy conversion and storage.
PG75P301A: Lab Course In Inorganic Chemistry	I. Preparation of selected coordination compounds 1. Copper-glycine complex : cis-and trans forms.	I. Preparation of selected coordination compounds 1.Bis(glycinato)copper(II) complex: cis-and trans-forms.

	2. Co(DMG)2 model for Vit.B12 and reactions 3. CuCl2 - DMSO complex. 4. Mercuric phenyl acetate 5. Pentammine chloro cobalt (III) chloride. 6. Preparation of nitro- and nitrito-complexes.(examples for linkage isomers) 7. Separation of optical isomers of cis[Co(en)2Cl2]Cl. 8. Tris(thiourea) copper(I) sulphate monohydrate 9. Hexaammine nickel(II) chloride 10. Mercury tetrathiocyanato cobaltate(II) 11. Tris(acetylacetanato)manganese(III) 12. Trans and cis-potassium dioxalato diaquo chromate(III) 13. N, N- bis (salicylaldehyde) ethylenediammine copper(II) II. Characterisation 1. Elemental analysis 2. N2 analysis by Kjeldahl's method . 3. Metal ion determination in above complexes 4. Anion estimation in above complexes 5. IR, Electronic, NMR, Magnetic and CV studies wherever possible. 6. Interpretation of IR and NMR spectra	2. Co(DMG)2 model for Vit B12 and reactions. 3. Hexaamminecobalt(III) chloride 4. Mercuric phenyl acetate 5. Pentaamminechloridocobalt(III) chloride. 6. Preparation of nitro- and nitrito-complexes. (examples for linkage isomers) 7.Separation of optical isomers of cis-[Co(en)2Cl2]Cl. 8.Tris(thiourea)copper(I) sulphate monohydrate. 9.Hexaamminenickel(II) chloride. 10.Mercury tetrathiocyanatocobaltate(II). 11.Tris(acetylacetanato)manganese(III). 12.Trans and cis-potassium dioxalatodiaquochromate(III). 13.N, N-bis(salicylaldehyde) ethylenediaminecopper(II). II. Characterization 1.Elemental analysis. 2.N2 analysis by Kjeldahl's method. 3.Metal ion determination in above complexes. 4.Anion determination in above complexes. 5.IR, Electronic, NMR, Magnetic and CV studies wherever possible. 6.Interpretation of UV-VIS, IR and NMR spectra.
PG75P302A: Lab Course in Inorganic Chemistry	**Instrumental methods of analysis** **a) Colorimetry** 1. Determination of Fe using o-Phenanthroline 2. Determination of Zr using Alizarin red S 3. Determination of Ti by H_2O_2 method 4. Determination of Mn / Cr /V in steel samples 5. Job's method for Fe-ophen complex 6. Mole ratio method - Zr + Alizarin red-S 7. Slope ratio method- Cu + en complex 8. Determination of stability constant of	**Instrumental methods of analysis** 1. Colorimetry: (i) Determination of Fe using o–Phenanthroline, (ii) Determination of Zr using Alizarin red S, (iii) Determination of Ti by H_2O_2 method, (iv) Determination of Mn / Cr /V in steel samples, (v) Job's method for Fe-1,10-phen complex, (vi) Mole ratio method–Zr + Alizarin red-S, (vii) Slope ratio method–Cu + en complex, (viii) Determination of stability constant of (7), (ix) Determination of pK_a of an indicator (methyl red) in aqueous solution.

	(7). 9. Determination of pKa of an indicator (methyl red) in aquious solution b) Conductometry c) Potentiometry d) Electrogravimetric analysis e) Magnetic susceptibility determination. f) Flame photometry	2. Conductometry: (Cl^-, Br–, $I^-$and SO_4^{2-}) 3.Potentiometry: (Halide mixture and Co^{2+} vs. ferricyanide) 4. Electrogravimetric analysis (Cu and Ni mixture) 5. Magnetic susceptibility determination
PG75P303A: Lab Course In Inorganic Chemistry	**Analysis of:** Coal Pharmaceutical drugs Vitamins and Food Use of Muffle furnace **Use of Computers**: The students shall learn how to operate a PC and how to run standard programs and packages such as MS-WORD, EXCEL, ORIGIN, SIGMA PLOT, CHEM SKETCH. Problems will be taken preferably from Inorganic chemistry for plotting first and second derivative curves, linear plots etc. Problems from chemical kinetics, polymer chemistry, analytical chemistry, electrochemistry, spectroscopy etc. will be solved. Writing the structures of inorganic and organic molecules, writing chemical equations and other interesting applications will be taught	1. Determination of vitamin C in juice/tablet by titrimetric method. 2. Fluorimetric determination of riboflavin (Vit B_2) in tablets. 3. Determination of iron in pharmaceuticals by visual and potentiometric titration using cerium(IV) sulphate. 4. Determination of sulpha drugs by potentiometry using $NaNO_2$ and iodometric assay of penicillin. 5.Assay of aspirin/caffeiene/phenacetin by spectrophoptmetry/titrimetry 6. Determination of vitamin A in vanaspathi by UV spectrophotometry 7. Analysis of a soil sample for (i) Available phosphorus by spectrophotometry, (ii) Nitrate-nitrogen/nitrite nitrogen/ammonia nitrogen by spectrophotometry, (iii) sodium and potassium by flame photometry. 8. Analysis of fertilizers: Urea and super phosphates

FOURTH SEMESTER (INORGANIC CHEMISTRY)

PG75T401: AInstrumental Methods of Analysis	**UNIT-I: Atomic Absorption Spectrometry :** Theory, Instrumentation, different types of nebulizers, non flame techniques, electrothermal vapourisers, cold vapour AAS, interferences, and analytical applications. **Emission Spectroscopy :** Flame Emission Spectroscopy, plasma emission spectrometry, basic	**UNIT–I: Optical methods:** Atomic absorption spectrometry: Theory, instrumentation, different types of nebulizers, non flame techniques, electrothermal vapourisers, cold vapour AAS determination of mercury, interferences, differences between AAS and flame photometry and analytical applications of AAS. Emission

	principles of flame photometry, interferences, applications of flame photometry, Inductively coupled plasma optical emission spectrometry-theory and applications. **Molecular Luminescence Spectroscopy:** Principle of fluorimetry, instrumentation, factors affecting fluorescence, its applications in quantitative analysis.	spectroscopy: Inductively coupled plasma optical emission spectrometry, theory and applications. Molecular luminescence spectroscopy: Theoretical basis for fluorescence and phosphorescence, instrumentation, factors affecting fluorescence, its applications in quantitative analysis and in the study of biomolecules.X–ray fluorescence elemental analysis.
	UNIT-II: Electrophoresis: Theory and classification, Factors influencing mobility, macromolecular size and charge, Factors affecting electrophoretic phenomena, electrolysis, electroosmosis, temperature and supporting media. Instrumentation, methodology, gel electrophoresis. Applications. **Gel Filtration:** Theory, different types of gels, techniques and applications. **Coulometry:** Principle, constant current and controlled potential coulometry, Applications. **Amperometry:** Principle, titrations, advantages and limitations, Applications	**UNIT–II: Analytical methods–I** Coulometric methods of analysis: General discussion, coulometry at controlled potential, apparatus and general technique, applications, coulometric titrations (amperometric coulometric): Principles, apparatus, comparison of coulometric titrations with conventional titrations, automatic coulometric titrations and applications. Amperometry: Principle, titrations, advantages and limitations. Applications. Ion selective electrodes: Glass ion selective electrodes, crystalline solid state ion selective electrodes, liquid–based ion selective electrodes and gas sensing electrodes. Supercritical fluid chromatography (SFC): Properties of supercritical fluids, instrumentation and operating variables, comparison of SFC with other types of chromatography. Applications.
	UNIT-III : Ion selective electrodes: Types of construction of ion selective electrodes, glass electrode, solid state and precipitate electrodes, sensing electrodes, glass microelectrodes and applications **Thermal methods**: Principle, methodology, factors affecting the results and applications-thermogravimetric and differential thermal analysis and differential scanning calorimetry.	**UNIT–III: Analytical methods–II** Polarography: Theory of classical polarography, polarograms, polarographic currents. Halfwave potential, oxygen interference, advantages and limitations. Pulse polarography. Applications of polarography. Electrogravimetric analysis: Theory, apparatus, deposition and separation, electrolytic separation of metals, applications. Electrophoresis: Theory and classification. Factors influencing the mobility-macromolecular size and

		charge, interaction with supporting electrolyte, pH and concentration discontinuities. Factors affecting electrophoretic phenomena-electrolysis, Electroosmosis, temperature and supporting media. Instrumentation. Methodology-preparation of gels-staining and destaining. Capillary electrophoresis methods - capillary zone electrophoresis, capillary gel electrophoresis. Light-Scattering methods: Nephelometry and turbidometry-Principle, instrumentation and applications.
	UNIT-IV: Polarography: Theory of classical polarography, measurements, polarograms, polarographic currents. Halfwave potential, oxygen interference, advantages and limitations. pulse polarography. Applications of polarography **Voltammetry:** Modified voltammetric methods, cyclic voltammetry-principle, experimental set up, quantitative analysis, determination of diffusion coefficients, criteria for reversible, quasi reversible and irreversible reactions. **Stripping analysis-** Principle, methodology, electrodes and cell design and applications. **Light-Scattering methods:** Nephelometry and turbidimetry-theory, effects of concentration, particle size and wavelength on scattering, instrumentation and applications.	**UNIT–IV: Analytical methods–III** Thermal method of analysis: Introduction. Thermogravimetric analysis (TGA): Types of thermogravimetric analysis, principles, factors affecting the results, heating rate, furnace, instrument control/data handling. Instrumentation and applications. Differential thermal analysis (DTA): Theory, variables affecting the DTA curves. Differences between TGA and DTA. General principles, instrumentation and applications. Differential scanning calorimetry (DSC): Basic principle, differences between DTA and DSC. Instrumentation, power compensated DSC, Heat flux DSC. Applications. Thermomechanical analysis. Dynamic mechanical analysis. Voltammetry: Fundamentals of voltammetry. Cyclic voltammetry: Principles and applications. Stripping analysis: Stripping voltammetry, basic principles, electrodes used for stripping analysis, apparatus for stripping analysis, applications, determination of lead in water by voltammetry.
PG75T402A: Nuclear and Environmental Chemistry	**UNIT-I: Radioactivity, Nuclear Reactions, Nuclear Power Reactors** – Radioactivity, determination of half life, Radioactive decay kinetics, parent-daughter decay-growth	**Unit–I: Nanomaterials and Electron Microscopies.** Nanomaterials: Introduction, terminology, novel optical properties, nanolayers, carbon nanotubes,

	relationships, Secular and transient equilibria, Compund nucleus theory, nuclear reactions induced by heavy ions, Spallation, Nuclear fission and fusion, Types of nuclear power reactors, basic features and components of a nuclear power reactor. Safety measures. An introduction to breeder reactors. Applications of Radioisotopes-Synthesis of various useful radioisotopes,Physico-chemical and analytical applications-isotope dilution method, activation analysis, radiometric titration and C^{14} dating. Medical, agricultural and industrial applications of isotopes	nanowires, quantum dots, nanocomposites, thin films, nanofoam, nanoclusters, smart nanostructures. Top–down and bottom-–up fabrication: Solution–based and vapour–phase synthesis of nanomaterials, physical vapour deposition, chemical vapour deposition, sol–gel synthesis, combustion method and hydrothermal method. One–dimensional control (CNT's and inorganic nanowires), two–dimensional control (quantum wells and solid–state superlattices) and three–dimensional control. Electron microscopies: Scanning electron microscopy (SEM), transmission electron microscopy (TEM), scanning transmission electron microscopy (STEM). Scanning probe microscopies: Scanning tunneling microscopy (STM) and atomic force microscopy (AFM). Nanosensors: Electrochemical sensors and biosensors.
	UNIT-II: Radiation Chemistry: Interaction of matter with radiation, radiation dosimetry-units and measurement of chemical dosimeters (Fricke and ceric sulphate dosimeters). Radiation chemistry of water. A brief introduction to radiolysis of gases, liquids and solids. Industrial applications of radiation chemistry (radiation polymerization, food irradiation and radiation synthesis). **Health and Safety Aspects:** Biological effects of radiation, Hazards in radiochemical work. Radiation protection, decontamination procedures, permissible exposure doses. Nuclear waste management including waste storage and disposal procedures	**UNIT–II: Nuclear Chemistry**: Nuclear reactions, nuclear fission and fusion, nuclear reactor, units of radiation energy, G–value. Chemical Dosimetry: Fricke and ceric sulphate dosimeters. Radiation chemistry of water. A brief introduction to radiolysis of liquids and solids. Health and safety aspects: Biological effects of radiation, permissible exposure of radiation dose and radioactive waste management. Radioanalytical techniques and isotopes: Radioactive techniques, tracer technique, neutron activation analysis, applications of radiation chemistry/isotopes (radiation synthesis, polymerization, medicine &, food irradiation). Radiometric titrations and ^{14}C dating.
	UNIT-III: Environmental segments, Air pollution and Soil pollution: Air pollutants, prevention and control,	**UNIT–III: Air pollution and Water Pollution:** Air pollutants, prevention and control,

	Green house effect and acid rain. CO - industrial and transportation sources. SO_x-sources, ambient concentration, test methods, control techniques - scrubbing, limestone injection process. Ozone hole and CFC's. Photochemical smog and PAN. NO_x - sources, ambient concentration, test methods, thermodynamics and NO_x, control techniques. Particulates: size distribution. Bhopal gas tragedy. Noise pollution Composition of soil - Inorganic and organic components in soil, micro and macro nutrients, nitrogen and sulfur pathways. **Soil pollution:** Classification of pollutants and their characteristics, sources, prevention and control	green house effect and acid rain. Carbon monoxide: Industrial and transportation sources. SO_x–sources, control technique, scrubbing, limestone injection process. Ozone hole and CFC's. Photochemical smog and PAN. NO_x: sources and NO_x, control techniques. Particulates: Size distribution. Bhopal gas tragedy. Noise pollution. Origin of waste water, types, water pollutants and their effects. Sources of water pollution: Domestic, industrial, agricultural soil and radioactive wastes as source of pollution. Measurement of colour, turbidity, total solids, acidity, alkalinity, hardness, sulphate, fluoride, phosphate and different forms of nitrogen in natural and polluted water. Determination and significance of BOD, COD and TOC. Pesticides as water pollutants and analysis. Toxic chemicals in the environment, impact of toxic chemicals on enzymes. Heavy metal pollution. Chemical speciation:Biochemical effects of heavy metals (Hg, As, Pb, Se).
	UNIT-IV: Hydrologic cycle, sources, criteria and standards of water quality- safe drinking water. Public health significance and measurement of colour, turbidity, total solids, acidity, alkalinity, hardness, sulphate, fluoride, phosphate and different forms of nitrogen in natural and polluted water. Determination of BOD, COD and TOC. Toxic chemicals in the environment, impact of toxic chemicals on enzymes. Detergents - pollution aspects, Pesticides - pollution of surface water. Heavy metal pollution. Chemical speciation- biochemical effects of heavy metals (Hg, As, Pb, Se), carbon monoxide, nitrogen oxides, sulphur oxides and hydrocarbon. Treatment of industrial liquid wastes.	**UNIT–IV: Chemistry of Selective Materials:** Glasses, oxide glasses, bond type, viscosity, Zachariasen's rules, criteria of Sun and Rawson, chalcogenide glass, the photocopying process, glass ceramics, applications, ceramics–structures, mechanical properties and application, clay products, refractories, characterisation properties and applications. LED: Principle, types, advantages and disadvantages of LED displays. Liquid crystal display (LCD): Properties, twisted nematic field display, advantages and disadvantages of LCD, comparison of LCD & LED. Shape memory alloys (SMA): Classification, working principles, non–linear optical materials and second harmonic generators.

PG75T403A: Organometallic Chemistry and Solid State Chemistry	**UNIT-I: Organometallic Chemistry:** Chemistry of Organometallic Compounds with π - bonding ligands : Synthesis, Structure, Spectroscopy, Reactions and bonding in metal – carbon π - bonded systems involving dihapto to hexahapto ligands viz, Olefins, acetylenes, allylic moieties, butadienes, cyclobutadienes, cyclopentadienes and arenes.	**UNIT–I: Organometallic Chemistry:** Chemistry of organometallic compounds with π–bonding ligands: Synthesis, structure, sSpectroscopy, reactions and bonding in metal–carbon π–bonded systems involving di–hapto to hexa–hapto ligands viz, olefins, acetylenes, allylic moieties, butadienes, cyclobutadienes, cyclopentadienes and arenes. Organometallic polymers.
	UNIT-II: Fluxinol behaviour of Organometallic Compounds Homogeneous and heterogeneous catalysis involving metal complexes and Organometallic Complexes, Oxidative additions, reductive elimination, insertion and deinsertion reactions, hydrogenation, hydroformylation, isomerisation, carboxylation, and polymerisation, water gas shift reaction. Organometallic reagents in organic synthesis : organo iron, organo copper and organo palladium compounds.	**UNIT–II: Fluxinol behaviour of Organometallic Compounds:** Rates of rearrangement and techniques of study. Stereochemical non–regidity in organometallic compounds, ring whizzing in η^1–Cp complexes, interchange of η^1–and η^5–Cp rings, allyl and allene complexes. Scrambling of carbonyl groups in metal carbonyls. Homogeneous and heterogeneous catalysis invivolng metal complexes and organometallic complexes. Teminology in catalysis, oxidative additions and oxidative coupling reductive elimination, insertion reactions, hydrogenation of alkenes and related reactions, hydroformylation (Monsanto, Cativa and Wacker Processes), carbonylation, isomerisation and olefinpolymerisation oligomerisation reactions. Water gas shift reaction. Organometallic reagents in organic synthesis: Organo–iron, organo–copper and organo–palladium compounds.
	UNIT-III: Solid State Chemistry: Electrical properties : Survey of electrical properties and materials. Super conductivity : Nature and properties of Super conductivity materials, Meisner effect, Types I and II Super conductors, Theories, high temperature oxide Super conductors, Junction involving metal - Super conductor - Super conductor. Applications. Ionic conductivity – Alkali halides: Vacancy conduction. Silver chloride: interstitial conduction.	**UNIT–III: Solid State Chemistry:** Electrical properties: Survey of electrical properties and materials. Super conductivity: Nature and properties of super conductivity materials, Meisner effect, type–I and II super conductors, theories, high temperature oxide super conductors, junction involving metal, super conductor and super conductor. Applications. Ionic conductivity: Alkali halides–vacancy conduction. Silver chloride–interstitial conduction. Solid

	Solid electrolytes : β - Alumina, AgI and Ag+ ion solid electrolytes. Anion conductors, requirements for conductivity, Applications. Magnetic properties : Mechanism of ferro and antiferro magnetic ordering, selected examples of magnetic materials, their structures and properties ; metals and alloys, transition metal oxides, spines, garnets, ilemenites, perovskites, magneto plumbites, applications, structure – property relation. Optical properties : Luminescence and phosphors, configurational coordinate model, some phosphor material, antistokes, phosphors, lasers.	electrolytes: β–alumina, AgI and Ag^+ ion solid electrolytes. Anion conductors, requirements for conductivity. Applications. Magnetic properties: Mechanism of ferro– and anti–ferro magnetic ordering, selected examples of magnetic materials, their structures and properties, metals and alloys, transition metal oxides, spines, garnets, ilemenites, perovskites, magneto plumbites, applications and structure–property relation. Optical properties: Luminescence and phosphors, configurational coordinate model, some phosphor material, antistokes, phosphors and lasers.
	UNIT-IV: Mechanical properties and dislocations in solids : Edge dislocations, screw dislocations. **Structural transformation of solids :** Solid solutions : Hume – Rothery rules, substitutional solid solutions and interstitial solid solutions. solid solution mechanism, experimental methods for studying solid solutions (x- ray powder diffraction and density measurements). Alloy systems : Phase diagrams, two and three component systems, study of alloy systems; steels with reference to iron - carbon systems, copper – zinc system.	**UNIT–IV: Mechanical Properties and Structural Transformation of Solids:** Mechanical properties & dislocations in solids: Edge dislocations & screw dislocations. Structural transformation of solids: Solid solutions, Hume–Rothery rules, substitutional solid solutions and interstitial solid solutions, solid solution mechanism, experimental methods for studying solid solutions (X–ray powder diffraction and density measurements). Alloy systems: Phase diagrams, two and three component systems, study of alloy systems, steels with reference to iron, carbon systems and copper– zinc system.
PG75D404A: Project Work	It may include inplant training in Industries/short term work in the Department or other educational Institutions/ R & D organizations/ Data Mining/ Review of current literature/ theoretical methods/computer applications, etc. Experimental work may involve studies on synthesis/characterization/properties/measurements/activities for reported/unreported research or any suitable combination thereof. In case of the students who will work	The project work may include in–plant training in industries/short term work in the department/other educational institutions/R&D organizations/data mining/review of current literature/theoretical methods/computer applications. Experimental work may involve studies on synthesis/measurements/study of properties/characterization by physical methods/activities for reported/unreported research or any suitable combination thereof. In case of the students who would work

	outside the campus, the supervising staff member shall visit the place atleast once during the tenure and hence he/she may be eligible for TA/DA as per the University rules.	outside the campus, the supervising staff member may visit to the work place at least once during the period and may be eligible for TA–DA as per the University rules.
PG75P401A: Lab Course In Inorganic Chemistry	**a)** Use of oxine, salicylaldoxime and DMG in the separation and estimation by volumetric/ gravimetric method i) Cu + Ni, ii) Al + Mg. iii). Ni in presence of Cr and Fe. **b)** Analysis of Ores: Hematite and Dolomite. **c)** Analysis of alloy: Boron, Stainless steel and Cu-Nickel alloy.	1. Determination of available K/Na in soil by flame photometry 2. Nephelometric/Turbidimetric determination of sulphate/phosphate. 3. Cyclic voltammetric studies on potassium ferrocyanide/ potassium ferricyanide. 4. TG–DTA studies of various hydrated solids-$CuSO_4.5H_2O$, $CaC_2O_4.H_2O$ and MgC_2O_4 mixture. 5. Determination of fluoride in drinking water by spectrophotometry. 6. Estimation of total cation concentration in water by ion-exchange method. 7. Determination of iron in mustard seed by spectrophotometry. 8. Determination of copper by potentiometric titration using EDTA. 9. Conductometric determination of total acidity of waste water. 10. Analysis of copper/calcium by PFHS method 11. Analysis of Na_2CO_3 and $NaHCO_3$ in baking soda by acid base titration.
PG75P402A: Lab Course In Inorganic Chemistry	Water analysis 1. Physico-chemical parameters (pH, colour, temperature and turbidity) for characterizing water quality. 2. Concentration of total dissolved solids in a given water sample. 3. Alkalinity in a given water sample. 4. Hardness of a given water sample a) Temporary and b) Permanent hardness 5. Chloride ion concentration in a given water sample. 6. Dissolved oxygen in a given water sample 7. Reducing power of a given water sample Determination of Na^+ and K^+ in given water sample	1. Determination of COD of a water sample. 2. Determination of phosphates in detergents. 3. Determination of dissolved oxygen (DO) by Winkler's method. 4. Determination of nitrate & nitrite in water samples and sea water. 5. Analysis of heavy metals in waste water and sea water (Pb, Hg etc. by spectrophotometry). 6. Determination of alkalinity of water samples. 7. Determination of phosphoric acid content in soft drinks. 8. Hardness of water by soap solution method 9. Determination of TDS in water samples.

		10. Preparation and characterization of nanoparticles. 11. Analysis of glass and ceramics
PG75P403A: Lab Course In Inorganic Chemistry	a. Use of cation resin b. Use of anion resin c. Analysis of soil sample d. Analysis of fertilizer e. Analysis of cement	1. Determination of total acidity of vinegar and wines by acid-base titration. 2. Determination of calcium in calcium gluconate/calcium carbonate tablets/injections and of calcium in milk powder by EDTA titration. 3. Determination of aluminium and magnesium in antacids by EDTA titration. 4. Determination of saccharin in tablets by precipitation titration. 5. Analysis of cement. 6. Analysis of Type metal–Sn gravimetrically and Sb titrimetrically using $KBrO_3$ 7. Determination of magnesium in milk of magnesium tablets by ion-exchange chromatography. 8. Conductometric titration of sodium acetate with HCl and NH4Cl with NaOH. 9. Analysis of urine for (i) urea and uric acid by titrimetry snd spectrophotometry (ii) Sulphate by precipitation titration after ion–exchange separation (iii) Sugar by Benedict's reagent. 10. Analysis of blood for (i) cholesterol by spectrophotometry and (ii) bicarbonate by acid–-base titration

THIRD SEMESTER (ORGANIC CHEMISTRY)

PG75T301B: Organic spectroscopy	**UNIT–I** **Electronic, Chiroptical and Vibrational Spectroscopy:** Electronic and Chiroptical Spectroscopy :Introduction. Energy considerations. Experimental methods. Beer-Lambert's law. Theory and classification of electronic transitions. Terminology, substituent and solvent effects. UV spectral study of alkenes, dienes, polyenes, carbonyl and aromatic compounds. Steric effects, isobestic points, model compounds, charge transfer bands. Vibrational Spectroscopy**:** Introduction and Experimental methods. Units, Notation and Regions. Dispersive and FT-IR. Sampling techniques. Complimentarity of IR and Raman. Fundamental vibrations, overtones, Group frequencies, factors affecting group frequencies; Conjugation, inductive, resonance, steric effects. Mechanical coupling, Fermi resonance, Applications of IR in the study of H-bonding, stereoisomerism, tautomerism. Identification of the following organic compounds by IR : Alkanes, Alkenes, Alkynes, Aromatic compounds, Aldehydes, Ketones, Alcohols, Thiols, Acids, Acid chlorides, Amides, Amines, Esters, halides, nitro compounds, etc.	**UNIT–I** **Electronic and Vibrational Spectroscopy:** Introduction, energy considerations, experimental methods, Beer–Lambert's law, theory and classification of electronic transitions, terminology, substituent and solvent effects. UV spectral study of alkenes, dienes, polyenes, carbonyl and aromatic compounds. Steric effects, isobestic points, model compounds and charge transfer bands. Vibrational Spectroscopy: Introduction, experimental methods, units, notation and regions. FT–IR, sampling techniques, complementarity of IR and Raman. Fundamental vibrations, overtones, Fermi resonance, group frequencies, factors affecting group frequencies: Conjugation, inductive, resonance, steric effects. Mechanical coupling, applications of IR in the study of H–bonding, stereoisomerism and tautomerism. Identification of the following organic compounds by IR: Alkanes, alkenes, alkynes, aromatic compounds, aldehydes, ketones, alcohols, thiols, acids, acid chlorides, amides, amines, esters, halides, nitro compounds, etc.
	UNIT–II **Proton Magnetic Resonance Spectroscopy:** Introduction- Magnetic properties of nuclei- Resonance condition. Field Frequency diagram. Precession of Nuclei, Relaxation- CW and PFT-methods-Instrumentation and Sample handling. Chemical shift- Mechanism of shielding and deshielding- in Alkanes, Alkyl halides, Alkenes, Aromatic compounds, Carbonyl compounds and Annulenes. Chemical shifts of Different types of Organic compounds. Empirical rules. Spin-spin coupling, geminal-vicinal coupling-Relative intensities. Karplus	**UNIT–II** **Proton Magnetic Resonance Spectroscopy:** Introduction, magnetic properties of nuclei, resonance condition. Field frequency diagram, precession of nuclei, relaxation. Intstrumentation: CW and FT–NMR techniques. Sample handling. Chemical shift, mechanism of shielding and deshielding in alkanes, alkyl halides, alkenes, aromatic compounds, carbonyl compounds and annulenes. Chemical shifts of different types of organic compounds. Empirical rules. Equivalence of protons: Chemical and magnetic equivalence. Spin–spin coupling,

	equation-Curve. Equivalence of protons-chemical and magnetic equivalence. Spin-systems First order and second order patterns. Long Range coupling – Spin decoupling, CIDNP, NOE. Lanthanide Shift reagents. Proton attached to elements other than carbon. Exchange phenomena, Temperature effects	geminal–vicinal coupling, relative intensities. Karplus equation–Curve. Spin–systems, first order and second order patterns. Long range coupling: Spin decoupling, CIDNP and NOE. Lanthanide Shift reagents. Proton attached to elements other than carbon (OH, NH and SH). Exchange phenomena and temperature effects.
	UNIT–III **Multi-Nuclear NMR and Correlation Spectroscopy:** ^{13}C-NMR. Broad Band and Off resonance decoupling methods of detection. ^{13}C- Chemical shifts of different classes of Organic compounds- Alkanes, Alkyl halides, Alkenes, Alcohols, Ethers, Carbonyl compounds and Aromatic compounds. ^{13}C – H Coupling DEPT. Introductory aspects of ^{15}N, ^{19}F, ^{31}P - NMR. Correlation NMR Spectroscopy: Theory, Pulse sequences. FT-Methods. ^{1}H - ^{1}H (COSY) and ^{13}C – H (HETEROCOSY) Methods	**UNIT–III** **Multi–Nuclear NMR and Correlation Spectroscopy:** ^{13}C–NMR, broad band and off resonance decoupling methods of detection. ^{13}C–chemical shifts of different classes of organic compounds: Alkanes, alkyl halides, alkenes, alcohols, ethers, carbonyl compounds and aromatic compounds. ^{13}C–^{1}H coupling DEPT. Introductory aspects of ^{15}N–, ^{19}F–, ^{31}P–, ^{10}B–, ^{11}B –NMR. Correlation NMR Spectroscopy: Theory, pulse sequences. FT–methods. ^{1}H–^{1}H (COSY) and ^{13}C–^{1}H (HETEROCOSY) methods
	UNIT–IV **Mass Spectroscopy and Composite Problems:** Ionisation and Mass analysis. Instrumentation, methods of ionization, EI, CI, DI, SI – Methods. Fragmentation : principles, odd and EE ions, molecular ion and base peak, Nitrogen rule, metastable ions. Isotope effects in chloro and bromo compounds. Stevenson rule. Fragmentation of : i) Normal and Branched Alkanes. ii) Alkenes. iii) benzene and its derivatives. iv) Alcohols. v) Aldehydes. vi) Ketones. vii) Acids. viii) Esters. ix) Ethers. x) Amines. xi) Nitro compounds. xii) Halo compounds. xii) Peptides McLafferty and McLafferty + 1 rearrangement. Calculation of molecular formula. Composite problems: Calculation of H- deficiency Index.	**UNIT–IV** **Mass Spectrometry and Composite Problems:** Ionisation and mass analysis. Instrumentation, methods of ionization, EI, CI, DI, SI methods. Fragmentation: Principles, odd electron ($OE^{+\cdot}$) and even electron (EE^{+}) ions, molecular ion and base peak, nitrogen rule, metastable ions. Isotope effects in chloro and bromo compounds. Stevenson rule. Fragmentation of: (i) normal and branched alkanes. (ii) alkenes (iii) benzene and its derivatives (iv) alcohols (v) aldehydes (vi) ketones (vii) acids (viii) esters (ix) ethers (x) amines (xi) nitro compounds (xii) halo compounds (xii) peptides. McLafferty and McLafferty + 1 rearrangement. Calculation of molecular formula. Calculation of H–deficiency index. Composite problems: Applications of UV, IR, NMR and MS methods and chemical reactions in structure elucidation of organic

	Applications of UV, IR, NMR and MS methods and chemical reactions in structure elucidation of organic compounds..	compounds.
PG75T302B: Stereochemistry and Reaction Mechanism	UNIT–I **Dynamic Stereochemistry:** Stereoselectivity in organic synthesis, stereospecific and stereoselective reaction, Principle of stereoselectivity, stereoselectivity in addition, elimination, substitution reaction. Asymmetric synthesis, enantioselective and diastereoselectivity in acyclic system, addition of nucleohphiles to carbonyl group, correalation of configuration, Cram's rule and Prelog's rule for diastereselection. ORD – Cotton effect, Octant and Haloketone rules, Applications in the determination of configuration of cyclic and steroidal ketones. Asymmetric epoxidation, Stereoselectivity in carbene addition, stereochemistry of catalytic hydrogenation. Asymmetric transformations.	UNIT–I **Dynamic Stereochemistry:** Stereoselectivity in organic synthesis, stereospecific and stereoselective reaction, principle of stereoselectivity, stereoselectivity in addition, elimination and substitution reaction. Asymmeteric Synthesis: Chiral pool synthesis, enantioselectivity and diastereoselectivity in acyclic system, addition of nucleohphiles to carbonyl group, Cram's rule and Prelog's rule for diastereselection. 1,2–Addition predictions: Various outcomes using predictive models such as Cram chelate and Felkin–Anh. Chiral Auxiliaries: Chiral auxiliaries in aldol condensations and Diels–Alder reaction. Oxazolidinones and chiral sulphoxides. Chiral Reagents: Isopinocamphenylboranes, BINOL and DIBAL. Chiral Catalysts: Calculation of enantiomeric excess, asymmetric epoxidation–Sharpless and Jacobsen Katsuki asymmetric epoxidation, epoxidation using dioxiranes. Stereochemistry of catalytic hydrogenation: Metal (Pd, Pt, Ni) catalyzed hydrogenation, diimide reduction, rhodium and Ruthenium catalysts with chiral phosphine ligands like (R)–PROPHOS, (R)–BINAP and (R, R)–DIOP. Asymmetric transformations, stereochemistry of carbene and nitrene addition.
	UNIT–II **Stereochemistry of Compounds other than Carbon:** Stereochemistry of Nitrogen Compounds : Quartenary ammonium salts, amines, tertiary amine oxides, oximes - determination of configuration of aldoximes and ketoximes, Stereochemistry of compounds (Cyclic and acyclic) containing nitrogen.	UNIT–II **Stereochemistry of Compounds other than Carbon:** Stereochemistry of nitrogen compounds: Quaternary ammonium salts, amines, tertiary amine oxides, oximes, determination of configuration of aldoximes and ketoximes, stereochemistry of compounds (cyclic and acyclic) containing nitrogen. Stereochemistry of Phosphorus compounds,

	Stereochemistry of Phosphorus compounds,Stereochemistry of Arsenic compounds and Stereochemistry of Sulphur compounds.Stereochemistry of Silicon compounds.	arsenic, sulphur compounds and silicon compounds.
	UNIT–III **Reaction Mechanism – I:** Nucleophilic substitution at allylic and trigonal carbon atom. Neighbouring group participation. Participation of σ, π cyclpropane aromatic rings in nucleophilic substitution reaction. Nucleophilic substitution at Silicon. Formation, structure, stability and reactions of Free radicals (ESR of organic free radicals), Nitrenes, Ylides and Enamines	UNIT–III **Reaction Mechanism–I:** Nucleophilic substitution at allylic and trigonal carbon atom, Tsuji–Trost reaction. Neighbouring group participation: Definition, participation of σ, π cyclpropane aromatic rings in nucleophilic substitution reaction. Nucleophilic substitution at silicon. Addition Reactions: Electrophilic addition across alkenes, *cis- and trans*-alkenes and dienes. Addition of nitrogen, oxygen and aulphur nucleophiles across carbonyl compounds.
	UNIT–IV **Reaction Mechanism – II:** Addition and Elimination Reactions. Addition Reactions: Electrophilic addition across Alkenes, cis-trans alkenes, Dienes. Addition of Nitrogen, Oxygen and Sulphur nucleophiles across carbonyl compounds. Elimination Reactions: E_2 , E_1, E_1CB pathways. Stereochemistry, Product proportions in Dehydration of Alcohols, Alkyl halides (chiral and achiral), Hoffmann and Saytzeff rules. Pyrolytic eliminations.	UNIT–IV **Reactive Intermediates and Activating agents** Reactive Intermediates**:** Formation, structure, stability and reactions of the following reactive intermediates: Carbocations (classical and non–classical), carbanions, carbenes (identification by ^1H NMR and ^{13}C NMR), carbenoids, free radicals (ESR of organic free radicals), nitrenes, ylides, Wittig and Tebbe olefination, enamines and Stork enamine reactions. Applications of the following in organic synthesis: Acetyl chloride, antimony pentachloride, borontrifluoride etherate, copper (I) trifluoromethane sulphonate, ethylaluminium dichloride, lithium halides and lithium perchlorides.
PG75T303B: Chemistry of Natural Products	UNIT–I **Steroids and Steroidal Hormones:** Structure, synthesis, stereochemistry and spectral features of : Cholesterol and Ergosterol. Steroidal Hormones : Estrogenic hormones – Estrone. Androgenic hormones – Androsterone. Corpus Luteum hormones – Progesterone. Transformations in steroids and hormones.	UNIT–I **Steroids and Steroidal Hormones:** Structure, synthesis, stereochemistry and spectral features of cholesterol and ergosterol. Steroidal Hormones: Estrogenic hormones–estrone, androgenic hormones–androsterone, corpus luteum hormones–progesterone.Transformations in steroids and hormones

	UNIT–II **Plant Products:** Structure, synthesis, stereochemistry and spectral properties (wherever applicable) of the following **:** Alkaloids: Papaverine, Reserpine, Morphine, Lysergic acid, Physostigmine. Photochemical synthesis of Nuciferene, Corydaline, Tylophorine. Terpenoids: Zingiberene, α-Pinene, Gibberillic acid, Camphor, Caryophyllene, Abietic acid, Farnesol.	UNIT–II **Plant Products:** Structure, synthesis, stereochemistry and spectral properties (wherever applicable) of the following: Alkaloids: Papaverine, reserpine, morphine, lysergic acid, physostigmine, yohimbine. Photochemical synthesis of nuciferene, corydaline and tylophorine. Terpenoids: α–Cadeine, zingiberene, α–Pinene, gibberillic acid, camphor, caryophyllene, abietic acid and farnesol.
	UNIT–III **Prostaglandins and Lipids:** Prostaglandins: Introduction, nomenclature, classification and biological role of Prostaglandins. Structure elucidation and stereochemistry of PGE1. Synthesis of prostaglandins by Corey and Stork routes. Lipids**:** Sphingolipids and Glycolipids, Naturally occurring fatty acids and their triglycerides, Essential fatty acids, Unusual fatty acids, Methods of isolation: Gunstone's partition method. Reactions of fatty acids – Fischer and trans esterification, Oxidation and Acyl group transfer reactions. Analytical values – Cetane number. Applications of GC, IR, ^{1}H NMR, ^{13}C NMR and MS techniques in the study of their structures. Emulsions and Biodiesel. Oleochemicals and their applications in the synthesis of heterocycles.	UNIT–III **Prostaglandins and Lipids:** Prostaglandins: Introduction, nomenclature, classification and biological role of prostaglandins. Structure elucidation and stereochemistry of PGE1. Synthesis of prostaglandins by Corey and Stork routes. Lipids: Sphingolipids, phospholipids, cyanolipids and glycolipids, naturally occurring fatty acids and their triglycerides, essential fatty acids, unusual fatty acids, methods of isolation: Gunstone's partition method. Reactions of fatty acids: Fischer– and trans–esterification, oxidation, hydrogenation, margarine and acyl group transfer reactions. Analytical values: Cetane number. Applications of GC, IR, ^{1}H–NMR, ^{13}C–NMR and MS techniques in the study of their structures. Emulsions and biodiesel. Oleochemicals and their applications in the synthesis of heterocycles
	UNIT–IV **Biomolecules:** Structure and synthesis of Nucleosides-Nucleotides. Methods of formation of internucleotide bonds. Polynucleotides, structure, formation and hydrolysis products of DNA and RNA. Role of nucleic acids in protein synthesis. Genetic code.	UNIT–IV **Biomolecules:** Structure and synthesis of nucleosides and nucleotides. Methods of formation of internucleotide bonds. Polynucleotides, structure, formation and hydrolysis products of DNA and RNA. Role of nucleic acids in protein synthesis. Genetic code. Peptide bond formation, structure and

	Peptide bond formation, Structure and Stereochemistry Peptide linkage, Primary structure of peptides. C-terminal amino acid determination (Hydrazinolysis), N-terminal amino acid determination. Edman's and Sanger's method.Application of Dansyl chloride, Partial hydrolysis of peptides. Mass-spectra of peptides. Synthesis of peptides: Oxytocin, Glutathione, Merrifield Solid phase peptide synthesis. Structure of proteins.	stereochemistry. Peptide linkage, primary structure of peptides. C–terminal amino acid determination (hydrazinolysis), N–terminal amino acid determination. Edman's and Sanger's method. Application of dansyl chloride, partial hydrolysis of peptides. Mass spectra of peptides. Synthesis of Peptides: Oxytocin, glutathione, merrifield Solid phase peptide synthesis. Structure of proteins. Reaction and mechanism of biochemical reactions associated with thiamine pyrophosphate, pyridoxal phosphate, Vit B_{12}, flavin and NADH.
PG75P301B: Lab Course in Organic Chemistry	Identification of the nature, bulk separation, purification and qualitative analysis (using ether) of the binary mixture of the following classes: Acids, bases, phenols and neutral compounds (without derivatives).	Identification of the nature, bulk separation, purification and qualitative analysis (using ether) of the binary mixture of the following classes: Acids, bases, phenols and neutral compounds (without derivatives).
PG75P302B: Lab Course in Organic Chemistry	1. Applications of computers in structure, stereochemistry, mechanism and conformational studies of organic compounds. 2. Chromatographic techniques: TLC and column chromatography. 3. Preparation of derivatives.	1) Applications of computers in structure, stereochemistry, mechanism and conformational studies of organic compounds. 2) Chromatographic techniques: TLC and column chromatography. 3) Preparation of derivatives.
PG75P303B: Lab Course in Organic Chemistry	Isolation, Characterization of Natural products: 1. Cysteine from human hair. 2. Hesperidine from orange peel. 3. Caffeine from tea leaves. 4. Myristine from nutmug. 5. Piperine form black pepper. 6. Azaleic acid from castor oil. Lycopene from tomato	Isolation, Characterization of Natural products: 1) Cysteine from human hair. 2) Hesperidine from orange peel. 3) Caffeine from tea leaves. 4) Myristine from nutmug. 5) Piperine form black pepper. 6) Azaleic acid from castor oil. Lycopene from tomato

FOURTH SEMESTER (ORGANIC CHEMISTRY)

PG75T401B: Organic Synthesis	UNIT – I **Retrosynthetic Analysis** Disconnection approach – Terminology, synthon, synthetic equivalent, functional group interconversion. One group C – X and two group disconnections. Applications of C – C disconnection in the synthesis of substituted 1,2- 1,3- and 1,4- bifunctional compounds. Retrosynthetic analysis and synthetic route for Alcohols, Benzocaine, Acetone cyanohydrin, p-Methoxy acetophenone, 6-Methyl quinoline, Pirindol, 6-methoxy indole –3- acetic acid. Application to the synthesis of Juvabione, Taxol, Longifolene, Prelog-Djerassi lactone.	UNIT – I **Synthetic Design and retrosynthetic analysis:** Protecting groups in organic synthesis: Principe of protection, protection of hydroxyl (–OH), amino ($–NH_2$, –NH), carboxylic (–COOH), carbony (RCOR′) groups, their synthetic applications and methods of deprotection. Retrosynthetic analysis: Terminology, synthon, synthetic equivalent, functional group interconversion and disconnection approach, one group C–X and two group disconnections. Applications of C–C disconnection in the synthesis of substituted 1,1–, 1,2– 1,3– and 1,4– bifunctional compounds. Retrosynthetic analysis and forward synthesis for alcohols, benzocaine, acetone cyanohydrin, *p*–methoxy acetophenone, 6–methyl quinoline, pirindol, 6–methoxy indole –3–acetic acid. Application to the synthesis of juvabione, taxol, longifolene, Prelog–Djerassi lactone.
	UNIT – II **Oxidations and Reductions** Oxidation of organic compounds using $KMnO_4$, PCC, OsO_4, CrO_3, $K_2Cr_2O_7$, SeO_2, $Pb(OAc)_4$, HIO_4, Oxygen, Oppaneur oxidation, Swern oxidation. Hydroboraton – Isomerisation and oxidation. Application in the synthesis of Esters, E - Z alkenes, Conjugated dienes, Alkynes. Reductions Reduction of organic compounds using the following reagents: $LiAlH_4$, $NaBH_4$, Stereochemistry of carbonyl reduction, Dibal-H ,Dissolving metal reduction. Birch Reduction, Wolf-Kishner Reduction.(Huang-Minlon Modification)	UNIT – II **Oxidations and Reductions:** Oxidations: Oxidation of organic compounds using $KMnO_4$, PCC, OsO_4, CrO_3, $K_2Cr_2O_7$, SeO_2, $Pb(OAc)_4$, HIO_4, oxygen, Oppaneur oxidation, Swern oxidation, ozonolysis. Hydroboraton– isomerisation and oxidation. Application in the synthesis of esters, E–Z alkenes, conjugated dienes, alkynes. Conditions: Catalytic oxidation and Pt, photosensitized oxidation of alkenes, oxidation with molecular oxygen, aromatization, silver based reagents. Reductions: Reduction of organic compounds using the following reagents: $LiAlH_4$, $NaBH_4$, lithium hydridoalkoxyaluminates, MPV reduction, catalytic hydrogenation, dissolving metal reduction (including acylion condensation), Clemmensen reduction. Birch Reduction, Wolf–Kishner reduction

		(Huang–Minlon modification), Raney–Ni desulphurisation
	UNIT – III **Newer reactions** Mechanism and Strategic applications of the following Named reactions : i) Suzuki coupling. ii) Prins reaction iii) Shapiro reaction. iv) Mitsunobu reaction. v) Robinson annulation. vi) Junjappa – Ila aromatic and heteroaromatic annulation. vii) Pauson-Khand reaction. viii) Simon -Smith reaction. ix) Huisgen 1,3-dipolar cycloaddition reaction x) Heck arylation.. xi) Hoffmann – Loffler- Freytag Reaction. Modern Techniques in Organic Synthesis. Brief outlines of Microwave, Ultra-sound, Clay catalysed techniques and use of Ionic liquids and polymer supports in Organic synthesis.	UNIT–III **Newer Reactions:** Mechanism and strategic applications of the following named reactions: Suzuki coupling, Prins reaction, Shapiro reaction, Mitsunobu reaction, Robinson annulation, Junjappa–Ila aromatic and heteroaromatic annulations, Pauson–Khand reaction, Simon–Smith reaction, Huisgen 1,3–dipolar cycloaddition reaction, O′Donnell Aminoacid synthesis, Heck arylation, Desmartin reaction, Houben–Hoesch reaction, Sonogashira reaction, Buchwald–Hartwig reaction.
	UNIT – IV **Newer Reagents and Reactions** Methods of preparation, mechanism of action and application of the following reagents in Organic synthesis: i) DCC. ii) 1,3-Dithiane. iii) LDA. iv) DDQ. v) Tributyl tinhydride. vi) Wilkinson Catalyst. vii) Crown ethers. viii) Trimethyl silyl iodide. ix) Bakers yeast. x) Gilman reagent. xi) Peterson reaction. Woodward and Prevost hydroxylations.	UNIT – IV **Newer Reagents:** Methods of preparation, mechanism of action and application of the following reagents in Organic synthesis: DCC, 1,3–dithiane (Corey–Seebach reaction), LDA, DDQ, Wilkinson catalyst, crown ethers, trimethyl silyl iodide, trimethyl silyl cyanide, hydrosilane, Iwanov reagent, Peterson reaction, Julia olefination, Woodward and Prevost hydroxylations, Lawesson's reagent
PG75T402B: Photochemistry and Pericyclic Reactions	UNIT – I **Organic Photochemistry:** Principles of photochemistry, photochemical processes, Energy transfer and photosensitisation, Photochemical Reactions :	UNIT–I **Organic Photochemistry:** Bonding and antibonding orbitals, principles of photochemistry, photochemical processes, singlet and triplet states, energy transfer and photosensitisation, photochemical reactions,

	Photoreduction, Norish type – I, type – II cleavages- Di-Pi methane rearrangement, Optical pumping. Photochemistry of cyclohexadienones, Photo Fries Rearrangement, Paterno Buchi reaction. Photochemistry of alkenes, benzenes, cyclohexanes, Yang cyclisation. Photochemistry of vision.	photoreduction, Photochemical fragmentation reactions: Norish type–I, type – II cleavages (Yang cyclisation)–di–pi methane rearrangement, optical pumping, photochemistry of cyclohexadienones, photo–Fries rearrangement, Paternò–Büchi reaction, photochemistry of alkenes, benzenes, cyclohexanes and photochemistry of vision.
	UNIT – II **Pericyclic Reactions:** Classification and features, Molecular orbital symmetry. Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl systems. Electrocyclic processes: Woodward Hoffmann rules for 4n and 4n + 2 π systems. Cycloaddition reactions : Diels-Alder reaction, (2+2) and (4+2) cycloaddition reaction, Supra facial and Antra facial addition. Significance of Reactions : Sigmatropic rearrangement, supra and antra facial hydrogen shifts. Claisen Cope, oxy cope and aza cope Rearrangements. Vitamin – D group isomerisations.	UNIT–II **Pericyclic Reactions:** Pericyclic reactions: Classification and features, molecular orbital symmetry, frontier orbitals of ethylene, 1,3–butadiene, 1,3,5–hexatriene and allyl systems. Electrocyclic processes: Introduction, Woodward–Hoffmann rules for 4n– and (4n+2)–π systems, stereochemistry under thermal and photochemical conditions. Cycloaddition reactions: Introduction, supra facial and antra facial addition, [2+2] and [4+2] cycloaddition reaction (Diels–Alder reaction) FMO analysis under thermal and photochemical conditions. Sigmatropic rearrangements: Classification, FMO approach for [1,3], [1,5] and [3,3] sigmatropic rearrangements, supra and antra facial hydrogen shifts. Walk, Claisen–Cope, oxy–Cope and aza–Cope rearrangements. Vitamin-D group isomerizations
	UNIT-III **Molecular Rearrangement:** Classification and general mechanistic pattern for electrophile, free radical and nucleophile rearrangement. Mechanisms of the following rearrangement : i) C – C migration : Pinacol-Pinacolone, Dienone- Phenol, Benzilic, Favorskii, Neber, Sommelet-Hauser, Anderson, Stevens, Smiles, Shapiro, Fritsch-Butenberg-Wiechell ii) C – N migration : Benzidine rearrangement.	UNIT–III **Molecular Rearrangement:** Molecular Rearrangement: Classification and general mechanistic pattern for electrophile, free radical and nucleophile rearrangement. Mechanisms of the following rearrangement: (i) C–C migration: Wagner–Meerwein, pinacol–pinacolone, dienone–phenol, benzilic, Favorskii, Sommelet–Hauser, Stevens, Smiles, Fritsch–Butenberg–Wiechell. (ii) C–N migration: Benzidine rearrangement, Neber, Beckmann, Hofmann, Curtius, Lossen, Schmidt. (iii) C–O migration: Baeyer-Viliiger, Dakin, Payne (including *aza* and *thia*),

	iii) C –O migration : Baeyer-Viliiger. iv) O-C migration : Baker-Venkataraman, Fries and Wittig rearrangements.	hydroperoxide, Crigee, Rupe, Ferrier, Petasis, Bamford–Stevens. (iv) O–C miigration**:** Baker–Venkataraman, Fries and Wittig rearrangements.
	UNIT-IV **Biochemical Mechanism:** Reaction mechanism of the Biochemical reactions associated with the following : Thiamine pyrophosphate (TPP). Pyridoxal phosphate (PLP) Lipoic.acid Vitamin – $B_{12.}$ Nicotinamide. Flavin. Tetrahydrofolic acid. Biotin. Coenzyme A.	UNIT–IV **Organo–Lithium, –Magnesium, –Zinc, and –Tin Compounds:** Organolithium and organomagnesium: Preparation, properties of organolithium and organomagnesium compounds and their uses in organic synthesis and in the preparation of organometallic compounds, Gilman reaction, LDA. Organozinc compounds: Preparation, structure and bonding, applications in C–C bond forming reactions *viz*., Simmons–Smith reaction, Negishi coupling, Fukuyama coupling, Barbier reaction and zinc acetylides.
PG75T403B: Heterocyclic and Medicinal Che mistry	UNIT – I **Heterocyclic Chemistry - I** Chemistry of three, four, and seven membered heterocycles with one Heteroatom. **Three membered :** Oxiranes, Aziridines and Thiranes. **Four membered :** Oxetanes, Azetidines and Thietanes. **Seven membered:** Oxepines, Azepines and Thiepines.	UNIT – I **Heterocyclic Chemistry–I** Chemistry of three, four, and seven membered heterocycles with one heteroatom. Three membered: oxiranes, aziridines and thiranes. Four membered: oxetanes, azetidines and thietanes. Seven membered: oxepines, azepines and thiepines.
	UNIT–II **Heterocyclic Chemistry - II** Transformations, Photochemistry and rearrangement in Heterocycles. Transformations : i) Coumarins to benzofurans. ii) Sydnones to Pyrazoles. iii) Chromones to Pyrazoles. iv) Furans to Pyridines. v) Pyrroles to Pyridines. **Heterocycles in Functional group Transformations:** i) Alkanes from Thiophenes. ii) Cycloalkanes from Pyrazolines. iii) Dienes from Pyrroles. iv) Alcohols from isoxazodiolines. v) Esters from Trichlorocyanuric acid.	**UNIT–II** **Heterocyclic Chemistry–II** Transformations, Photochemistry and rearrangement in heterocycles. Transformations of: (i) coumarins to benzofurans, (ii) sydnones to pyrazoles, (iii) chromones to pyrazoles (iv) furans to pyridines and (v) pyrroles to pyridines. Heterocycles in functional group fransformations: (i) alkanes from thiophenes, (ii) cycloalkanes from pyrazolines, (iii) dienes from pyrroles (iv) alcohols from isoxazodiolines (v) esters from trichlorocyanuric acid, (vi) acetylenes from 1,2,3-selenadiazoles and (vii) deoxygenation of phenols tetrazoles. Rearrangements in heterocycles: (i) Dimroth

	vi) Acetylenes from 1,2,3-selenadiazoles and vii) Deoxygenation of Phenols tetrazoles. **Rearrangements in Heterocycles:** i)Dimroth Rearrangement ii)Boultan-Katritzky Rearrangement. iii)Fischer Indole cyclisation.	rearrangement, (ii) Boultan–Katritzky rearrangement and (iii) Fischer Indole cyclisation.
	UNIT – III **Medicinal Chemistry – I:** Modern theories of drug action, concept of receptors, computer aided drug design, Qualitative and quantitative SAR. Sulfa Drugs: Sulfadiazines, Sulfamethazines, Sulfaguanidines, Sulfa isoxozoles, Sulfamerazine. Analgesics : Classification of Narcotic and Non-narcotic analgesics. Narcotic : Opium alkaloids, Morphine, Metopon**,** Benzomorphan and Phenazocine**.** Non-narcotic : 4-Phenylpiperidines – Pethidine, Diisopropylamines, Methadone, Pyrazolones, Antipyrine. Anti-Fertility Drugs: Steroidal and non-steroidal compounds; Norethindrone, Mestranil, Norgestrol and non-steroidal antifertility drugs.	UNIT–III **Medicinal Chemistry–I:** Modern theories of drug action, concept of receptors, computer aided drug design, qualitative and quantitative SAR. Sulfa drugs: Sulfadiazines, sulfamethazines, sulfaguanidines, sulfaisoxozoles and sulfamerazine. Analgesics: Classification of narcotic and non–narcotic analgesics. Narcotic: Opium alkaloids, morphine, metopon, benzomorphan and phenazocine. Non–Narcotic: 4–Phenylpiperidines, pethidine, di–isopropylamines, methadone, pyrazolones and antipyrine. Anti–Fertility Drugs: Steroidal and non–steroidal compounds, norethindrone, mestranil, norgestrol and non–steroidal antifertility drugs.
	UNIT – IV **Medicinal Chemistry – II:** Antineoplastic Agents: Nitrogen Mustards, Chlorabucil, Sarcolycin Dopan and Cyclophosphomide. Pteridines: Amethopterin, Pyrimidines, 5-fluoro uracil, Cis-platines**,** anti-platines etc. Antibiotics: Structure, Synthesis, stereochemistry and spectral features of the following antibiotics : Natural penicillins, Semisynthetic penicillins,Patulin, Chloramphenicol, Steptomycin, Structural features and uses of common antibiotic drugs. Norfloxacin, Rifamycin and Amoxycillin.	UNIT – IV **Medicinal Chemistry–II:** Antineoplastic agents: Nitrogen mustards, chlorabucil, sarcolycin dopan and cyclophosphomide. Pteridines: Amethopterin, pyrimidines, 5–fluorouracil, cis–platines, anti–platines, etc. Antibiotics: Structure, synthesis, stereochemistry and spectral features of the following antibiotics: natural penicillins, semisynthetic penicillins, patulin, chloramphenicol, steptomycin, structural features and uses of common antibiotic drugs. Norfloxacin, rifamycin and amoxycillin.

PG75D404B: Project Work*	The project work may include inplant training in Industries/short term work in the Department/other educational institutions/R&D organizations/Data mining/Review of current literature/ Theoretical methods/computer applications. Experimental work may involve studies on synthesis/measurements/study of properties/characterization by physical methods/activities for reported/unreported research or any suitable combination there of In case of the students who would work outside the campus, the supervising staff member may visit to the work place at least once during the period and may be eligible for TA-DA as per the University rules.	The project work may include in–plant training in Industries/short term work in the department/other educational institutions/R&D organizations/data mining/review of current literature/theoretical methods/computer applications. Experimental work may involve studies on synthesis/measurements/study of properties/characterization by physical methods/activities for reported/unreported research or any suitable combination thereof.
PG75P401B: Lab Course in Organic Chemistry	Multi-step preparation of organic compounds involving various reactions like addition, elimination, oxidation, hydrolysis etc. and purification methods like distillation and crystallization.	Multi-step preparation of organic compounds involving various reactions like addition, elimination, oxidation, hydrolysis etc. and purification methods like distillation and crystallization.
PG75P402B: Lab Course in Organic Chemistry	Ternary mixture analysis (without derivatives). Qualitataive analysis of three component mixture containing amino acids, low boiling liquids, nitrophenols etc.	Ternary mixture analysis (without derivatives). Qualitataive analysis of three component mixture containing amino acids, low boiling liquids, nitrophenols etc.
PG75P403B: Lab Course in Organic Chemistry	Preparation of Derivatives / Spectral Analysis.	Preparation of Derivatives / Spectral Analysis/

THIRD SEMSTER (PHYSICAL CHEMISTRY)

PG75T301C: Quantum Mechanics, Group Theory & Diffraction.	**UNIT-I: Quantum Mechanics-I:** Review of Classical Mechanics: Equation of motion for a particle, Newtonian, Lagrangian and Hamiltonian equations of motion, elementary wave motion. Postulates of quantum mechanics, operators, eigen values and expectation values. Commuting operators, linear operator and Hermitian operators. Application of Schrodinger equation: Review of the results of particle in a box of one and three dimensions, degeneracy. Reflection and penetration of a particle in a one-dimensional box of semi-infinite barrier, a particle in a box of finite walls, linear harmonic oscillator. Hermite polynomials. A rigid planar rotator, derivation of selection rules for transitions in rotating molecule. **UNIT – II: Quantum Mechanics-II:** Equation for hydrogen atom and its solutions, separation of variables, the phi, theta and radial equations, the problems of spherical symmetry. Approximate methods in quantum mechanics: Variation method and variation theorem, linear variation functions, secular equations and secular determinants. Application of variation method to hydrogen molecule ion, hydrogen molecule and normal helium atom. Perturbation theory (first order and non-degenerate), application of perturbation theory to the helium atom.	**UNIT–I :Quantum Mechanics:** Equation for hydrogen atom and its solutions, separation of variables, the phi, theta and radial equations, the problems of spherical symmetry. Approximate methods in quantum mechanics: variation method and variation theorem, linear variation functions, secular equations and secular determinants. Application of variation method to hydrogen molecule ion, hydrogen molecule and normal helium atom. Perturbation theory (first order and non-degenerate), application of perturbation theory to the helium atom. **UNIT- II: Atomic Structure and Atomic Spectra:** A summary of the hydrogen spectrum. Alkali spectra and alkali like spectra, spark spectra and arc spectra. Moseley lines. Helium and alkaline earth spectra. Multiplet structure of line spectra. Doublet structure of alkali spectra and compound doublets, triplets and singlets of alkaline earths and helium, prohibition of intercombinations. Multiplicities and term symbols. Space Quantization: Zeeman effect, normal and anomalous Zeeman effects, Paschen–Back effect and Stark effect.

	UNIT-III: Atomic Structure and Atomic Spectra: A summary of the hydrogen spectrum. Alkali spectra and alkali like spectra, spark spectra and arc spectra. Moseley lines. Helium and alkaline earth spectra. Multiplet structure of line spectra. Doublet structure of alkali spectra and compound doublets, triplets and singlets of alkaline earths and helium, prohibition of intercombinations. Multiplicities and term symbols. Space quantization: Zeeman effect, normal and anomalous Zeeman effects, Paschen- Back effect, Stark effect. **UNIT-IV:** **Polymer Chemistry:** Mechanism of polymerization: free-radical, cationic, anionic and ring opening polymerizations. Ziegler-Natta polymerization, metallocene catalysis polymerization, atom transfer radical polymerization (ATRP), metathesis polymerization, coordination initiator polymerization, group transfer polymerization. Polymer membranes in separation science: Mechanism of transport in polymeric membranes and rejection performance, and industrial applications of micro filtration (MF) and ultrafiltration (UF) membranes. Reverse osmosis (RO) and Electrodialysis (ED). Preparation of ion-exchange membranes grafted on polyethylene film using styrene and chloromethylstyrene. Preparation of anion exchange membranes using chloromethylated polysulfone and 4,4'-bipyridine. Preparation of styrene-divinyl benzene-based ion exchange membranes.	**UNIT–III: Symmetry Properties of Molecules and Group Theory:** Introduction to symmetry, molecular symmetry, symmetry elements, symmetry operations and matrix method in symmetry. Molecular point groups: point groups identification of point groups, construction of group multiplication tables, symmetry species and point group character tables. Reducible and irreducible representations, properties of irreducible representation, Mulliken symbolism rules for irreducible representation, structure of character tables, the standard reduction formula and the great orthogonality theorem. Normal mode analysis: number of normal modes of vibrational symmetry types, infrared and Raman activity, Rule of mutual exclusion. **UNIT–IV:** **Diffraction Studies:** X-ray diffraction: Reciprocal lattice, indexing of single crystal rotation photographs, determination of molecular parameters, the structure factor calculations, Fourier series and phase problems. Refinements of Fourier procedures and general concept of solution of structures. Neutron diffraction: Neutron diffraction and differences from X-ray diffraction. Electron diffraction: Theoretical principles, structure analysis: visual comparison of intensities, radial distribution function and its refinements. The rotating sector method.

PG75P302C: Spectroscopy & Voltammetry	**UNIT – I: Rotation of Molecules and Rotational Spectra:** Classification of molecules; momental ellipsoid, energy levels of linear, symmetric, spherical and asymmetric top molecules and their symmetry properties. Thermal distribution of rotational energy levels. Infrared rotational spectra, non rigid rotor treatment. **Vibration of Molecules:** Molecule as harmonic oscillator : vibrational eigen functions and eigen values. Hermite polynomials; calculation of transition of probabilities and selection rules. The anharmonic oscillator, energy levels, selection rules and I.R.Spectra. Mathematical form of potential energy curves.	**UNIT–I: Rotational and Vibrational Spectroscopy:** Rotation of polyatomic molecules: classification of molecules, momental ellipsoid, energy levels of linear, symmetric, spherical and asymmetric top molecules and their symmetry properties. Selection rules. Thermal distribution of rotational energy levels. Infrared rotational spectra and non rigid rotor treatment. **Vibration of molecules**: Molecule as harmonic oscillator, vibrational eigen functions and eigen values. Hermite polynomials, calculation of transition of probabilities and selection rules. The anharmonic oscillator, energy levels, selection rules and IR spectra. Anharmonicity and Morse equations. **Rotation-vibration spectra of polyatomic molecules**: Rotation - vibration spectra, shapes of absorption bands in case of (i) linear, (ii) symmetric top, (iii) spherical top and (iv) asymmetric top, molecules. Isotopic effects. Applications of IR spectroscopy. Numerical problems on IR spectroscopy.
	UNIT – II: Rotation-Vibration Spectra: Rotation - vibration spectra, shapes of absorption bands in case of (i) linear, (ii)symmetric top, (iii) spherical top and (iv)asymmetric top, molecules. Isotopic effects. Applications of I.R. spectroscopy **Microwave Spectroscopy** Gaseous microwave spectra and rotational transitions: Study of inversion of ammonia and hindered rotations in molecules. Instrumentation. Stark effect in molecular spectra; first and second order Stark effects.	**UNIT–II: Nuclear Magnetic Resonance-I:** Magnetic properties of nuclei: concept of nuclear spin, interaction between spin and external magnetic field, energies and energy levels of nuclear spin states, population of energy levels. Larmor precession, relaxation processes and relaxation times, theoretical principles underlying NMR, experimental set up and instrumentation: continuous wave and pulsed Fourier transform technique in NMR. Concept of chemical shift, shielding and deshielding mechanisms, diamagnetic–anisotropy, ring currents.

		Spin–spin coupling, coupling constants and rules governing the interpretation of first order ^{1}H–NMR spectra and elucidation of structure. Kinetic applications.
	UNIT – III: Nuclear Magnetic Resonance: Magnetic properties of nuclei, theoretical principles underlying NMR and experimental set up. Shielding and deshielding mechanisms and concept of chemical shift. High resolution NMR. Spin-spin coupling, coupling constants and elucidation of structure by NMRspectra. Kinetic applications.	**UNIT–III: Magnetic Resonance Spectroscopy-II and Optical Spectroscopy** **Nuclear quadrupole resonance spectroscopy**: Theory and instrumentation, effect of magnetic field on the spectra, relationship between electric field gradients and molecular structure. Applications. The interpretation of eQq data, effect of crystal lattices on the magnitude of eQq. Structural information from NQR spectra. **Electron spin resonance spectroscopy**:Introduction and theoretical principles. Intensity, frequency, position and representation of ESR absorptions. Hyperfine structure of ESR absorptions. Zero field splitting and Kramer's degeneracy. Instrumentation. Applications to the study of free radicals and compounds with unpaired electrons: ESR spectra of hydrogen and nitrogen atoms, semi–quinone ion, naphthalene negative ion, methyl radical and methyl substituted radicals. Measurements of distribution of unpaired electron density in radicals. Study of coordination compounds by ESR technique.**Optical rotatory dispersion and circular dichroism**: Simple theoretical account and instrumentation. Treatment of data, applications to gross structure determination,octant rule, determination of stereochemistry and absolute configuration.
	UNIT – IV: Nuclear Quadrupole	**UNIT–IV: Voltammetry:**

	Resonance Spectroscopy: Theory and instrumentation. Effect of magnetic field on the spectra, relationship between electric field gradients, q and molecular structure. Applications. The interpretation of eQ_q. data effect of crystal lattice on the magnitude of eQ_q Structural information from NQR spectra. **Electron Spin Resonance Spectroscopy:** Theoretical principles and instrumentation. ESR spectra of hydrogen and nitrogen atoms, Semi-quinone ion, naphthalene negative ion, methyl radical and methyl substituted radicals Zero field splitting, Kramer's degeneracy. Measurements of distribution of unpaired electrons in radicals. Study of co-ordination compounds by ESR technique. **Optical Rotatory Dispersion and Circular Dichroism:** Simple theoretical account and instrumentation. Treatment of data, applications to gross structure determination, octant rule, determination of stereochemistry and absolute configuration	**Voltammetry: Principles, and instrumentation, voltametric techniques:** Linear sweep voltammetry, staircase and square wave voltammetry, anodic stripping voltammetry, cathodic stripping voltammetry, cyclic voltammetry, normal and differential pulse voltammetry and their theoretical aspects, electrodes, cells and their set-up. Electron transfer (ET) or charge transfer process: reversible ET, irreversible ET, quasi reversible ET and their diagnostic tests. Applications of voltametric techniques. Polarography: Principles, dropping mercury electrode (DME), instrumentation, linear scan polarography, polarography currents, polarograms. Diffusion current at dropping electrodes, residual currents, advantages and disadvantages of dropping mercury electrode, current-sampled polarography, half wave potentials. Pulse polarography. Applications.
PG75T303C: Statistical Mechanics and Polymer Chemistry	**UNIT – I: Diffraction Studies:** X-Ray Diffraction: Reciprocal lattice, indexing of single crystal rotation photographs, determination of molecular parameters, the structure factor calculations, Fourier series and the phase problems. Refinements of Fourier procedures. Neutron diffraction: Neutron diffraction and differences from X-Ray diffraction. Electron diffraction: Theoretical principles, structure analysis: Visual comparison of intensities, radial distribution function and its refinements.	**UNIT–I: Statistical Mechanics and Statistical Thermodynamics–I:** Microscopic and macroscopic systems. Microstates and macrostates. Assemblies of independent localised and non-localised systems. Phase space or γ-space and μ-space. Ensembles. Classical statistics: Maxwell–Boltzmann distribution for ideal gases and mixture of gases. Determination of Lagrangian multipliers, alpha and beta. Heat capacities of solids: Einstein's theory of heat capacity of solids, Debye's theory, characteristic temperature and use of

	The rotating sector method.	Debye equation for the determination of heat capacity at low temperature. Entropies and heat capacities of ortho–, para–hydrogen systems, comparison of third law entropies with statistical entropies.
	UNIT – II: Symmetry Properties of Molecules and Group Theory: Symmetry elements,Symmetry operations and point group. Determination of point group. Construction of group multiplication tables. Symmetry species and character tables. Reducible and irreducible representations. Analysis of reducible representations. Number of normal modes of vibrational symmetry types. Rule of mutual exclusion. I.R.and Raman active fundamentals.	**UNIT–II: Statistical Mechanics and Statistical Thermodynamics–II:** Quantum statistics: Bose–Einstein, Fermi–Dirac and comparison with Maxwell–Boltzmann statistics. Numerical problems. Partition functions: Definition of partition function and separation of partition functions. Translational, Sackur–Tetrode equation, rotational, vibrational and electronic partition functions for monoatomic, diatomic and polyatomic gaseous molecules.Equipartition of energies.
	UNIT – III: Statistical Mechanics and Statistical Thermodynamics-I: Microscopic and Macroscopic systems.Microstates and macrostates. Assemblies of independent localised and non-localised systems. Phase space or γ-space and μ-space. Ensembles. Classical Statistics: Maxwell-Boltzmann distribution for ideal gases and mixture of gases. Determination of Lagrangian multipliers, alpha and beta. Equipartition of energies. Heat Capacities of Solids Einstein's theory of heat capacity of solids, Debye's theory. Characteristic temperature and use of Debye equation for the determination of heat capacity at low temperature Sackur - Tetrode equation: Entropies and heat capacities of ortho-, para-hydrogen systems, comparison of third law entropies with statistical entropies.	**UNIT–III: Polymer Chemistry and Fuel cells:** Dendrimers and hyper-branched polymers:introduction to dendrimers, methods of preparation, common properties and applications. Synthesis of polyamidoamines using divergent route and dendritic polyether macromolecules using convergent route. Hyper–branched polymers, preparation of aromatic polyesters by the self-condensation of 3, 5–bis (acetoxy)benzoic acid. Polymeric nonlinear optical: Materials, definition, classification of NLO materials, basic molecular characteristics of second–order NLO materials, types of second–order NLO materials with examples, schematic representation of experimental setup for the measurement of second harmonic generation (SHG). Preparation of polyimide from diamino NLO chromophores.

		Semiconducting polymers: basic criteria for semiconducting properties, electrochemical polymerization, precursor route to poly (p–phenylenevinylene) (PPV) and synthesis of poly (3–alythiophene). **Fuel cells**: Introduction, difference between conventional cell and a fuel cell, limitations, advantages, types of fuel cells. Construction and working of hydrogen–oxygen and methanol–oxygen fuel cells. Applications of fuel cells.
	UNIT – IV: Polymer Chemistry: Transitions in polymers: Definition of glass transition temperature (T_g) and flow temperature (T_f) and melting temperature (T_m), thermal behaviour of amorphous and crystalline polymers, factors affecting the T_g. Plasticizers, properties and their effect on $T_g$of PVC and diethylhexylsuccinate, efficiency of plasticizers, comparison of T_g and T_m.T_g of copolymers and polymer blends, relation between T_g and T_m. Preparation, properties and commercial importance: Vinyl polymers: polyethylene, polypropylene, polystyrene, polymethylmethacrylate, polyvinyl chloride, polytetrafluoroethylene. Polyesters: poly(ethylene terephthalate). Polyamides: aramides (Kevlar and Nomex). Polyimides. Polysulphone. Polyurethanes. Polyureas. Natural polymers: polyisoprenes, chitosan. Methods of polymer fabrications: Fabrication of polymer films: solution casting, melt pressing, melt extrusion and bubble blown. Fabrication of shaped polymer objects: compression moulding, injection moulding, reaction injection moulding, blow moulding extrusion	**UNIT–IV: Polymer Membrane Chemistry:** Polymer membranes in separation science: mechanism of transport in polymeric membranes and rejection performance, and industrial applications of micro filtration (MF) and ultrafiltration (UF) membranes. Reverse osmosis (RO): principles of RO process and determination of its efficiency in terms of flow of water and salt. Preparation of polyamide and cellulose based RO membranes. Electrodialysis:principle of ED, working model of ED. Preparation of ion-exchange membranes grafted on polyethylene film using styrene and chloromethylstyrene. Preparation of styrene-divinyl benzene based ion exchange membranes. Preparation of anion exchange membranes using chloromethylated polysulfone and 4, 4'–bipyridine. Preparation of sulfonated poly(phosphazene) membrane. Preparation of ion exchange membrane using 4–vinyl pyridine and epichlorohydrin. Applications of Electrodialysis. Vinyl polymers (preparation, properties and commercial importance): polyethylene, polypropylene, polystyrene, polymethylmethacrylate, polyvinyl

	moulding and calendaring. Spinning industrial polymers: solution spinning and melt spinning.	chloride, polytetrafluoroethylene. Polyesters: poly(ethylene terephthalate). Polyamides: aramides (Kevlar and Nomex), polyimides, polysulphone, polyurethanes, polyureas. Natural polymers: polyisoprenes, chitosan.
PG75P301C: Lab Course In Physical Chemistry	**1. Viscosity :** Molecular weight of a high polymer by viscosity determination. **2. Solubility:** Heat of solution (e.g. Oxalic acid, benzoic acid etc.) by solubility experiments. **3. Phase Equilibria:** a) Distribution of benzoic acid (or succinic acid) between benzene and water. b) Molecular weight of benzene (or nitrobenzene) by steam distillation. c) Vapour pressure of chlorobenzene by steam distillation. **4. Refractometry**: Electron polarization and electron polarizability of a liquid. **5. Polarimetry:** Percentage composition of two optically active substances (e.g,d- sucrose and d- tartaric acid) **6. Absorptiometry:** a) Applicability range (for an absorbing substance in solution and evaluation of absorbency index, measuring unknown concentration. b) Mixture analysis by absorptiometry. c) Application of Hammett Acidity function. 7. **Electrolytic Conductance:** a) Verification of the Onsager equation as applied to electrolytes. b) Comparison of strengths of weak acids (e.g. Chloroacetic acid and acetic acid). **8. Reaction Kinetics:** Hydrolysis of methyl acetate:i) catalytic coefficients (or strengths of acids) ii) Arrhenius parameters. **9. Emf of cells:** a) Standard electrode potential of reversible metal-metal ions at room temperature. b) Solubility of sparingly soluble salts c) Dissociation constants of a weak monobasic acid **10. Cryoscopy:** Determination of cryoscopic constant of the given solvent.	**1. Viscosity:** Determination of number average molecular weight by hydroxyl end group analysis. **2. Conductance:** Verification of the Debye-Huckel-Onsagar equation for strong electrolytes. **3. Reaction Kinetics:** Studying the acid catalysed kinetics of oxidation of glycene by chloramine-T (CAT) and hence determination of order of reaction w.r.t. CAT and glycene and hence overall order of the reaction. **4. Potentiometry:** Potentiometric estimation of a mixture of a halides, (KCl, KBr and KI) by titrating against $AgNO_3$ **5. Cryoscopy:** Determination of the molecular weight of the given solute by the vacuum flask method. **6. pH metry:** Determine the acid and base dissociation constant of an amino acid and hence find its isoelectric point **7. Refractometry:** Analysis of a binary mixture (glycerol and water) by refractive indices measurement. **8. Spectrophotometry:** Individual and simultaneous estimation of Fe(III) and Cu(II) spectrophotometrically by titrating against EDTA. **9. X-Ray diffraction:** To determine the lattice constant and Bravais lattice using X-ray diffraction pattern. Zeeman effect: Study the Zeeman effect and determine e/m ratio of electron.
PG75P302C Lab Course In Physical Chemistry	**1. Surface Tension:** a) Variation of surface tension of aqueous solutions of a liquid (n-propyl alcohol) with concentration and determination of limiting cross sectional area of the alcohol molecule. b) Interfacial tension between two	**1. Surface Tension**: Variation of surface tension of aqueous solutions of a liquid (n–propyl alcohol) with concentration and determination of limiting cross sectional area of the alcohol molecule.

	immiscible liquids (e.g., benzene & water at room temperature) c) Effect of added salt on the surface tension of water d) Critical micelle concentration of a soap molecule. (e.g., Potassium laureate). **2. Thermochemistry:** Heat of neutralization of weak and strong acid. **3. Electrolytic Conductance:** Conductometric titrations : a) Weak acid Vs weak base, b) H_2SO_4 Vs $BaCl_2$ c) Moderately weak acid like salicylic acid Vs NaOH (Salt line method and alkali method), d) Dilute solution of a weak acid (0.01 to 0.001N) Vs NaOH by addition of solvent of low dielectric constant, using ammonia and NaOH titrants and by double alkali method **4. Reaction Kinetics:** Hydrolysis of methyl acetate : Degree of hydrolysis of urea hydrochloride using HCl and equinormal urea hydrochloride solutions. **5. Emf of Cells:** a) Acid and base dissociation constants of an amino acid and its iso-electric point. b) Titration of Fe^{2+} with Ce^{4+} and determination of the formal redox potential of Fe^{3+}/Fe^{2+} and Ce^{4+}/Ce^{3+}. c) Mean ionic activity coefficient of hydrochloric acid at different concentrations using a	**2. Adsorption**: Investigation of adsorption of oxalic acid from aqueous solution by activated charcoal and examine the validity of Freundlich and Langmuir's adsorption isotherm. **3. Conductance:** Moderately weak acid like salicylic acid vs NaOH (Salt line method and alkali method). **4. Reaction Kinetics:**Determination of degree of hydrolysis of urea hydrochloride by studying kinetics of hydrolysis of methyl acetate using HCl and equinormal urea hydrochloride solutions. **5. Potentiometry:** (i) Acid and base dissociation constants of an amino acid and its isoelectric point and (ii) Mean ionic activity coefficient of hydrochloric acid at different concentrations using a concentration cell without transference: influence of ionic strength on the mean ionic activity coefficient. **6. Refractometry**: Variation of refractive index with composition

	concentration cell without transference: influence of ionic strength on the mean ionic activity coefficient. **6. Refractometry:** Variation of refractive index with composition of mixture (e.g., CCl_4 and $CH_3COOC_2H_5$) **7. Cryoscopy:** Determination of degree of dissociation of given electrolytes (KCl, urea) **8. Transport Number:** Transference number of Ag^+ and Cl^- ions by making boundary method. **9. pH meter:** a) Determination of strength of unknown solution of acids (strong, weak, etc) b) Determination of pH of buffer solutions **10. Viscosity:** Effect of temperature on the viscosity of the liquid	of mixture (e.g., CCl_4 and $CH_3COOC_2H_5$). **7. Transport Number**: Transference number of Ag^+ and Cl^- ions by making boundary method. **8. Viscosity:** Determination of molecular weight of polyhexamethylenesebacamide (nylon 6, 10) by amine end group analysis. **9. Optics:**To determine the wavelength of He–Ne laser by measuring the fringe width from interference pattern.
PG75P303C: Lab Course In Physical Chemistry	**1.Viscosity** : Viscosity of air by Rankine`s method **2. Solubility**: Effect of addition of an electrolyte on the solubility of an organic acid. **3. Phase Equilibria**: Equilibrium constant of the reaction: $KI+I_2$ KI_3 and the determination of an unknown concentration of KI solution. **4. Thermochemistry**: a) Heat of hydration of $CuSO_4$(heat of crystallization of $CuSO_4{\cdot}5H_2O$) b) Integral heat of solution and dilution of salts (e.g.KNO_3,NaCI etc.) **5. Absorptiometry:** a) Absorptiometry titration of hydrochloric	**1. Solubility:**Study the effect of addition of an electrolyte (NaCl, KCl, Na_2SO_4 and K_2SO_4) on the solubility of an organic acid (Benzoic acid or salicylic acid). **2. Phase equilibria**: Construction of phase diagram of three component system (water, benzene and ethanol or acetic acid, water and chloroform or benzene). **3. Conductance**: Studying the kinetics of saponification of ethyl acetate by conductance method and hence determine the rate constant.

	acid b) Absorptiometry estimation of Fe (III) with EDTA. **6. Electrolytic Conductance**: Equivalent conductance of a weak acid, e.g. acetic acid at different concentrations and testing the applicability of Ostwald`s dilution law. **7. Mobilities of ions:** Transference numbers of silver and nitrate ions in a solution of silver nitrate by Hittorf 's method. **8. Reaction Kinetics** a) Reaction kinetics of H_2O_2 and HI: Clock reaction b) Salt effect on the persulphate oxidation of iodide ion. c) Auto catalysis : Mn(VII) oxidation of oxalic acid in the presence of H_2SO_4 d) Kinetics of decomposition of the complex formed between sodium sulphide and sodiumnitroprusside **9.Emf of cells** a) Stability constants of Cu^{2+} - EDTA complex. b) Ionic product of water at 25°C c) Titration of H_3PO_4 with NaOH d) Titration of Zn(II) with $K_4Fe(CN)_6$ and verification the formula of the complex formed between Zn(II) and$[Fe(CN)_6]^{4-}$. **10. Cryoscopy**: Determination of activities of an electrolyte and a nonelectrolyte by cryoscopic method.	**4. Thermochemistry:**Determination of step wise heat of neutralization of a polybasic acid. **5. Reaction Kinetics**: Reaction kinetics of H_2O_2 and HI: Clock reaction. **6. Potentiometry:**Potentiometric determination of stability constant of Cu^{2+}–EDTA complex. **7. Cryoscopy:** Determination of degree of dissociation of given electrolytes (KCl, urea) using cryoscopy method. **8. Refractometry:** Molar refraction of a solid substance by dissolving it in a solvent. **9. Solid state:**Determine the curie temperature of ferromagnetic material. **10. X-ray diffraction**: Determine the linear position and inter planar spacing using X-Ray diffraction patterns.

FOURTH SEMESTER (PHYSICAL CHEMISTRY SPECILIZATION)

PG75T401C : Quantum Mechanics and Solid-State Chemistry	**UNIT-I: Chemical Bonding:** Molecular orbital and valence bond theories of chemical bonding, comparison of the two applications to hydrogen molecule ion, H2 molecule, Improvements in the Hitler-London wave functions, Slater orbitals and SCF method for many electron atoms,	**UNIT–I: Chemical Bonding–I:** Electronic structure of diatomic molecules. The Born–Oppenheimer approximation. Valence bond and molecular orbital theories of chemical bonding, comparison of the two theories. Applications of valence bond and molecular orbital theories to hydrogen molecule and hydrogen molecule ion.

	Bonding and antibonding molecular orbitals. Molecular orbital theory applied to homonuclear and heteronuclear diatomic molecules.	Improvements in the Hitler–London wave functions. Bonding and antibonding molecular orbitals. Molecular orbital theory applied to homonuclear and heteronuclear diatomic molecules, molecular electron configuration and calculation of bond order. Slater orbitals, Hartree–Fock self-consistent field method for many electron atoms. Configuration interaction and Roothaam equations.
	UNIT-II: Polyatomic molecules: Localized and non-localized molecular orbitals, hybridization and direct valence. Conjugated and aromatic molecules. Simple Huckel molecular orbital theory and M.O. description of normal and cyclic butadienes, ethylene and aromatic molecules (benzene as an example), Calculation of delocalization energies, fractional bond orders, charge density calculations. extended Huckel theory.	**UNIT–II: Chemical Bonding–II:** Loclized and non-localized molecular orbitals, hybridization and direct valence. Quantum mechanical treatment to sp–, sp^2– and sp^3–hybridization and the geometry associated with sp–, sp^2– and sp^3–orbitals. Conjugated and aromatic molecules: Huckel molecular orbital theory and MO description of normal and cyclic butadienes, ethylene and aromatic molecules (benzene as an example), calculation of delocalization energies, fractional bond orders, charge density calculations and extended Huckel theory
	UNIT-III: Solid State Chemistry – I: Different types of solids: Ionic, covalent, metallic, molecular and hydrogen bonded crystals. Lattice energy of ionic crystals. Properties of solids (only elementary account mechanical, thermal, magnetic electrical and optical) Defects in Solids: Frenkel and Schottky defects and chemical reactivity of solids.	**UNIT–III: Solid State Chemistry–I** Introduction, properties of Solids: Malleability, ductility, elasticity, plasticity, brittleness hardness, enantiotropy, monotropy and isomorphism. Allotropy and polymorphism of solids. Bonding in solids: Ionic, covalent, metallic, molecular and hydrogen bonded crystals. Lattice energy of ionic crystals. Numerical problems. Imperfection in solids: Types of defects including Frenkel and Schottky defects, thermodynamics of Frenkel and Schottky defects. Reactivity in solid state: Introduction, thermodynamics, classification, experimental methods for the study, kinetic equation, energy of activation of solid state reactions, diffusion mechanism in solid state reactions, factors affecting the reactivity of solids
	UNIT-IV: Solid State Chemistry – II: **Semiconductors**: Bonding and conductivity, mechanism of conductivity, energy bands in semiconductors, impurity conductors and p-n and n-p-n junctions. Importance of semiconductors. Super conductors: Occurrence of super conductivity, its destruction by	**UNIT–IV: Solid State Chemistry–II:** **Semiconductors**: Bonding and conductivity, mechanism of conductivity, energy bands in semiconductors, impurity conductors, p–n and n–p–n junctions and importance of semiconductors. Superconductors: Occurrence of super conductivity, its destruction by magnetic fields, effect of I.R. and isotope effect, B.C.S. theory of superconductivity applications.

	magnetic fields, effect of I.R. and isotope effect, B.C.S. theory of superconductivity applications.	

PG75T402C : Catalysis and Polymer Chemistry	**UNIT-I: Statistical Mechanics and Statistical Thermodynamics-II: Quantum statistics**:Bose-Einstein, Fermi-Dirac and Maxwell-Boltzmann statistics and comparison between them.Partition functions: Definition of partition function and separation of partition functions. Translational, rotational, vibrational and electronic partition functions for monoatomic, diatomic and polyatomic gaseous molecules.	**UNIT–I: Homogeneous Catalysis:** Homogeneous Catalysis: Introduction, general catalytic mechanism: equilibrium treatment and steady-state treatment, activation energies for catalysed reactions. Acid-Base catalysis: General acid–base catalysis, mechanism of acid-base catalysis, catalytic activity and acid-base strength, salt effects in acid-base catalysis and specific acid-base catalysis: Bronsted relation and linear free energy changes. Acidity functions: Zucker–Hammett hypothesis and Bunnett hypothesis. Enzyme Catalysis: Influence of substrate concentration, pH, temperature and inhibitors, transient-phase kinetics. Mechanism of enzyme catalysis: Michaelis–Menten mechanism and Lineweaver–Burk plot.
	UNIT-II: Reaction Dynamics: Potential energy surfaces, methods employed in the construct of potential surfaces, calculating reactions. Effect of solvent, pressure and ionic strength for ion-ion, ion-neutral molecule type reactions, cage effects. Fast reaction**s:** flow methods, stopped flow technique, relaxation methods and flash photolysis.	**UNIT–II: Adsorption and Heterogeneous Catalysis:** **Adsorption:** The phenomenon of adsorption and thermodynamics of adsorption, adsorption isotherms, Langmuir adsorption isotherm, Langmuir constant and Gibbs energy of adsorption, Langmuir adsorption with lateral interaction, BET adsorption isotherm, Freundlich isotherm and adsorption on heterogeneous surface. Heterogeneous catalysis: Catalysis at surfaces, mechanism of heterogeneous catalysis: Langmuir–Hinshelwood mechanism and Eley–Rideal mechanism. Transition–state theory of heterogeneous surface reaction: Rates of chemisorptions, rates of desorption, unimolecular and bimolecular surface reactions. Industrial applications of heterogeneous catalysis. Comparison of homogenous and heterogeneous reaction rates.
	UNIT-III: Catalysis and Adsorption: General acid-base catalysis and specific acid-base catalysis: Bronsted relation and linear free energy changes, Zucker-Hammett hypothesis and Bunnett hypothesis. Enzyme Catalysis:	**UNIT–III: Polymer Rheology and Molecular Weight Determination:** Rheological Properties: Introduction, Hook's law, Newton's equation and stress-strain behaviour in polymers. Measurements of average molecular weights: Osmometry, viscometry, light scattering, and gel permeation chromatography. Practical significance of

	Mechanism of single substrate reactions, Michaelis-Menten mechanism, influence of pH, temperature and inhibitors. **Electrochemistry:**Electrical double layer: Lippman equation, theories of electrical double layer-Helmholtz-Perrin, Gouy-Chapman and Stern theories. Effect of ions on zeta potential. Activity of ions in solution: ion-solvent interactions, ion-ion interactions and free energy of ions in solution. Born model and modifications, solvation number and their determination. triple ion formation and conductance minima.	polymer molecular weight and related numerical problems
	UNIT-IV: Polymer Chemistry: Kinetics of polymerization: Kinetics of free-radical addition polymerization, cationic polymerization, anionic polymerization, copolymerization and determination of reactivity ratios. Dendrimers and hyper-branched polymers:Introduction to dendrimers, methods of preparation, common properties and applications. Synthesis of polyamidoamines using divergent route and dendritic polyether macromolecules using convergent route. Hyper-branched polymers, preparation of aromatic polyesters by the self-condensation of 3,5-bis (acetoxy)benzoic acid. Polymeric nonlinear optical (NLO) materials: Definition, classification of NLO materials, basic molecular characteristics of second-order NLO materials, types of second-order NLO materials with examples, schematic representation of experimental setup for the measurement of second harmonic generation (SHG).	**UNIT–IV: Thermal and Polymer Fabrication Techniques**: Thermal method of analysis: Introduction, thermal characterization techniques: Thermogravimetric analysis (TGA) and differential thermal analysis (DTA), introduction, experimental procedure, advantages and disadvantages of TGA/DTA. Differential scanning calorimetry (DSC): Introduction, experimental setup, heat capacity, glass transition temperature, crystallization, melting and determination of percent crystallinity.Methods of Polymer Fabrications: Fabrication of polymer films, solution casting, melt pressing, melt extrusion and bubble blown. Fabrication of shaped polymer objects: compression moulding, injection moulding, reaction injection moulding, blow moulding, extrusion moulding and calendaring. Spinning industrial polymers: Solution spinning and melt spinning.

PG75T403C: Spectroscopy and Microscopy	**UNIT-I: Raman Spectroscopy :** Theories of Raman effect, Concept of polarizability and polarizibility ellipsoid. Vibrational Raman Spetcra, Rotational Raman Spectra of Molecules. Symmetry selection rule and prohibition of inter combination. Influence of nuclear spin in case of homonuclear diatomic molecules. Rotational -Vibrational Raman Spectra, principle of mutual exclusion, polarization of Raman lines and ortho- and para- modifications. An introduction to laser resonance Raman spectroscopy. Elucidation of structure of molecules, e.g.H_2O, N_2O, CO_2 by Raman Spectra.	**UNIT–I: Raman Spectroscopy:** Introduction to scattering phenomenon, Raman effect: Theories of Raman effect (Classical and quantum theory). Concept of polarizability and polarizability ellipsoid. Rotational–Raman Spectra and vibrational–Raman spectra of Molecules. Symmetry selection rule and prohibition of inter–combination, influence of nuclear spin in case of homonuclear diatomic molecules, ortho– and para–modifications. Rotational–vibrational–Raman spectra, rule of mutual exclusion. Polarization of Raman lines and depolarization ratio. An introduction to Laser resonance Raman spectroscopy. Structure elucidation using combined Raman and infrared spectroscopy (e.g.H_2O, N_2O and CO_2). Numerical problems.
	UNIT-II: Photoelectron Spectroscopy: Valence and binding energies, shift in energies due to chemical effects and Auger transitions. Instrumentation. Applications to free molecules and surfaces. **Mossbauer Spectroscopy:** Principles, instrumentation,resonance line shifts, chemical shifts, quadrupole interactions and magnetic interactions. Applications of Mossbauer Spectroscopy	**UNIT–II: Mass Spectrometry**: Mass Spectrometry: Introduction, theoretical principles and instrumentation: ionization and ionization methods (electron ionization, chemical ionization, desorption ionization and electron spray ionization techniques). Mass analyser (magnetic deflection and time of flight mass analyser).Metastable ions. Ionization and appearance potentials, experimental determination of ionization and appearance potential and applications in mass spectrometry.Fragmentation: Principles, Stevenson rule, odd electron ($OE^{+\cdot}$)and even electron (EE^{+}) ions, molecular ion and base peak, fragmentation pattern and correlation with structure. Isotope effects in chloro and bromo compounds. McLafferty rearrangement. Nitrogen Rule. Application of mass spectrometry in structure diagnosis and determination of empirical molecular formula from the peak intensities of molecular ion and isotopic peaks. Numerical problems
	UNIT-III: Mass Spectrometry: Instrumentation and theoretical principles, determination of empirical formula, fragmentation patterns and correlation with structure. Appearance potentials and ionization potential. **Polarography and Cyclic Voltammetry:** Principles, instrumentation and	**UNIT–III: Photoelectron and Mossbauer Spectroscopy**: Photoelectron Spectroscopy: Introduction, photoelectric effect, instrumentation. Valence and binding energies, molecular term symbols, shift in energies due to chemical effects. Augar electron spectroscopy (AES), its advantages and limitations. Electron spectroscopy for

	applications	chemical analysis (ESCA). Applications to free molecules and surfaces. Mössbauer Spectroscopy: Theoretical principles, Mössbauer effect, conditions for Mössbauer spectroscopy and instrumentation. Resonance line shifts, chemical shifts, electric quadrupole interactions and magnetic interactions. Applications of Mossbauer Spectroscopy
	UNIT-IV: Characterization Techniques: Differential Scanning Calorimetry (DSC): Introduction, experimental setup, heat capacity, glass transition temperature, crystallization, melting, determination of percent crystallinity. Differential Thermal Analysis (DTA): Introduction, experimental procedure, advantages and disadvantages of DTA. Measurements of average molecular weights: Osmometry, viscometry, light scattering, and gel permeation chromatography. Practical significance of polymer molecular weight.	**UNIT–IV: Microscopy:Introduction to Microscopy**. Scanning electron microscopy (SEM): Introduction, principle and instrumentation, sample preparation, scanning process, image formation and applications of SEM. Transmission electron microscopy (TEM): Introduction, principle and instrumentation, sample preparation, advantages/disadvantages and applications of TEM.Atomic force microscopy (AFM): Introduction, principle, imaging modes, topographic image, advantages/disadvantages and applications of TEM.Attenuated total reflectance (ATR) spectroscopy: Introduction, principle, sampling method, crystal methods for ATR, factors affecting the spectrum, sampling: liquid and solid sampling. Applications. Photoacoustic spectroscopy: Introduction, principle, photoacoustic effect, advantages and limitations of photoacoustic spectroscopy, examples and applications of photoacoustic spectroscopy.

PG75P401C: **Lab Course in Physical Chemistry**	**1. . Viscosity** Determination of molecular radius of glycerol by viscosity measurements. **2. Solubility** Variation of solubility of $Ca(OH)_2$ in NaOH solution and hence determination of the solubility product of Ca $(OH)_2$.	**1. Viscosity:** Viscosity of air by Rankine`s method. **2. Solubility**: Variation of solubility of $Ca(OH)_2$ in NaOH solution and hence determination of the solubility product of $Ca(OH)_2$.

	3. Thermochemistry a) Heat of neutralisation of HCl and CH_3COOH and their relative strength. b) Heat of reaction (precipitation/formation) of $BaSO_4$. c) Heat of transition of Glauber's salt ($Na_2SO_4.10H_2O$) **4. Refractometry** Comparison of Mixture of unknown composition (including the case of salt solution) **5. Absorptiometry** a) Dissociation constant of a weak acid b) Absorptiometric titrations of Fe(II) with KMnO4 **6. Electrolytic Conductance** a) Conductometric titrations: acid mixtures Vs NaOH i) Acetic acid + hydrochloric acid mixture Vs NaOH ii) Oxalic acid + hydrochloric acid mixture Vs NaOH b) Conductometric titrations: Sodium acetate (or oxalate Vs NaOH) c) Conductometric titrations: $HCl+NH_4Cl$ Vs NaOH **7. EMF of Cells** a) Heat of reaction and K_{eq} of the reaction between metallic zinc and pb $(NO_3)_2$ solution b) Estimation of halides in a mixture c) Degree of hydrolysis and K_h of aniline hydrochloride	**3. Thermochemistry**: (i) Heat of reaction (precipitation/formation) of $BaSO_4$. (ii) Heat of transition of Glauber's salt ($Na_2SO_4.10H_2O$) **4. Surface Tension**: Critical micelle concentration of a soap molecule. (e.g., Potassium laureate). **5. Potentiometry**: Determination of degree of hydrolysis and K_h of aniline hydrochloride **6. Polarimetry:** Kinetics of inversion of sucrose and determination of catalytic coefficient. **7. Cryoscopy:** Determination of activities of electrolytes and non-electrolytes using cryoscopy method. **8. Spectrophometry**: Investigation of complex formation between Fe^{+3}

	8.Polarimetry Kinetics of inversion of sucrose and determination of catalytic coefficient. **9. Computer applications** The students will be taught to learn how to operate a PC and how to run standard programs and packages such as MS-WORD, EXCEL, ORIGIN, SIGMA PLOT, CHEM SKETCH etc. and solve chemistry problems. Problems will be taken preferably from physical chemistry for plotting first and second derivative curves, linear plots etc. Problems from chemical kinetics, polymer chemistry, analytical chemistry, electrochemistry, spectroscopy etc. will be solved.	and salicylic acid and determination of empirical formula, stability, ΔG value calculation and pH effects. **9.** Glass transition temperature: Determination of glass transition temperature by dilatometer. **10.** Solid state: To determine the electron–phonon coupling constant of copper

PG75P402C: LAB COURSE IN PHYSICAL CHEMISTRY	**1. Surface Tension** a) Comparison of cleansing powers of two detergent samples. b) Comparison of a mixture of two liquids **2. Phase Equilibria** a) Phase diagram of naphthalene and diphenyl system. b) Phase diagram of acetamide and salicylic acid or picric acid and benzene. **3. Electrolytic Conductance** a) Conductometric titrations: Acid mixtures Vs NaOH i) Acetic acid + oxalic acid mixture Vs NaOH ii) Nitric and sulphuric acid mixture Vs NaOH b) Conductometric titrations: H_2SO_4 + CH_3COOH + $CuSO_4$ Vs NaOH	**1. Surface Tension:**Comparison of cleansing powers of two detergent samples. **2. Phase Equilibria**: Phase diagram of naphthalene & diphenyl system, acetamide & salicylic acid and picric acid and benzene systems. **3. Conductance:**Determination of the ionic conductance of Cu^{2+} at infinite dilution by Hittorf's method.

	4. Reaction Kinetics a) Decomposition of H_2O_2 catalysed by iodide ions. b) Iodination of acetone c) Study of kinetics of hydrolysis of tertiary butyl halide d) Saponification of ethyl acetate by titration method and conductometric method. e) Chromic acid oxidation of 2-propanol and determination of i) effect of addition of Mn (II) ii) substituent effects oxidation of benzyl alcohols. **5. EMF of Cells** a) Titration of HCl + CH_3COOH with NaOH b) Stability of the complex Ag $(NH_3)_2$ (concentration cells) **6. Solubility** a) Variation of solubility of potassium hydrogen tartarate with ionic strength involving a common ion and determination of mean ionic activity coefficients. b) Influence of ionic strength on the solubility of $CaSO_4$ and determination of its thermodynamic solubility product and mean ionic activity. **7. Cryoscopy** A study of complex formation between mercury and potassium halides. **8. Mobilities of ions** Determination of the ionic conductance of Cu^{2+} at infinite dilution by Hittorf's method. **9. Computer applications** The students will be taught to operate a PC and how to run standard programs and packages such as MS-WORD,	**4. Reaction Kinetics**: Studying the kinetics of photodegradation of indigo carmine (IC) using ZnO/TiO_2 as photocatalyst and study the effect of ZnO/TiO_2 and IC on the rate of photodegradation. **5. Potentiometry:** Stability of the complex $Ag(NH_3)_2$ (concentration cells) **6. Solubility:**Influence of ionic strength on the solubility of $CaSO_4$ and determination of its thermodynamic solubility product and mean ionic activity. **7. Cryoscopy:**A study of complex formation between mercury and potassium halides using cryoscopy method. **8. Mobilities of ions**: Determination of the ionic conductance of Cu^{2+} at infinite dilution by Hittorf's method.

	EXCEL, ORIGIN, SIGMA PLOT, CHEM SKETCH etc. and solve chemistry problems. Problems will be taken preferably from physical chemistry for plotting first and second derivative curves, linear plots etc. Problems from chemical kinetics, polymer chemistry, analytical chemistry, electrochemistry, spectroscopy etc. will be solved.	9. **Solid State:** To determine the energy gap of semiconductor by resistivity measurement using four probe method. 10. **Potentiometry:** Determination of Hammet constant of ortho–, meta– and para–amino/nitro benzoic acid by pH measurements.
PG75P403C: LAB COURSE IN PHYSICAL CHEMISTRY	**1. Surface Tension** Molecular surface energy and association factor. **2. Phase Equilibria** a) Formula of the complex formed between copper ions and ammonia by distribution method. b) Phase diagram of a three-component system: water, benzene and ethanol or acetic acid, water and chloroform or benzene. **3. Thermochemistry** Stepwise heat of neutralization of polybasic acid **4. Refractometry** Molar refraction of a solid substance by dissolving it in a solvent. **5. Absorptiometry** a) Investigation of complex formation of absorptiometry (e.g. Fe (III)	1. **Surface Tension**: Molecular surface energy and association factor. 2. **Phase Equilibria**: Formula of the complex formed between copper ions and ammonia by distribution method. 3. **Refractometry:** Ionization constant of bromophenol blue. 4. **Reaction Kinetics**: Kinetics of oxidation of 2-propanol by chromic acid and determination of effect of addition of Mn (II) on the reaction rate. 5. **Reaction Kinetics:** Studying the kinetics of reaction

	salicylic acid, formula, stability constant, free energy and pH effects Fe (III)- sulfosalicylic acid and Ni-1,10-Phenanthroline). b) Composition of Cu(II)and Fe(III) solution by photometric titration with EDTA c) Ionization constant of bromophenol blue. **6. Electrolytic conductance** Equivalent conductance of a weak electrolyte (eg.aceticacid, formic acid)using Kohlrausch's law **7. Reaction Kinetics** a) Chromic acid oxidation of 2-propanol and determination of i) order ii) effect of added oxalic acid b)Oxidation of benzyl alcohols by Chromic acid c) Decomposition of oxalic acid in solution photosensitized by uranyl sulphate. **8. EMF of cells** a) Transport number of Ag^+ and NO^{3-} in solution (concentration cells) b) Determination of the molecular state and the given calculation of the association/dissociation constant of the given solute c) Determination of Hammet constant of ortho-, meta- and para-amino/nitro benzoic acid by pH measurements. **9. Computer applications** The students will be taught to operate a PC and how to run standard programs and packages such as MS-WORD, EXCEL, ORIGIN, SIGMA PLOT, CHEM SKETCH etc. and solve chemistry problems. Problems will be taken	between CAT and indigocaramine spectrophotometrically and determination of rate constant **6. Potentiometry:** Transport number of Ag^+ and NO_3^- in solution (concentration cells) **7. Viscosity:**Effect of temperature on the viscosity of the liquid Viscosity of air by Rankine`s method. **8. Solid state:**Determination of magnetic susceptibility of paramagnetic substance by Quinke's method **9. Solid state**: Determine the relative integrated intensities of ZnS by Debye Scherrer pattern. **10.Computer applications**: The students will be taught to operate a PC and how to run standard programs and packages such as MS-WORD, EXCEL, ORIGIN, SIGMA PLOT, CHEM SKETCH etc. and solve chemistry problems. Problems will be taken preferably from physical

	preferably from physical chemistry for plotting first and second derivative curves, linear plots etc. Problems from chemical kinetics, polymer chemistry, analytical chemistry, electrochemistry, spectroscopy etc. will be solved	chemistry for plotting first and second derivative curves, linear plots etc. Problems from chemical kinetics, polymer chemistry, analytical chemistry, electrochemistry, spectroscopy etc. will be solved.

PG75D404C: PROJECT WORK	**Project work** It may include in-plant training in Industries/short term work in the Department/other educational Institutions/ R & D organizations/ Data Mining/ Review of current literature/ theoretical methods/computer applications, etc. Experimental work may involve studies on synthesis/characterization/properties/measurements/activities for reported/unreported research or any suitable combination thereof. In case of the students who will work outside the campus, the supervising staff member shall visit the place at least once during the tenure and hence he/she may be eligible for TA/DA as per the University rules.	**Project Work** The project work may include in–plant training in industries/short term work in the Department/other educational institutions/R&D organizations/data mining/review of current literature/theoretical methods/computer applications. Experimental work may involve studies on synthesis/measurements/study of properties/characterization by physical methods/activities for reported/unreported research or any suitable combination thereof. In case of the students who would work outside the campus, the supervising staff member may visit to the work place at least once during the period and may be eligible for TA–DA as per the University rules.

THIRD SEMESTER (ANALYTICAL CHEMISTRY SPECILIZATION)

PG75T301D: Instrumental Methods of Analysis	**UNIT- I** **Introduction to Analytical Chemistry** Analytical Chemistry, Classification of Analytical Methods, Advantages and disadvantages of the methods, Steps in Analysis, Selectivity, Sensitivity and detection limits . Accuracy and Precision, Weighing errors, Weighing the sample, Filtering, Drying, Measuring volume, Calibration of Burette and Pipette. Basic Laboratory operations, Sampling, Weighing, Drying, Dissolving, Acid treatment, Flux treatment, Decomposition of organic matter, Precipitation, Formation of precipitate. Properties of precipitate, Particle size, Colloidal state, Coprecipitation, Post precipitation, Surface adsorption, Occlusion. Types of precipitates, Types of precipitating agents, General rules for performing quantitative determinations, Safety in laboratory.	**UNIT–I** **Optical Methods:** Atomic absorption spectrometry: Theory, instrumentation, different types of nebulizers, non flame techniques, electrothermal vapouriser, cold vapour AAS determination of mercury, interferences, differences between AAS and flame photometry and analytical applications of AAS. Emission Spectroscopy: Inductively coupled plasma optical emission spectrometry–theory and application Molecular Luminescence Spectroscopy: Theoretical basis for fluorescence and phosphorescence, instrumentation, factors affecting fluorescence, its applications in quantitative analysis and in the study of biomolecules. X-ray fluorescence elemental analysis.
	UNIT- II **Redox Titrations** Equilibrium constants for Redox reactions - Electrode potentials in equilibrium systems, Calcuulation of equilibrium constant, Redox titration curves- Formal potentials, Feasibility of Redox titrations, Detection of end points, Redox indicators, Theory, Choice of Indicators, Sample preparation, Pre- reduction and Pre oxidation, Karl – Fischer reagent for water determination and applications. **Precipitation Titrations:** Titration curves, Feasibility of precipitation titrations, Factors affecting titrant and analyte concentration, completeness of reaction, Titrants and Standards, Indicators for precipitation titrations involving silver nitrate, The Vohlard, the Mohr and the Fajan's methods, Typical Applications	**UNIT–II** **Analytical methods–I** Coulometric methods of analysis: General discussion, coulometry at controlled potential, apparatus and general technique, applications, coulometric titrations (amperometric coulometric): Principles, apparatus, comparison of coulometric titrations with conventional titrations, automatic coulometric titrations and applications. Amperometry: Principle, titrations, advantages and limitations and applications. Ion selective electrodes: Glass ion selective electrodes, crystalline solid state ion selective electrodes, liquid–based ion selective electrodes and gas sensing electrodes. Supercritical fluid chromatography (SFC): Properties of supercritical fluids, instrumentation and operating variables, comparison of SFC with other types of chromatography and applications.

	UNIT- III **Complexometric Titrations** Complex formation reactions, stability of Complexes, Chelating agents. EDTA - Acidic properties. Complexes with metal ions. Equilibrium calculations involving EDTA. Derivation of EDTA titration curves. Effect of complexing agents. Factors affecting the shape of titration curves. Completeness of reaction, indicators for EDTA Titrations, Theory of common indicators Titration methods employing EDTA- Direct, Back and Displacement titration's, indirect determinations. Titration's of mixtures, selectivity, Masking and Demasking agents. Typical applications of EDTA titration's - Magnesium and Aluminum in antacid. Magnesium and Zinc in a Mixture.	**UNIT–III** **Analytical methods–II:** Polarography: Theory of classical polarography, polarograms, polarographic currents. Halfwave potential, oxygen interference, advantages and limitations. pulse polarography and applications of polarography. Electrogravimetric analysis: Theory, apparatus, deposition and separation, electrolytic separation of metals and applications. Electrophoresis: Theory and classification, factors influencing the mobility–macromolecular size and charge, interaction with supporting electrolyte, pH and concentration discontinuities. Factors affecting electrophoretic phenomena–electrolysis, electroosmosis, temperature and supporting media. Instrumentation. Methodology: Preparation of gels–staining and destaining. Capillary electrophoresis methods: Capillary zone electrophoresis and capillary gel electrophoresis. Light–scattering methods: Nephelometry and turbidometry: Principle, instrumentation and applications.

	UNIT- IV **Paper, Column and Elution Chromatography** i) Paper Chromatography: Definitions, Theory and Principles. Techniques of paper chromatography, Ascending chromatography, Descending Chromatography, Radial Paper Chromatography, Two Dimensional Paper Chromatography, Methodology - Choice of Paper, Choice of Solvent, Preparation of Sample, Spotting, Development, Drying **Conventional Column Chromatography and Applications :** High Pressure Liquid Chromatography, (HPLC) Apparatus, Solvent Delivery Systems, Pumps, Sample, injection System, Column Packing, Detectors used in HPLC, Performance Method, Materials, Advantages of HPLC, Effect of Temperature and Applications of HPLC **Elution Chromatography** Theory and principle of size exclusion chromatography, experimental techniques for gel filtration chromatography (GfC) and Gel-permeation chromatography methods. (GPC) Materials for packing - factors governing column efficiency, methodology and applications Affinity Chromatography :Introduction, theory, stationary phase, preparation of column, separation of antigens	**UNIT–IV** **Analytical methods–III** Thermal method of analysis: Introduction. Thermogravimetric analysis (TGA): Types of thermogravimetric analysis, principles, factors affecting the results, heating rate, furnace, instrument control/data handling. Instrumentation and applications. Differential thermal analysis (DTA): Theory, variables affecting the DTA curves, differences between TGA and DTA, general principles. Instrumentation and applications. Differential scanning calorimetry (DSC): Basic principle, differences between DTA and DSC. Instrumentation, power compensated DSC, heat flux DSC and applications. Thermomechanical analysis and dynamic mechanical analysis. Voltammetry: Fundamentals of voltammetry. Cyclic voltammetry: Principles and applications. Stripping analysis: Stripping voltammetry, basic principles, electrodes used for stripping analysis, apparatus for stripping analysis, applications and determination of lead in water by voltammetry.
PG75P301D: Lab Course in Analytical Chemistry–I	1. Sodium carbonate and sodium bicarbonate in baking powder by acid base titration. 2. Calcium in lime stone by redox titration 3. Calcium in milk powder by EDTA method 4. Copper in alloy by iodometric method 5. Vitamin C by iodometric method 6. Flame photometry 7. Iodine value of an oil sample 8. Saponification of oil sample 9. aluminium and magenisium in antacids by EDTA titrations. 10. Separation technique (i)Thin layer chromatography 11. Preparation of tris (oxalato) ferrate (III) and estimate the metal ion.	1. Nephelometric/turbidimetric determination of sulphate/phosphate in ground water samples. 2. Determination of calcium in milk powder using EDTA. 3. Separation and determination of chloride and bromide on an anion exchanger. 4. Cation exchange chromatographic separation of cadmium and zinc and their estimation by EDTA titration. 5. Analysis of a mixture of iron(II) and iron(III) by EDTA titration using *p*H control. 6. Evaluation of the composition of Fe(II)–1,10-phenanthroline complex by spectrophotometry. **7.** Colorimetric determination of Ti(IV) using H_2O_2.

PG75T302D: Molecular Spectroscopy	**UNIT-I** **Basic concepts and Introduction:** Properties of electromagnetic radiation: Wave property- interference, diffraction. Particle property- Photoelectric effect. Regions of the electromagnetic spectrum, energies corresponding to various kinds of radiation. Interaction of electromagnetic radiation with matter (absorption,emission, transmission, reflection, dispersion, polarisation and scattering.) General application **Electronic spectroscopy:** Molecular electronic absorption spectroscopy.(UV-Visible) Electronic spectra of diatomic molecules, electronic transitions, selection rules, assignment of transition band intersities, substituent and solvent effect, change transfer transitions, Application to organic and inorganic molecules.	**UNIT–I** **Basic concepts, Electronic Spectroscopy and Mass Spectrometry:** Properties of electromagnetic radiation. Wave property: Interference and diffraction. Particle property: Photoelectric effect. Regions of the electromagnetic spectrum, energies corresponding to various kinds of radiation. Interaction of electromagnetic radiation with matter (absorption, emission, transmission, reflection, dispersion, polarisation and scattering). General application. Electronic spectroscopy: Molecular electronic absorption spectroscopy (UV–Visible), electronic spectra of diatomic molecules, electronic transitions, selection rules, assignment of transition, band intersities, substituent and solvent effect and change transfer transitions. Application to organic and inorganic molecules. Mass Spectrometry: Ionization and mass analysis. Fragmentation: Principles, odd electron ($OE^{+\cdot}$) and even electron (EE^{+}) ions, molecular ion and base peak, nitrogen rule, metastable ions. Isotope effects in chloro and bromo compounds. Fragmentation of inorganic and oraganic compounds.
	UNIT-II **Vibrational spectroscopy:** Infrared spectroscopy-Vibrational energy levels, infrared spectra of diatomic and polyatomic molecules, Normal modes of vibration, force constant, selection rules, anhormonicity, the vibration-rotation spectroscopy. Infrared spectra of simple molecules and coordination compounds, changes in infrared spectra of donor molecules upon coordination (N,N-dimethylacetamide, urea, DMSO, pyridine N-oxide, ammine, cyano, cyanato and thiocyanato complexes), mono and multinuclear carbonyl complexes, nitosyls, phosphine and arsine complexes. Change in spectra accompanying change in symmetry upon coordination ($NO3,^{-}$, $SO4^{2-}$, $NO2^{-}$, and ClO4), hydrogen bonding, instrumentation including FTIR. **Raman spectroscopy:** Theory, relation with I	**UNIT–II** **Vibrational Spectroscopy:** Vibrational spectroscopy: Infrared spectroscopy: Vibrational energy levels, infrared spectra of diatomic and polyatomic molecules, normal modes of vibration, force constant, selection rules, anhormonicity, the vibration–rotation spectroscopy. Infrared spectra of simple molecules and coordination compounds, changes in infrared spectra of donor molecules upon coordination (N,N–dimethylacetamide, urea, DMSO, pyridine N–oxide, ammine, cyano, cyanato and thiocyanato complexes), mono and multinuclear carbonyl complexes, nitrosyls, phosphine and arsine complexes. Change in spectra accompanying change in

	R spectroscopy, resonance Raman stimulated hyper and inverse Raman effects. Experimental techniques, structure determination from I R and Raman spectra	symmetry upon coordination (NO_3^-, SO_4^{2-}, NO_2^-, and ClO_4^-), hydrogen bonding. Instrumentation including FTIR. Raman spectroscopy: Theory, relation with IR spectroscopy, resonance Raman stimulated hyper and inverse Raman effects. Experimental techniques, structure determination from IR and Raman spectra.
	UNIT-III **Magnetic Resonance spectroscopy:** Nuclear Magnetic Resonance spectroscopy. Magnetic properties of nuclei, population of energy levels, the Larmar precession, relaxation processes, Chemical shift, shielding mechanism, spin-spin interactions, rules governing the interpretation of first order spectra, effect of chemical exchange on spectra. Analysis of complex NMR spectra, 1H nmr spectra of organic molecules and complex metal ligands, NMR studies of nuclei other than proton, ^{13}C (including heteronuclear coupling with other nuclei viz 19F and ^{31}P) ,^{19}F, ^{31}P, ^{11}B, ^{15}N. Spectra of paramagnetic complexes, contact shift, double resonance technique, shift reagents, Instrumentation including FT nmr.	**UNIT–III** **Magnetic Resonance spectroscopy:** Nuclear magnetic resonance spectroscopy: Magnetic properties of nuclei, population of energy levels, the Larmor precession, relaxation processes, chemical shift, shielding mechanism, spin–spin interactions, rules governing the interpretation of first order spectra, effect of chemical exchange on spectra. Analysis of complex NMR spectra, ^1H–NMR spectra of organic molecules and complex metal ligands. Spin–systems: First order and second order patterns. Long range coupling : Spin decoupling, CIDNP and NOE. NMR shift reagents. NMR studies of nuclei other than proton, ^{13}C–NMR (including heteronuclear coupling with other nuclei viz., ^{19}F and ^{31}P), ^{19}F, ^{31}P, ^{11}B, ^{15}N. Spectra of paramagnetic complexes, contact shift, double resonance technique. Instrumentation including FT–NMR.
	UNIT-IV **Electron Paramagnetic Resonance (EPR) Spectroscopy:** Basic principles, Selection rules, intensity, width, position of spectral line, multiplet structure of EPR spectra, hyperfine interaction, spin-orbit coupling, zerofield splitting and Kramer's degeneracy, rules for interpreting spectra, factros affecting the magnitude of values. Instrumentation. Applications to the study of free radicals, Coordination compounds, biological studies, rate of electron exchange reactions **Mössbauer Spectroscopy:** Introduction, Principles, conditions for Mössbauer spectroscopy, parameters from	**UNIT–IV** **Electron Paramagnetic Resonance and Mössbauer Spectroscopy:** Electron Paramagnetic Resonance (EPR) Spectroscopy: Basic principles, selection rules, intensity, width, position of spectral line, multiplet structure of EPR spectra, hyperfine interaction, spin–orbit coupling, zerofield splitting and Kramer's degeneracy, rules for interpreting spectra, factros affecting the magnitude of values. Instrumentation. Applications to the study of free radicals, coordination compounds, biological studies and rate of electron exchange reactions.

	Mossbauer spectra, isomer shifts, electric quadrupole interaction, magnetic interactions, Mossbauer spectrometer, applications, Fe3(CO)12, Prussion blue, Oxyhemerythrin, Hexacyanoferrates, Nitropruside, Tin halides.	Mössbauer Spectroscopy: Introduction, principles, conditions for Mössbauer spectroscopy, parameters from Mossbauer spectra, isomer shifts, electric quadrupole interaction, magnetic interactions, Mossbauer spectrometer. Applications in structure determination of $Fe_3(CO)_{12}$, Prussian blue, oxyhemerythrin, hexacyanoferrates, nitropruside, tin halides
PG75P301D: Lab Course in Analytical Chemistry–I	**I. Separation Techniques :** Paper chromatography - Qualitative separation of given mixture containing amino acids. **III. Estimations of essential metabolites:** 1. Glucose by a) By DNS method b) Fehling's solution method c) Sugar in presence of one another 2. Cholesterol from Blood by Spectrophotometry. 3. Iron a) from Blood Serum by Spectrophotometry b) in Mustard seeds by Spectrophotometry. 4. Phosphorus present in peas. 5. Conductometric titrations : a. Sodium acetate with HCl. b. NH_4Cl with NaOH. c. HCl, CH_3COOH and $CuSO_4$.	1. **Chromatography**: (i) Paper chromatography: Qualitative separation of amino acids in a given mixture (ii) Column chromatography: Separation of plant pigments 2. **Conductometric titrations**: (i) Sodium acetate with HCl (ii) NH_4Cl with NaOH (iii) HCl, CH_3COOH and $CuSO_4$ 3. Estimation of iron in razor–blade by potentiometric & visual titration using sodium vanadate. 4. Assay of iron in pharmaceutical preparation by visual & potentiometric titration by $Ce(SO_4)_2$ 5. Determination of aluminium and magnesium in antacids by EDTA titration. 6. Determination of saccharin in tablets by precipitation titration.
PG75T303D: Selected Topics in Analytical Chemistry-I	**UNIT - I** **Flame Photometry and Fluorometry** Basic principles of flame photometry, Standard addition method, Internal standard method, Interferences, Applications of flame photometry, Instrumentation and applications.Difference between atomic absorption and flame emission spectroscopy, Advantages of atomic absorption spectroscopy over flame emission spectroscopy. Plasma emission source. Inductively coupled argons plasma, Direct current argon plasma. Principles of fluorimetry, Instrumentation, Factors affecting fluorescence, its applications in quantitative analysis. Atomic Absorption Spectroscopy: Theory, Instrumentation, different types of nebulizers, non flame techniques, electro thermal vapourisers, cold vapour AAS,	**UNIT–I** **Sensors** Sensors: Membrane electrodes, classification and properties, principle, membrane potential, sensors types: Crystalline, liquid membrane and enzyme electrodes, gas sensors, voltammetric sensors, optical sensors and thermal sensors. Biosensors: Introduction to biosensors, characteristics of an ideal biosensor. Basic electrochemical principles and measurement system. Enzyme based electrochemical biosensors: Theory and applications of glucose, urea and alcohol biosensors. Transducer technology, enzyme based calorimetry, enzyme reactors with HPLC. Enzyme based micro electrodes. Analytical and biological applications of sensors.

	interferences, calibration graph, analytical applications. Comparison of AAS with AES. **UNIT -II** **Polarography and Amperometry** Polarography: Theory, Instrumentation, diffusion and limiting current, half wave potential, DME, Oxygen interference, methods of measurement of diffusion current, shape of polarographic maximum, Derivative polarography, applications. Amperometric Titrations: Principle, methodology, apparatus, RPM, Swcessive titrations, Titrationn to zero current, Comparison with other methods. **Coulometry, Ion Selective Electrodes And Conductometry:** Coulometry; Fundamantal principles, apparatus, coulometers, constant current and controlled potential coulometry stripling analysis and applications. Ion selective electrodes: Terminolgy, Types and constrction of ion selective electrode, glass electrode, solid state and precipitate electrodes, enzyme and gas sensing electrodes, glass microelectrodes and applications. Conductometry: Introduction, Import and laws, Definition and relations, effect of dilution, conductance measurements and applications. **UNIT -III** **Thermoanalytical Techniques** Introduction, thermogravimetric analysis(TGA), types of thermogravimetric analysis, principle and method. Automatic thermogravimetric analysis, instrumentation, types of recording thermobalances, sample holders, factors affecting results and applications. Isothermal analysis. Differential thermal analysis (DTA), principle of working, theory and instrumentation. Simultaneous DTA-TGA curves, factors affecting results and applications. Thermometric titration: introduction, apparatus and applications (Acid-base, precipitation, complexation, redox and non-aqueous titrations). **UNIT -IV** **Computational Chemistry**	**UNIT–II** **Bioinorganic Chemistry:** Bioinorganic chemistry: Metal ions in biological systems, essential and trace metals, Transport and storage of dioxygen, haemoglobin, myoglobin, hemerythrin and hemocyanins. Electron transfer proteins: Cytochromes, iron–sulphur proteins. Metalloproteins as enzymes: Carboxy peptidase, catalases, peroxidases, cytochrome P–450, superoxide dismutase, copper oxidases, vitamin B_{12} coenzyme, chlorophyll and its role in photosynthesis, photosystems–I & II, nitrogen fixation and metal complexes in medicine. **UNIT–III** **Automated methods of analysis:** Automated methods of analysis: Overview, advantages and disadvantages of automated analyses, types of automatic systems, flow injection analysis, instrumentation, sample and reagent transport systems, sample injectors and detectors, separations in FIA. Dialysis and gas diffusion, principles of FIA, dispersion, applications, stopped flow methods, flow injection titrations, microfluidics, discrete automatic systems, robotics, discrete clinical analyzers and automatic organic elemental analyzers. **UNIT–IV** **Computational Chemistry:** Computational Chemistry: Introduction to computers and computing, introduction to computer languages, programming in chemistry, developments in involving simple formulae in chemistry, Van der Waals equation, pH titration, radioactive decay. Elementary structural features, bond angles and bond lengths, running standard programs and packages: Linear regression, X–Y plot, operational packages, MS word and MS Excel.

	Introduction to computers and computing, Introduction to computer languages, Programming in chemistry: Developments of programs in involving simple formulae in chemistry, vandar Waal's equation, Ph titration, radioactive decay. Elementary structural features, Bond angles and Bond lengths, Running standard programs and packages: Linear regression, X-Y Plot, Operational packages: MS word, MS Excel.	
PG75P303D: Lab course in Analytical Chemistry–III	**1. Separation Techniques :** Column Chromatography; Separation of plant pigments 2. **Polarimetry** i. Determination of specific rotation. (a) of cane Sugar solution, (b) cane sugar cane by inversion method ii. Determination of specific rotation cane sugar solution in presence of other sugar solution 3. **Conductometric Titration :** i. Analysis of halides ii. Determination of sulphates iii. Estimation of mercury as per chlorate 4. Water Analysis **:** Determination of some physical and chemical parameters of water. Determination of DO, COD, BOD, and analysis of surfactants in water sample. Identification and counting of common pathogens in water. 5. Determination of water in hydrated calcium sulphate by Karl –Fischer titration	**Analytical Chemistry–III** 1. **Polarimetry:** Determination of specific rotation of (i) cane Sugar solution (ii) cane sugar cane by inversion method (iii) cane sugar solution in presence of other sugar solution. 2. **Potentiometric Titrations:** (i) analysis of mixture of halides (ii) determination of iron using potassium dichromate. 3. **Conductometric Titrations:** (i) analysis of halides, (ii) determination of sulphates. 4. **pH Metric titrations:** (i) Determination of strength of acids (ii) determination of strength of commercial phosphoric acid (H_3PO_4) by pH titration (iii) determination of soda ash in washing soda. 5. **Spectrophotometry:** Analysis of waste water for (i) phosphate by molybdenum blue method (ii) ammonia-nitrogen by Nessler's method OR nitrite-nitrogen by NEDA method.
FOURTH SEMESTER (ANALYTICAL CHEMISTRY)		
PG75T401D: Pollution and Analysis	**UNIT -I** **Soil and Fuel Analysis** **Soil analysis**-Preparation of laboratory sample. Measurement of pH and conductivity, acidic and alkaline soil. Analysis of major constituents-organic matter, nitrogen, sulphur, sodium, potassium and calcium. Analysis of trace elements-	**UNIT–I** **Soil pollution and Analysis:** Soil pollution: Acidification, salinisation, sodification, agrochemical pollution, urban and industrial pollution, effects of soil pollution and solutions for soil pollution. Soil analysis: Preparation of laboratory

	copper, molybdenum, zinc and boron. **Fuel analysis-**Definition and classification of fuels, characteristics of fuels. Sampling, proximate and ultimate analysis of coal, determination of calorific value. Liquid fuels-Determination of flash point, fire point, aniline point. Knocking of petrol and diesel octane and cetene numbers, carbon residue. Gaseous fuels- Analysis of coal gas, water gas, producers gas, gober gas and blast furnace gas. Relative merits of solid, liquid &gaseous fuels. **UNIT -II** **Air Pollution and Analysis** Classification and properties of air pollutants. Emission sources, major emissions from global sources. Behaviour and fate of air pollutants –wet precipitation, dry deposition, interaction at the earth's surface, chemical reactions in the atmosphere, photochemical smog. Effects of air pollution on human health, vegetation and materials, Air pollution sampling and measurement- ambient air sampling, collection of gaseous and particulate air pollutants. Analysis of air pollutants. SO_2 –ambient air measurements, stack gas measurement chemiluminescent techniques.CO-NDIR, amperometric, FID & catalytic oxidation methods. Coulometric & chemiluminescent methods**. Hydrocarbons**-total and individual hydrocarbons by chromatographic methods. Particulates optical & mass measurement methods. **UNIT -III** **Analysis of Ores, Minerals and Fertilizers** Composition, Properties and analysis of Minerals and Ores: Heamatite, Pyrolusite, Dolomite, Chromate, Bauxite, Limestone, Zillmenite, Gypsum and Epsom. a) Fertilizer analysis : Types, analysis of Nitrogenous Fertilizers, Organic Nitrogenous, Phosphatic and Potassic Fertilizers. b) Pesticide and Insecticide Analysis : Introduction, Classification and analysis of DDT, Gammexane, endosulphon, Zinaf, Ziram, Malathian, Thiram, Thiometon, Simazine and Chloridane. **UNIT – IV** **Metals and Alloy Analysis:** Steel, Cu-Ni Alloy, Solder, Bronze, Brass, Aluminum alloy, Ferroalloys of Silicon, Molybdenum, Chromium Titanium and Vanadium Analysis of structural materials: Cement and Glass	sample, measurement of pH and conductivity, acidic and alkaline soil. Analysis of major constituents: Organic matter, nitrogen, sulphur, sodium, potassium and calcium. Analysis of trace elements: Copper, molybdenum, zinc and boron. **UNIT–II** **Air Pollution and Analysis:** Air pollutants: Classification and properties of air pollutants, emission sources, major emissions from global sources. Behaviour and fate of air pollutants, wet precipitation, dry deposition, interaction at the earth's surface, chemical reactions in the atmosphere, photochemical smog, effects of air pollution on human health, vegetation and materials. Air pollution sampling and measurement: Ambient air sampling, collection of gaseous and particulate air pollutants. Analysis of air pollutants: SO_2–ambient air measurements, stack gas measurement chemiluminescent techniques, CO–NDIR, amperometric, FID & catalytic oxidation methods, Coulometric & chemiluminescent methods. Hydrocarbon measurement: Total and individual hydrocarbons by chromatographic methods, particulates optical & mass measurement methods. **UNIT–III** **Water Pollution and Analysis:** Sources of water pollution, classification of water pollutants: Organic, inorganic, sediment, thermal and radioactive materials, effects and solutions. Analysis of water parameters: Hardness, carbonate, bicarbonate, chloride, sulphate, fluoride, sodium, potassium, iron, chromium, manganese, chlorine demand, dissolved oxygen, ciochemical oxygen demand and chemical oxygen demand.

	Analysis of Refractory materials: Fire Clay, Fluorspor.	**UNIT–IV** **Noise and Radiation Pollution and analysis:** Noise pollution: Concept of sound, noise and hearing problems, measurement of noise, sources of noise, effects of noise pollution. Regulation and control rules 2000 for noise pollution. Radiation Pollution: Sources, effects, protection from radiation pollution, disposal of radioactive waste. Analysis of radionuclides.
PG75P401D: Lab course in Analytical Chemistry.	I. **Solvent Extraction** 1. Determination of Iron by solvent extraction. 2. Determination of molybdenum by thiocynate method II. **Ion Exchange Method** 3. Separation of anions using anion exchange resin 4. Separation of cations using cation exchange resin **III. Potentiometric Titrations**: 5. Analysis of mixture of halides. 6. Determination of iron by ceric sulphate and dichromate 7. Determination of stability constant of a complex **IV. Analysis of ores:** Hematite, Pyrolysite, Dolamite **V. Organic Reagents:** Separation and estimation of copper and nickel, separation and estimation of aluminium and magnesium. **VI. Analysis of Fertilizers:** Urea, Super phosphates. VII. Analysis of water for alkalinity and acidity by pH metric titrations. VIII. Determination of ammonia in Household cleaners by conductometric titrations.	1. Analysis of water for alkalinity and acidity by pH metric method 2. Determination of strength of commercial phosphoric acid by pH titration 3. Determination of ammonia in household cleaners by conductometric titrations. 4. Determination of sodium and potassium in soil by flame photometry 5. Determination of phosphate in domestic waste water by spectrophotometry. 6. Analysis of mercury/lead in industrial effluents by spectrophotometry 7. Determination of DO, BOD and COD of a waste water sample by titrimetry 8. Determination of fluoride by spectrophotometric method 9. Soil analysis
PG75T402D: Quality Control, Analysis of Food, Beverages and Pharmaceuticals .	**UNIT- I** **Quality Control and Assurance** An introduction to quality control and quality assurance –Basic concepts, quality assurance , aspects of specification and tolerance, quality acceptance, sampling, reliability, cost aspects of	**UNIT–II** **Analysis of Beverages, Food Preservatives and Adulterants:** Introduction: Soft drinks, alcoholic drinks, tea, coffee and fruit juices. Analysis of Caffeine in coffee and tannin in tea,

quality decisions. Quality control in raw materials, production(in process), finished product. Current trends in quality control, ISO 9000 and ISO 14000 series. Laws related to quality control. Case studies of quality control in various industries such as plastics and polymers, fertilizers, agrochemicals, petrochemicals, dyes and pharmaceuticals.

UNIT - II

Radiochemical Methods of Analysis

Detection of nuclear radiation and counting devices. Radioactivity tracers principles and applications, isotopic dilution analysis, direct, inverse, special analytical applications, radiometric titration's,Neutron activation analysis, principle, instrumentation, applications and limitations, Radio chromatography, radio immunoassay **Automated methods of analysis:** Introduction, An overview of automatic instruments and instrumentation. Advantages and disadvantages of automatic analysis, unit operation in chemical analysis, types of automatic analytical systems. Flow.-injection analysis. Instrumentation-sample and reagent transport systems. Sample injectors and detectors, separations in FIA. Dialysis and gas diffusion, extraction principles of flow-injection analysis, Applications of flow-injection analysis. limited dispersion applications. Medium-Dispersion applications. Stopped Flow methods. Flow injection titrations. An automated system for mercury concentrations. Discrete automatic systems. Automatic sampling and sample definition of liquids and gases. Robotics. The centrifugal fast scan analyzer. Automatic organic elemental analyzers. Analysis based on multilayer films. General principles. Film structures, Instrumentation, reflective photometer, potentiometry, performance and applications Automated methods of Analysis.

UNIT- III

Water Analysis

Types of pollution, Sources of water pollution, Classification of water pollutants- Oragnic, Inorganic, Sediment, Thermal and radioactive materials, Analysis of water parameters- hardness , carbonate, bicarbonate, chloride, sulphate, fluoride, sodium, potassium, Iron, Chromium, Manganese, Chlorine demand, Dissolved oxygen, Biochemical oxygen demand, Chemical oxygen demand.

UNIT- IV

Analysis of Beverages

Introduction - Soft drinks, Alcoholic drinks, Tea, Coffee and Fruit juices, Analysis of Ceffeine in Coffee and Tea, Detection of Chicory in coffee, Chloral hydrate in Toddy. Estimation of methyl alcohol in alcoholic beverages, Poisonous materials derived from containers. Food preservatives like sodium benzoate, sodium propionate, sodium sulphate, potassium metabiosulphate (qualitative and quantitative analysis).

Food Adulterants: Artificial sweeteners like saccharin and dulcin, coal tar dyes and non–permitted colours and trace metals, detection and estimation.

UNIT–III

Drugs and Pharmaceutical Analysis:

Antibiotics: Introduction, classification, structure elucidation, stereochemistry and reaction mechanism of pencillins, tetracycline and chloramphenical.

Analysis of common drugs:

Analgesics: Aspirin and paracetamol. Antihelmentics: Mebendazole. Antiallergies: Chlorpheneramine malleate. Anti–inflammatory agents: Oxyphenbutazone. Antimalarials: primaquine phosphate. Antituberculosists: Isoniazid(INH). Narcotics: Nicotine, morphine. Sedatives: Diazepam. Vitamins: A, B_1, B_2, B_6, C & folic acid.

UNIT–IV

Analysis of dairy products and edible oils:

Chemistry, principles and analysis of liquids (edible): (i) general composition of edible oils, qualitative tests to purity, rancidity of fats and oil, estimation of rancidity, hydrogenated fat, tests for common edible oils like groundnut oil, castor oil, cottonseed oil & mustard oil. Tests for adulterants like argemoss oil & mineral oils and (ii) analytical principles in the analysis of dairy products composition of milk and milk products, alcohol test, fermentation, dye reduction. Methylene blue and resaturin tests. Tests to distinguish between buffed olemargarine, phosphate tests for efficacy of pasteurization. Analysis of fat content,

	Analysis of Food Preservatives and Adulterants: Food preservatives like Sodium benzoate, Sodium propionate, Sodium sulphate, Potassium metabiosulphate (Qualitative and Quantitative detection estimation) Food Adulterants : Artificial sweeteners like Seccharin and Dukin, Detection and estimation of Coal tar dyes and Non-Permitted colours and trace metals.	mineral in milk and butter. Estimation of added water in milk.
PG75P402D: Lab course in Analytical Chemistry.	**I. Spectrophotometric Methods**: 1. Determination of Iron. 2. Determination of Zirconium. 3. Determination of Copper. 4. Determination of pKa value of an Indicator. 5. Determination of fluoride. 6. Determination of Cr^{+6} and Mn^{2+} in a mixture. II. **pH Metric titrations**: 7. Determination of strength of acids 8. Determination of strength of commercial phosphoric acid (H_3PO_4) by pH titrations **III. Analysis of Alloys:** Solder, Steel, Cuprinickel alloy **IV. Estimation of functional groups;** Hydroxy, Amino, Nitro **V. Analysis of body fluids:** Determination of cholesterol in blood Determination of Glucose in blood, Determination of Uric acid in Urine, Determination of creatinine in Urine. **VI. Analysis of Medicines:** APC Tablet, Paracetomol, Sulladiazine **VII.Food Analysis:** Signification value of an oil Determination of iron in mustard sugar, Determination of Phosphorus in peas, Determination of ascorbic acid in tomato. Isolation of Caffeine from tea powder. Determination of benzoic acid in food products by titration with methanolic KOH in chloroform using Thymol Blue. **VIII. Soil Analysis.**	1. Analysis of medicines: APC tablet, paracetomol, sulpha drugs by potentiometry/spectrophotometry/titrimetry 2. Assay of aspirin / caffeiene / phenacetin by spectrophoptmetry 3. Determination of vitamin A in vanaspathi by UV spectrophotometry. 4. Isolation of casein and lactose from milk 5. Food analysis: Determination of iron in mustard sugar, phosphorus in peas, ascorbic acid in tomato, benzoic acid in food products 6. Determination of iodine value of an oil sample 7. Saponification of an oil sample
PG75T403D: Selected Topics in Analytical Chemistry–II	**UNIT - I** **Drug Design - A Rational Approach:** 1. Introduction. 2. Concept of Lead compound-crude drugs and analogues. 3. Factors governing the drug design 4. Rational approach to drug design 5. Tailoring of drug 6. Study structure activity relationship	**UNIT– I** **Analysis of Biomedical samples:** Composition of body fluids and detection of abnormal levels of certain constituents leading to diagnosis of disease. Sample collection and preservation of physiological fluids, analytical methods for the constituents of physiological fluids (blood, serum,urine). Blood–estimation of glucose, cholesterol, urea, haemoglobin and bilirubin. Urine: Urea, uric acid, creatinine, calcium phosphate, sodium,

		potassium and chloride. Biological significance, analysis and assay of enzymes (pepsin, monoaminoxide,tyrosinase), vitamins (thiamine, ascorbic acid, vitamin–A) and harmones (progesterone,oxytocin, insulin). Chemical, instrumental and biological assays to be discussed wherever necessary. Estimation of poisonous materials such as lead, mercury and arsenic in biological materials.
	UNIT- II **Analysis of Pharmaceuticals** Antibiotics: Introduction, Classification, structure elucidation, Steriochemistry and reaction mechanism of their action of their action of the following. Pencillins, Aminoglycosides, Tetracyclin, Chloramphenical. Analysis of common drugs like Aspirin,Paracetemol,Tetracycline, Iodomethacin,Warfarin odium . **Biomedical and Forensic Analysis** Composition of body fluids and detection of abnormal levels of certain constituents leading to diagnosis of disease. Sample collection and preservation of physiological fluids, Analytical methods for the constituents of physiological fluids (blood, serum, urine). Blood-Estimation of glucose, cholesterol, urea, haemoglobin and bilirubin. Urine- urea, uric acid, creatinine, calcium phosphate, sodium, potassium and chloride. Biological significance, analysis and assay of enzymes (pepsin, monoaminoxide, tyrosinase); Vitamins (thiamine, ascorbic acid, vitamin A) and harmones (progesterone, oxytocin, insulin). Chemical, instrumental and biological assays to be discussed wherever necessary. **Forensic analysis:** General discussion of poisons with special reference to mode of action of cyanide, organophosphates and snake venom. Estimation of poisonous materials such as lead, mercury and arsenic in biological materials. **UNIT -III** **Chemistry, Principles and Analysis of Liquids (EDIBLE)** **Chemistry, Principles and analysis of liqids (Edible) :** (a) General composition of edible oils, Qualitative tests to purity, Rancidity of Fats and Oil, Estimation of Rancidity, Hydrogenated Fat,	**UNIT–II** **Analysis of Ores, Minerals and Fertilizers:** Composition, properties and analysis of minerals and ores: Heamatite, pyrolusite, dolomite, chromate, bauxite, limestone, zillmenite, gypsum and epsom. Fertilizer analysis: Types, analysis of nitrogenous fertilizers, organic nitrogenous, phosphatic and potassic fertilizers. Pesticide and insecticide analysis: introduction, classification and analysis of DDT, gammexane, endosulphon, zinaf, ziram, malathian, thiram, thiometon, simazine & chloridane. **UNIT–III** **Metals, Alloys and Cement Analysis:** Steel, Cu–Ni alloy, solder, bronze. brass, aluminum alloy, ferroalloys of silicon, molybdenum, chromium, titanium and vanadium. Analysis of structural materials: Cement and glass. Analysis of refractory materials: Fire clay, fluorspar. Analysis of cement

	Tests for common edible oils like Groundnut oil, Castor Oil, Cottonseed Oil and Mustard Oil, Tests for adulterants like Argemoss Oil and Mineral Oils. b) Analytical principles in the analysisof diary products. Composition of milk and milk products, alcohol test, Fermentation, Dye Reduction, Methylene Blue and Resaturin tests. Tests to distinguish between Bufferl Olemargarine, Phosphate tests for efficacy of pasteurization. Analysis of fat content, Mineral in Milk and butter. Estimation of added water in milk. **UNIT-IV** **Heame and Non Heame Systems:** Transport and storage of dioxygen- heme proteins, oxygen uptake, functions of haemoglobin, myoglobin, hemerythrin and hemocyanins, synthetic oxygen carriers. Electron transfer proteins- cytochromes and iron-sulphur proteins-rubredoxins, ferredoxins and HIPIPs. Model compounds. Vitamin B_{12} and its coenzyme. Synthetic model compounds.	**UNIT–IV** **Analytical procedures in refineries:** Types of crude oil (sweet and sour), composition of crude cil, causes for corrosion in refinery (sulfidic & naphthenic acid) crude oil refining, fractional distillation (atmospheric and vacuum distillation). Purification processes (merox, alkylation, reformulation, hydrotreating, cracking etc.). Products of refinery (naphtha, gasoline, diesel, furnace oil, lube oil etc.), residues of refining processes (sulfur, pet coke). Specifications of gasoline, jet fuel and diesel in India and abroad. Paraffins, iso–paraffins, olefins, naphthenes, aromatics. Analytical techniques used in crude oil and products evaluation: True boiling point distillation, spectroscopic evaluation (NIR & FTIR), density, viscosity, cloud point, pour point, PIONA analysis in gasoline, simulated distillation, GC–MS, HPLC, cetane number and octane number .
PG75P403D: Lab course in Analytical Chemistry	Estimation of aluminium and magnesium. II. Analysis of Fertilizers: Urea, Super phosphates. III. Analysis of water for alkalinity and acidity by pH metric titrations. IV. Determination of ammonia in Household cleaners by conductometric titrations. Analysis of Alloys: Solder, Steel, Cuprinickel alloy VI. Analysis of Medicines: APC Tablet, Paracetomol, Sulladiazine VII. Soil Analysis.	1. Analysis of fertilizers: Urea, super phosphates 2. Analysis of pyrolusite ore 3. Analysis of alloys: cupronickel and bronze 4. Analysis of cement 5. Determination of (i) aluminium and magnesium in a mixture 6. Analysis of Stainless steel-Ni gravimetrically using DMG, Fe volumetrically using Ce(IV), Cr volumetrically by persulphate oxidation, 7. Analysis of body fluids: Determination of cholesterol, glucose in blood; uric acid, creatinine in urine .

PG75D404D: Project work*	It may include inplant training in Industries/short term work in other educational Institutions/ R & D organizations/ Data Mining/ Review of current literature/ theoretical methods/computer applications, etc. Experimental work may involve studies on synthesis/characterization/properties/ measurements/activities for reported/unreported research or any suitable combination thereof. In case of the students who will work outside the campus, the supervising staff member shall visit the place atleast once during the tenure and hence he/she may be eligible for TA/DA as per the University rules.	It may include in–plant training in industries/short term work in other educational institutions/R&D organizations/data mining/review of current literature/theoretical methods/computer applications etc. Experimental work may involve studies on synthesis/ characterization/properties /measurements/activities of reported/unreported research or any suitable combination thereof. In case of students who will work outside the campus, the supervising staff member shall visit the place at least once during the tenure and hence he / she may be eligible for TA/DA as per the University rules.

B. Elective		
PG75O302B: Applied Organic Chemistry	UNIT–I **Molecular Parameters, Isomerism and Prochirality:** Molecular Parameters: bond lengths, bond angles, bond energies, bond polarity and dipole moment. Geometrical and optical isomerism: E/Z, R/S nomenclature, Fischer, Sawhorse, Newmann projections. Enantiomers, diastereomers and epimers, Prochirality: Homotopic, enantiotopic, diastereotopic groups & faces and their reactivity. **UNIT–II** **Organic Reactions:** Classification of organic reactions, mMethods of identification, kinetic, non–kinetic methods, isotopic labeling techniques, intermediates, cross over products and product proportions in different types of reactions. Named Reactions: Classification, aldol,	UNIT–I **Molecular Parameters, Isomerism and Prochirality:** Molecular Parameters: bond lengths, bond angles, bond energies, bond polarity and dipole moment. Geometrical and optical isomerism: E/Z, R/S nomenclature, Fischer, Sawhorse, Newmann projections. Enantiomers, diastereomers and epimers, Prochirality: Homotopic, enantiotopic, diastereotopic groups & faces and their reactivity. **UNIT–II** **Organic Reactions:** Classification of organic reactions, mMethods of identification, kinetic, non–kinetic methods, isotopic labeling techniques, intermediates, cross over products and product proportions in different types of reactions. Named Reactions: Classification, aldol, dieckmann, Claisen–Schmidt and

OR	dieckmann, Claisen–Schmidt and similar carbanion addition reactions. UNIT–III **Chemistry of Heterocycles:** Structure, synthesis, reactivity of the following heterocycles and their biologically important derivatives: (i) indole (ii) thiazole (iii) pyrimidine (iv) quinoline (v) furan (vi) thiophene and (vii) pyrrole. UNIT–IV Functional group Transformations: Multi step organic functional group inter conversions involving substitution, addition, eliminations, oxidation, reduction, etherification, hydrolysis and diazocoupling reactions.	similar carbanion addition reactions. UNIT–III **Chemistry of Heterocycles:** Structure, synthesis, reactivity of the following heterocycles and their biologically important derivatives: (i) indole (ii) thiazole (iii) pyrimidine (iv) quinoline (v) furan (vi) thiophene and (vii) pyrrole. UNIT–IV Functional group Transformations: Multi step organic functional group inter conversions involving substitution, addition, eliminations, oxidation, reduction, etherification, hydrolysis and diazocoupling reactions.
PG75O302C: Applied Physical Chemistry	**UNIT–I** **Reaction Kinetics:** A critical account of collision and transition state theories. Kinetics and Mechanism: Steady state approximation and simple examples relating kinetics to mechanism. Theories of unimolecualar reactions: RRKM theory. Isomerisation of methyl isocyanide. General features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and the nuclear magnetic resonance method. **UNIT–II** **Thermodynamics :** Thermodynamic criteria for spontaneous chemical changes, standard free energies and their determination, relation between free energy change and equilibrium constant. The pressure dependence of free energy of non-ideal gases and fugacity. Standard state for non-ideal gas, equilibrium constants in non-ideal systems. Temperature dependence of free energy and equilibrium	**UNIT–I** **Reaction Kinetics:** A critical account of collision and transition state theories. Kinetics and Mechanism: Steady state approximation and simple examples relating kinetics to mechanism. Theories of unimolecualar reactions: RRKM theory. Isomerisation of methyl isocyanide. General features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and the nuclear magnetic resonance method. **UNIT–II** **Thermodynamics :** Thermodynamic criteria for spontaneous chemical changes, standard free energies and their determination, relation between free energy change and equilibrium constant. The pressure dependence of free energy of non-ideal gases and fugacity. Standard state for non-ideal gas, equilibrium constants in non-ideal systems.

	constants. **UNIT–III** **Electrochemistry:** Introduction to electrochemistry, electrical Double Layer: Lippman equation, theories of electrical double layer-Helmholtz-Perrin, Gouy–Chapman and Stern theories. Effect of ions on zeta potential. Activity of ions in solution: ion-solvent interactions, ion-ion interactions and free energy of ions in solution. Born model and modifications, solvation number and their determination. triple ion formation and conductance minima. **UNIT–IV** **Introduction to Polymers:** Basic Concepts: Monomers, repeat units, polymers and degree of polymerization. General classification of polymers, homopolymers, copolymers, terpolymers, additon polymers and condensation polymers with examples, tacticity, comparison between thermoplastics and thermosetting polymers. Methods of polymer fabrications: Fabrication of polymer films, solution casting, melt pressing, melt extrusion and bubble blown. Fabrication of shaped polymer objects: compression molding, injection molding, reaction injection molding, blow molding extrusion molding and calendaring. Spinning industrial polymers: solution spinning and melt spinning. Preparation, properties and commercial importance; Vinyl polymers: polyethylene, polypropylene, polystyrene, polytetrafluoroethylene, polyvinyl chloride and polymethylmethacralate Polyesters: poly(ethylene terephthalate). Polyamides: aramides (kevlar and nomex). Polyimides, Polysulphone, Polyurethanes and polyureas. Natural polymers: polyisoprenes, chitosan,	Temperature dependence of free energy and equilibrium constants. **UNIT–III** **Electrochemistry:** Introduction to electrochemistry, electrical Double Layer: Lippman equation, theories of electrical double layer-Helmholtz-Perrin, Gouy–Chapman and Stern theories. Effect of ions on zeta potential. Activity of ions in solution: ion-solvent interactions, ion-ion interactions and free energy of ions in solution. Born model and modifications, solvation number and their determination. triple ion formation and conductance minima. **UNIT–IV** **Introduction to Polymers:** Basic Concepts: Monomers, repeat units, polymers and degree of polymerization. General classification of polymers, homopolymers, copolymers, terpolymers, additon polymers and condensation polymers with examples, tacticity, comparison between thermoplastics and thermosetting polymers. Methods of polymer fabrications: Fabrication of polymer films, solution casting, melt pressing, melt extrusion and bubble blown. Fabrication of shaped polymer objects: compression molding, injection molding, reaction injection molding, blow molding extrusion molding and calendaring. Spinning industrial polymers: solution spinning and melt spinning. Preparation, properties and commercial importance; Vinyl polymers: polyethylene, polypropylene, polystyrene, polytetrafluoroethylene, polyvinyl chloride and polymethylmethacralate Polyesters: poly(ethylene terephthalate). Polyamides: aramides (kevlar and nomex). Polyimides, Polysulphone, Polyurethanes and polyureas. chitosan,