VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

JNANASAGARA CAMPUS, BALLARI-583105

Department of Studies in Chemistry

SYLLABUS

Master of Science

(III Semester)

With effect from:

2021-22

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

Department of Chemistry

Jnana Sagara, Ballari - 583105

Distribution of Courses/Papers in Postgraduate Programme I to IV Semester as per Choice Based Credit System (CBCS) Proposed for PG Programs

III – SEMESTER

With Practical

Semester	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	SEE	Total	L	T	P		
THIRD	DSC9	21CHE3C9L	Spectroscopy	30	70	100	4	-	-	4	3
	DSC10	21CHE3C10L	Chemistry of Heterocyclic Compounds	30	70	100	4	-	-	4	3
	DSE1	21CHE3E1AL	A. Polymer Science & Technology	30	70	100	4	-	-	4	3
		21CHE3E1BL	B. Nanomaterials and Applications								
		21CHE3E1CL	C. Applied Physical Chemistry								
	DSE2	21CHE3E2AL	A. Nuclear Chemistry and Materials Science	30	70	100	4	-	-	4	3
		21CHE3E2BL	B. Green Chemistry								
		21CHE3E2CL	C. Industrial Inorganic Chemistry								
	GEC1	21CHE3G1AL	A. Analytical techniques	20	30	50	2	-	-	2	1
		21CHE3G1BL	B. Separation and purification techniques								
		21CHE3G1CL	C. Environmental Chemistry and Waste management								
	SEC3	21CHE3S3P	Semi micro Qualitative Inorganic analysis	20	30	50	1	-	2	2	1
	DSC9P7	21CHE3C9P	Instrumentation/ Physical Chemistry Practicals	20	30	50	-	-	4	2	4
	DSC10P8	21CHE3C10P	Quantitative analysis of Organic functional groups	20	30	50	-	-	4	2	4
			Total Marks for III Semester			**600**				**24**	

Dept Name: Chemistry

Semester-III
DSC9: Spectroscopy

Course Title: **Spectroscopy**	Course code: 21CHE3C9L
Total Contact Hours: 56	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 Hours
Summative Assessment Marks: 70	

Course Outcomes (CO's):

1. To understand the basic spectral aspects and characteristics
2. To study theoretical concepts of microwave and vibrational spectroscopy and their applications.
3. To familiarize with advanced spectroscopic techniques for the characterization and prediction of chemical structure
4. To apply spectroscopic techniques for qualitative analysis

At the end of the course, students will be able to:

1. Apply the advanced knowledge of spectroscopy in the characterization and prediction of structure.
2. Able to apply the techniques in academic, industrial and research

Unit	Description	Hours
1	**Introduction**: Intensity of spectral lines, Natural line width and broadening, Rotational, vibrational and electronic energy levels, selection rules. **Microwave Spectroscopy** The rotation of molecules – rotation spectra of diatomic molecules – the rigid diatomic molecule – rotational energy levels – selection rules – effect of isotopic substitution – the rigid and non rigid rotator. Applications - Principles of determination of Bond length and moment of inertia from rotational spectra. Stark effect in rotation spectra and determination of dipole moments. spectrum of a non rigid rotator – polyatomic linear molecules – Moment of inertia expression for linear tri-atomic molecules, symmetric Top molecules, techniques and instrumentation.. **Vibrational Spectroscopy** Vibrating diatomic molecule – simple harmonic oscillator – vibrational energy levels – anharmonic oscillator selection rules – fundamental vibrations, overtones and hot bands – diatomic vibrator rotator, Vibration of polyatomic molecules – The number of degrees of freedom of vibration. Vibration and rotation spectra of carbon monoxide.interaction of rotation and vibration – Breakdown of Born – Oppenheiner approximation. Problems	10
2	**Infra Red Spectroscopy** Introduction – Molecular vibrations – Mode of Vibrations, calculation of vibrational frequencies, instrumentation-– FT – IR Spectrometer. Sampling techniques, interpretation of IR spectra factors affecting group frequencies and band shapes – Physical state of samples vibrational coupling, electrical and inductive effects, Hydrogen bonding and ring structures, co-relation chart, important regions in the IR spectrum – H stretching, triple bond, double band stretching, finger print	10

	region, applications of IR spectroscopy in the structural elucidation of organic. Compounds, application of far IR spectroscopy – Limitations of IR spectroscopy. (Problems & Exercise). IR spectra of coordination modes of ligands like nitrate, thiocynate, sulphate, carbonate(bridging, bidentate etc.,), and water.	
3	**HNMR Spectroscopy** Introduction – Nuclear spin and magnetic moment, origin of NMR spectra, Theory of NMR spectroscopy, resonance flipping, instrumentation and sampling, inter preparation of NMR spectrum, equivalent and non-equivalent protons, chemical shifts(down field and up field), factors influencing chemical shifts, anisotropic effects, NMR scale, units, internal references, simple and complex splitting / coupling, coupling constant, correlation chart of chemical shifts, spin-spin relaxations, equivalence of protons–chemical and magnetic equivalence, spin–systems. solvent effects and Nulear Overhauser Effect. Karplus relationships (Karplus curve–variation of coupling constant with dihedral angle), double resonance techniques, first order and second order patterns, lanthanide shift reagents, exchange phenomena. . High resolution 1H NMR. FT NMR and its advantages. Applications of NMR spectroscopy in structure elucidation of simple organic and inorganic molecules. Pulse techniques in NMR, two dimensional and solid state NMR. Use of NMR in Medical diagnostics. Deuterium exchange techniques limitations of H NMR spectroscopy .	12
4	**Introduction and applications of 13C NMR spectroscopy**, Broad band and off resonance coupling methods of detection. 13C Chemical shifts of different classes of organic compounds–alkanes, alkyl halides, alkenes, alcohols, ethers, carbonyl compounds and aromatic compounds. 2 DNMR spectroscopy, use of PMR spectrum in structural elucidation of organic compound.^{31}P and ^{19}F NMR. COSY, NOESY (Nulear Overhauser Effect) and EXSY (Exchange Spectroscopy), MRI. Conformational analysis, keto-enol tautomerism, Hbonding. Spectra of simple organic molecules, phosphates, polyphosphates, PH_3, phosphor halides, fluoro acetic acid, SF_4, P_4S_4, HPF_2. **Raman Spectroscopy:** Raman and Rayleigh scattering, Stokes and anti-Stokes lines, polarization of Raman lines, depolarization factor, polarizability ellipsoid. Classical theory of Raman Effect – rotational Raman spectra – Linear – Vibrational Raman Spectra, rule of mutual exclusion principle.Instrumentation. Resonance Raman Spectroscopy: Resonance Raman Effect and its applications. Non-linear Raman effects: Hyper, stimulated and inverse Raman effects. Coherent Anti-Stokes Raman Scattering and its applications.	12
5	**X-Ray Diffraction:** Production of X-Rays, Measurement of X-Rays Principles of X-Ray absorption. Principles and instrumentation in X-Ray fluorescence. X-Ray diffraction - Bragg's laws - Miller indices laws - transmission and reflection method - Debye Scherrer method . Experimental methods – powder and rotating crystal methods, indexing of powder and rotating crystal photographs. Single crystal and polycrystalline diffraction studies. Atomic scattering factor, structure factor, Fourier synthesis, electron density diagrams and 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	12

	refinements. Electron diffraction of gases, experimental technique, Scattering-Intensity curves, Wierl equation (no derivation), Radial distribution method determination of bond lengths and bond angles. Electron microprobe – principles and instruments – principles of electron diffraction - working of SEM and TEM. Photoelectron Spectroscopy: Basic principles-photoelectric effect, ionization-process, Koopman's theorem-photoelectric spectrum of simple molecules, ESCA-chemical information from ESCA.	

References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York, (2005).
2. Analytical Chemistry, G.D. Christian, 5th ed, John Wiley & Sons, Inc, India (2001).
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, prentice Hall, Inc. New Delhi, (1993).
4. Physical Methods in Inorganic chemistry, R.S. Drago, East-West Press, 2012
5. Structural Methods in Inorganic chemistry, EAV Ebsworth, David W H Rankin, Stephen Cradock, Blackwell scientific publications, 1987.
6. An introduction to Magnetic Resonance spectroscopy, D.N. Sathyanarayana, I.K. International, 2013.
7. Vibrational Spectroscopy- Theory and Applications, D.N. Sathyanarayana, 3rd Ed., New Age Publications, 2021.
8. Symmetry and Spectroscopy of Molecules, K. Veerareddy, New age international, 2020.
9. Molecular Structure and Spectroscopy, G. Aruldhas, 2nd Edition, Prentice Hall, India, 2007.
10. Fundamentals of Molecular Spectroscopy, C.N. Barnwell, Tata McGraw Hill, 1983.
11. Introduction to Molecular Spectroscopy, G.M. Barrow, 4th Edition, McGraw Hill, 2018.
12. Spectroscopy of Organic compounds – P.S. Kalsi, New Age International Publications, New Delhi (6th Edn.), 2007.
13. Organic Spectroscopy – William Kemp 3rd Edn. ELBS, 1991
14. Application of absorption spectroscopy of organic compound – John R Dyer, Prentice Horll India, EEE, Recent Edn, 1978
15. Instrumental Methods of Chemical analysis – G.R. Chatwal and S.K. Anand, Himalaya Publication House, Delhi (Recent Edn.), 2011
16. Instrumental methods of chemical analysis. – B.K. Sharma – Goel Publishing House – Meerut, 2014.
17. Spectroscopic methods in organic chemistry – D.H. Williams, I. Fleming – 6th Edition, Tata McGraw Hill, 2007.
18. Introduction to NMR Spectroscopy – R.J. Abraham, J. Fisher, P. Loftus, - Wiley Publications, 1988.

Date Course Coordinator Subject Committee Chairperson

DSC10: Chemistry of Heterocyclic Compounds

Course Title: Chemistry of Heterocyclic Compounds	Course code: 21CHE3C10L
Total Contact Hours: 56	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 Hours
Summative Assessment Marks: 70	

Course Outcomes (CO's):

1. To understand the heterocyclic compounds and natural compounds which comprise the major part of organic compounds.
2. To gain the useful knowledge on various reaction mechanism and structural activity of organic compounds.
3. To acquire advance knowledge on synthesis and their pharmaceutical approach.
4. To study the various useful organic natural products and their synthesis.
5. To acquaint with plant based organic compounds.

At the end of the course, students will be able to:

1. Get familiarize with heterocyclic compounds, natural products and pant pigments.
2. Able to apply heterocyclic compounds in pharmaceuticals.
3. Interpret the concept of reaction mechanism in the transformation from reactant to product.
4. Interpret the mechanistic and stereochemical aspects of heterocyclic and biomolecules.

Unit	Description	Hours
I	**Basics of Heterocycles and their synthesis:** IUPAC nomenclature of heterocyclic ring systems (3-7 membered rings and simple fused systems) comparative aromaticity of pyrrole, furan, thiophene, pyridine. **Methods of synthesis:** Electrophilic and nucleophilic substitutions reactions of pyrrole, furan, thiophene, and pyridine ring systems. Comparison of basicity of pyridine, piperidine, and pyrrole.	11
II	**Meso-ionic and fused Heterocycles: Synthesis and pharmaceutical approach** **Meso-ionic Heterocycles:** General classification chemistry of some important meso-ionic heterocycles of type-A and B and their applications. **Fused Heterocycles:** Fused Heterocycles of 6 & 5 membered rings-synthesis and reactions of indole, benzofuran, quinoline, isoquinoline with special references to Fischer indole synthesis, and Skraup synthesis, Bischler-Napier Laski synthesis, mechanism of electrophilic substitution reaction of indole, quinoline, and benzofuran. **Synthesis of pharmaceutical compounds having a heterocyclic ring with one or more heteroatom:** **Antibiotics:** Pencillin-G, Pencillin-V, Cyclosporine, Cephalosporin–C, Cephalexin, Tetracycline. **Depressants:** Benzodiazepine, Midazolam, Diazepam, **Antidepressants**: Fluoxetine, Escitalopram, Antacids/Proton Pump **Inhibitors**: Omeprazole, Pentoperazole. **Antihypertensive:** Nifedipine, Losartan, Metoprolol	14
III	**Natural products:** **Alkaloids**: Classifications occurrence, general methods of structural elucidation,	10

	stereo Chemistry, and synthesis of quinine, papaverine, morphine, LSD. **Terpenoids**: Occurrence general methods of structural elucidation, stereo Chemistry, and synthesis of following representative molecules-citral,citronellol, camphor, and santonin. **Steroids**: Cholesterol, ergosterol structure,Vit-$D_3$and synthesis. **Porphyrins**: Structure and synthesis of Haemoglobin and chlorophyll.	
IV	**Bio-organic molecules:** **Carbohydrates**: Determination of ring structures of monosaccharides and disaccharides with reference to glucose, fructose, and maltose. **Proteins**: Amino acids, peptides, peptide synthesis using blocking reagents, modern methods of peptide synthesis. **Structure of proteins:** Primary, secondary and tertiary structure, sequence of amino acids in proteins, end-group analysis. **Nucleic acids:** Chemical and enzymatic hydrolysis of nucleic acids, purine & pyrimidine bases, the double helix of DNA, base pairing via H-bonding, various types of RNA & their functions.	10
V	**Plant pigments, Flavonoids and Prostaglandins** **Plant Pigments:** Occurrence, nomenclature and general methods of structure determinations, isolation and synthesis, Quercetin, Quercetin-3-Glucoside, Cyanidin-7-arabinoside cyanidine, Hirsutidin. **Biosynthesis of Flavonoids:** Acetate pathway and shikimic acid pathway. **Prostaglandins:** Occurrence, nomenclature, classification, biogenesis and physiological effects, Synthesis of PGE2 and PGF2.	10

References:

1. R.R.; Kumar, M.; Gupta, V Heterocyclic Chemistry, Vol.1-3, SpringerVerlag, 1998.
2. Joule, J.A.; Mills, K.; Smith, G. F. Heterocyclic Chemistry, 3rd edition, Chapman and Hall, 1998.
3. Acheson, R.M. An Introduction to the Heterocyclic Compounds, John Wiley.Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y., 1960
4. Katrizky, A.R.; Rees, C.W. Comprehensive Heterocyclic Chemistry, Pergamon Press.Pergamon Press, Ltd., Headington Hill Hall, Oxford OX3 OBW, England. 1984.
5. Sriram, D.; Yogeeswari, P. Medicinal Chemistry 2nd Ed. Pearson.Pearson India, 2009
6. Eicher, T.; Hauptmann, S.; Thieme, The Chemistry of Heterocycles.Thieme Medical Pub, 1995
7. Gilchrist, T.L. Heterocyclic Chemistry, 3rd edition, Longman Scientific Technical, 1992.
8. Newkome, G.R.; Paudler, W.W. Contemporary Heterocyclic Chemistry, Wiley-Inter Science. 1982
9. Finar, I.L. Organic Chemistry, Vol. 2, 5th edition, ELBS, 1975.
10. Nogradi, M. Stereoselective Synthesis: A Practical Approach, VCH.Wiley-VCH; 2nd Edn, 1994
11. Coffey, S. Rodd's Chemistry of Carbon Compounds, Elsevier.1966
12. Hostettmann, Kurt; Gupta, M.P.; Marston, A. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Harwood Academic Publishers, 2013
13. Aggarwal, O.P. Chemistry of Organic Natural Products, Vol. 1 & 2. Krishna Prakashan Media

Date Course Coordinator Subject Committee Chairperson

DSE1: A. **Polymer Science and Technology**

Course Title: Polymer Science and Technology	Course code:21CHE3E1AL
Total Contact Hours:56	Course Credits:04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 Hours
Summative Assessment Marks:70	

Course Outcomes (CO's)

1. Understand basic concepts of polymers.
2. Study the properties and testing of polymers.
3. Impart knowledge on processing of polymers for different applications

At the end of the course, students will be able to

1. Acquire knowledge on Polymeric techniques and also its preparation.
2. Acquaint with important properties of polymers.
3. Able to apply Applications of polymers in various fields.

Units	Description	Hours
I	**Basic Concepts of Polymers**: Monomers, Polymers, degree of polymerization. Linear, branched and network polymers. Classification of polymers. Polymerization: Condensation, addition, co-polymerization. Polymerization reactions with examples. Polymerization in homogenous and heterogeneous systems, Polymerization Techniques. Methods of polymerization, thermoforming of polymer resins, Plastics, Rubbers: classification, vulcanization, synthetic rubbers, synthesis and applications of Buna-S and Butyl rubbers	11
II	**Molecular weight of Polymers**. Number, weight and viscosity average molecular weights. Polydispersity and molecular weight distribution. The practical significance of molecular weight. Measurement of molecular weights. End-group, viscosity, light scattering, osmotic and ultracentrifugation methods. Analysis and testing of polymers-chemical analysis of polymers, spectroscopic methods, X-ray diffraction study. Microscopy. Thermal analysis and physical testing-tensile strength. Fatigue, impact and Tear resistance of polymers. Hardness and abrasion resistance. Moulding of polymers, Solubility of polymers	11
III	**Crystalline polymers** - Crystal structures of polymers. Morphology of crystalline polymers, strain-induced morphology, crystallization and melting. Polymer structure and physical properties-crystalline melting point, Tm-melting points of homogenous series, effect of chain flexibility, entropy and heat of fusion. The glass transition temperature, Tg-Relationship between Tm and Tg, effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking on Tg. polymer utilization.	11
IV	**Testing of Polymers:** Need for testing-specifications and standards, mechanical-short term (tensile, flexural, impact, tear resistance, abrasion resistance etc.,) long term (creep and fatigue). Electrical-conductivity, volume resistivity, surface, breakdown voltage, dielectric constant, loss factor, thermal, heat distortion temperature, vicat softening point, low temperature, properties, thermal conductivity. **Solution properties of polymers**: Polymer dissolution, thermodynamics of polymeric solutions, Floury-Huggins theory, nature of polymer molecules in solution, their size and shape, theta solvent, theta temperature, thermodynamics of mixing, solution viscosities.	11

V	**Polymer processing:** Plastics, elastomers and fibers, compounding. Processing techniques; calendaring, die casting, rotational casting, film casting, injection molding, blow molding, extrusion molding, thermoforming, foaming reinforcing. **Properties and applications of commercial polymers:** Polyethylene (HDPE and LDPE), poly (vinyl chloride), polyamides, polyester, phenolic resins, epoxy resins and silicon polymers. Functional polymers, electrically conduction polymers, biomedical polymers: contact lens, dental polymers, artificial heart, kidney skin and blood cells	**12**

REFERENCES:

1. Text book of Polymer Science (3rd edition) F.W. Billmayer, A Wiley-Interscience, 1984
2. Contemporary Polymer Chemistry (2nd edition), H.R.Allcock and F.W.Lampe, Prentice Hall, Englewood Cliff's, New Jersy, 1981
3. Polymer Science, V.R.Gowariker, N.V.Viswanathan and JayadevSreedhar, 4th Edition, New Age International (P) Limited, 2021.
4. Introductory Polymer Chemistry, G.S. Misra, Wiley Eastern Limited, 1993
5. Polymer Science and Technology of Plastics and Rubbers, Premamoy Ghosh, Tata McGraw Hill, 1990
6. Polymer characterization, Physical Techniques, D. Campbell and J.R. White, Chaopman and Hall, 1989.
7. Principles of Polymer Science Systems, F. Rodriguez, McGraw Hill Book co., 1970.

Date Course Coordinator Subject Committee Chairperson

DSE1: B. Nanomaterials and Applications

Course Title: Nanomaterials and Applications	Course code: 21CHE3E1BL
Total Contact Hours: 56	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 Hours
Summative Assessment Marks: 70	

Course Outcomes (CO's)

1. Understand the various concepts and properties of the Nanomaterials.
2. Able to synthesis and characterize Nanomaterials.
3. Apply Nanomaterials for various applications.

At the end of the course, students will be able to

1. Gain knowledge on Nanomaterials and methods of fabricating nanostructures.
2. Relate the unique properties of Nanomaterials to the reduce dimensionality of the material.
3. Describes the characterization tools to study properties of nanostructures.
4. Capitalize applications of Nanomaterials and implication of health and safety related to Nanomaterials

Units	Description	Hours
I	**Introduction to Nanostructured materials** Importance, Sources of nanomaterials, classification, Quantum wells, Quantum wires, Quantum dots, Clusters and nanocrystals, Properties of Nanostructured materials: Electronic, Optical, Metallic, Semiconducting and superconducting and magnetic properties. Polymeric nanostructured materials, Polymer nanocomposites. Alloys and oxide materials.	11
II	**Synthesis of Nanomaterials** Nanoparticle synthesis: Sol-Gel, Hydrothermal, Combustion, Solvothermal, microwave, Chemical methods. Nanowires, Carbon nanotubes and films, energetic of self-assembly, directed assembly, growth on patterned substrate. Biosynthesis and Green synthesis of nanomaterials, Understanding of interacellular and extracellular strategies.	11
III	**Nanobiomaterials** Introduction, differences of Nanobiomaterials and Nanomaterials, Biological derived nanomaterials, surface immobilized biomolecules Bio-inspired synthesis of nanomaterials, biometric and self-assembly, molecular motors and transducers, self-assembled monolayers and Langmuir-Blodgett film deposition, Surface and bulk properties of biomaterials.	11
IV	**Supramolecular Chemistry** Definition, introduction, Synthesis, Characterization and applications of organic supramolecules **Applications of Nanomaterials** Nanomagnets, Applications of nanomagnets in Sensor, high density data storage, long wavelength detector. Carbon nanotubes and its applications, Applications of nanofillers, Solvothermal. Biosensor applications, Solar energy conversation applications, PV CELL: construction and working and applications.	11
V	**Modern Methods of Characterization Techniques** Density measurements, X-ray methods: Powder X-Ray Diffraction (PXRD), structure determination from PXRD, Xray photoelectron spectroscopy.	12

	Electron microscopy: Principles and application of scanning electron microscopy (SEM), transmission electron microscopy (TEM), energy dispersive analysis of X-rays (EDAX). Optical spectroscopy: Inductively coupled Plasma- mass spectroscopy (ICP-MS), ICP-AES (Atomic Emission Spectroscopy), AIP-OES (Optical Emission Spectroscopy)	

References

1. Nanomaterials Chemistry by C.N.Rao, A Muller, A.K. Cheetham, Wiley VCH, 2007
2. Introduction to Nanoscale Science and Technology (Nanostructure Science and Technology),Massimiliano Ventra, StephaneEvoy, J. R. Heflin, 2004.
3. Nanostructures and Nanomaterials: Synthesis, Properties, and Applications (World Scientific Series in Nanoscience and Nanotechnology) by Guozhong Cao and Ying Wang, 2011
4. Understanding Nanomaterials by Malkiat S. Johal, 2011
5. Nanoscale materials, Luis M Liz Marzan and P.V. Kamat, Kluwer Academic Publishers, 2004
6. Biointeractions of Nanomaterials, Vijaykumar B. Sutariya, YashwantPathak, CRC Press, 2014
7. Encyclopedia of Materials Characterisation by C. Richard Brundle Charles A.Evans. Jr. Shaun Wilson, Butterworth-Heinemann, 1992.
8. Nanostructures and Nanomaterials, Synthesis, Properties and application by Guozhong Cao Imperial College Press, 2004.

Date Course Coordinator Subject Committee Chairperson

DSE1: C. APPLIED PHYSICAL CHEMISTRY

Course Title: Applied Physical Chemistry	Course code:21CHE3E1CL
Total Contact Hours:56	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 Hours
Summative Assessment Marks:70	

Course Outcomes (CO's)

1. Familiarized with Surface chemistry, Atomic structure, Thermodynamics, gases and Colloid
2. Correlate fundamental concepts with properties and applications
3. Select and apply appropriate techniques, resources and modern technology in multidisciplinary science.

At the end of the course, students will be able to

1. Demonstrate specific understanding of major concepts in Physical Chemistry
2. Able to physical chemistry approach and practices in various fields

Units	Description	Hours
I	**Surface Phenomena** Adsorption, adsorption isotherms, surface area determination, Gibbs adsorption equation and its verification, Surface tension, electrical phenomena at interfaces including electrokinetic effects, micelles, reverse micelles, solubilization. Thermodynamics of micellisation, factors affecting critical micelle concentration (CMC), experimental methods of CMC determination. Application of photoelectron spectroscopy, ESCA. Significance of surface phenomena in advanced technologies like nanotechnology, drug formulation etc.	11
II	**Atomic Structure** Review of hydrogen spectrum, Hydrogen like spectrum, Atomic spectra of alkali and alkali like elements, Atomic spectra of helium atom, atomic spectra of alkaline and alkaline earth like elements. Mosely lines, Multiple structure, Space quantization, Stern-Gerlach experiment, Normal Zeeman effect, Anomalous Zeeman effect, Paschen Back effect, Stark effect, Comparison between Stark and Zeeman effect.	11
III	**Thermodynamics** Third law of thermodynamics, experimental verification, Nernst heat theorem, entropy changes in chemical reactions, determination of absolute entropy – limitation of third law of thermodynamics **Thermodynamics of Living Systems** Bioenergetics and thermodynamics, Phosphate group transfer and ATP, Biological oxidation-reduction reactions.	11
IV	**Theory of gases** Postulates of kinetic theory of gases, P-V-T relations for an ideal gas, non-ideal behavior of gases, equation of state, compressibility factor, virial equation, van der Waal's equation, excluded volume and molecular diameter, relations of van der Waal's constants with virial coefficients and Boyle temperature. Molecular collision in gases, mean free path, collision diameter and collision number in a gas and in a mixture of gases, kinetic theory of viscosity and diffusion	11

V	**Colloids** Types of colloidal systems, properties, determination of size of colloidal particles, Electrical double layer, zeta potential, Flocculation values, Hardy-Schutz rule. Surfactants, critical micelle concentration. Emulsions, foams and aerosols. Importance of colloids, Applications of colloid and surface science in petroleum recovery, coating and painting, food, pharmaceutical and cosmetic industry.	12

References

1) Physical chemistry of surfaces – A. W. Adamson, 4thEd. John Wiley, 1982.
2) . Introduction to Colloid and Surface Chemistry – D. Shaw, Butterworth Heinemann, 1992. (Elsevier Pub)
3) Surface Activity: Principles, Phenomena and Applications (Polymers, Interfaces and Biomaterials) – K. Tsujii, 1st Ed. Academic Press, 1998
4) Atomic structure and Atomic spectr by G.Herzberg, ACS Publications-1937
5) Introduction to Atomic spectra by H.E.White, 1934
6) Physical Chemistry Through Problems by Dogra & Dogra, New Age International Publisher, 2015
7) Chemical Thermodynamics by Rastogi & Mishra, VI th Edition, Vikash Publihser, 2018

Date Course Coordinator Subject Committee Chairperson

DSE2: A. Nuclear Chemistry and Materials Science

Course Title: Nuclear Chemistry and Materials Science	Course code: 21CHE3E2AL
Total Contact Hours: 56	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 h
Summative Assessment Marks: 70	

Course Outcomes (CO's):

1. To Understand the basic and theoretical aspects of nuclear and materials and material applications of chemistry
2. To acquire knowledge on various nuclear reactions.
3. To learn the concept of solid state chemical reactions

At the end of the course, students will be able to:

1. Acquire fundamental and basic knowledge of nuclear reactions and their applications.
2. Able to understand the crystal structure of solids.
3. Able to acquire knowledge on super conductivity and its applications

Unit	Description	Hours
I	**Introduction:** The Atomic nucleus and its outer sphere, Elementary Particles, Sub nucleons -The Quarks, Classification of Nuclides, Nuclear Stability, Nuclear potential, Exchange force, Mass Defect and Binding Energy. **Nuclear models:** Shell model, Liquid drop model, Fermi Gas Model, Optical Model. **Radioactivity:** Radioactive elements, general characteristics of radioactive decay, interaction of α, β and γ-rays with matter. **Units of Radioactivity and its measurements:** Units, scintillation counter, Ionization Counter, Proportional Counter, G. M. counter, Neutron Detectors.	11
II	**Induced Radioactivity**: Nuclear reactions: types of nuclear reactions, reaction cross-section – compound nucleus theory – specific nuclear reactions, Transuranium elements, photonuclear reactions. **Nuclear Fission**: Process of Fission, Fission fragments and their mass distributions, Charge Distribution. **Theory of nuclear fission**: Fission energy, Neutron evaporation & Spallation, Nuclear Fusion, Thermonuclear Reactions. **Nuclear Reactors:** Classification, Critical size of a reactor, Power Reactor, Breeder reactor, Reprocessing of spend fuels, Nuclear power stations in India,Applications of nuclear sciences. Nuclear waste management including waste storage and disposal procedures.Advantages and disadvantages of nuclear reactors. **Applications of Nuclear Chemistry:** Chemical investigation, Analytical applications, Age determinations, Radio dating, Neutron Activation Analysis, Application in medical field.	12

III	**Atomic packing in crystals**: Rules governing atomic packing, effect of radius ratio, Pauling's rules & its application to actual structure, Polymorphism, Isomorphism & solid solutions. **Imperfections in atomic packing:** Types, Point defects, line defects & plane defects. **Mechanical Properties of Crystals:** Classification of properties, Properties of engineering importance, Anisotropy in crystals, Elastic deformation, Plastic deformation. **Phase Diagrams and Phase Transitions:** One Component, Two components, Three component Systems, Simple and Binary Systems, Classification of Phase Transitions, Representation of Phase Transitions, Factors Influencing Rate of Phase Transitions.	11
IV	**Electronic Properties and Band Theory:** **Introduction**: Metals, Insulators and Semiconductors , Electronic Structure of Solids, Band Theory, k-space and Brilliouin zones, Band structure of metals, insulators and semiconductors, Applications of semiconductors. **Magnetic Properties:** Behaviour of substances in a magnetic field, Effect of Temperature, Mechanism of ferro and antiferro magnetic ordering, Permanent Magnets.	11
V	**Optical properties**: Types of luminescence, Luminescence and Phosphorescence, Light-emitting diodes (LEDs), Phosphors,Phosphor thermometry, Thermoluminescence dating, applications. **Lasers**:Laser Types, solid state lasers- Ruby Laser and neodium lasers, construction and working, applications. **Organic Solid State Chemistry:** Electrically conducting organic solids, Organic metals, Conjugated systems, Doped poly acetylene, Polyparaphenylene, Polypyrrole, Organic Charge Transfer complexes and new Super conductors, applications.	12

References:

1. Nuclear Physics by I. Kaplan, Addison – Wiley, Reading Mass, 1963 (IBH).
2. Nuclear Chemistry, Choppin and Rydberg, Pergaman Press.1980
3. Nuclear and Radiochemistry, G. Friedlander, J.W. Kennedy, E.S. Macias and J.M. Miller, Wiley Interscience, NY. 1981
4. Essentials of Nuclear Chemistry, H.J. Arnikar, New Age International Private Limited; Fourth Edition,2011
5. Introduction to Solids, Leonid V. Azaroff, Tata McGraw-Hill New Delhi Tata McGraw Hill Publishing Company Ltd,1960
6. Solid State Chemistry and its Applications, Anthony R West – John Whiley and SonsWiley; 2nd edition, 2022
7. Inorganic Chemistry, C.S.G. Philips and R.J.P. Williams, Oxford Press, Oxford University Press; 1st Edition,1965
8. The Structure and Properties of Materials, R.M. Rose, L.A. Shepard and J.Wulff, Wiley, John Wiley & Sons,1980
9. Introduction to Magneto chemistry, A. Earnshaw, Academic Press 1968
10. Advanced Inorganic Chemistry, F.A. Cotton and G. Wilkinson, Wiley; 6th edition,1999
11. Callister's Material Science and Engineering, R.Balasubramanyam, Wiley and Sons, Wiley; Second edition, 2014
12. New Directions in Solid State Chemistry, CNR Rao and J. Gopalkrishnan, Cambridge University

Date Course Coordinator Subject Committee Chairperson

DSE2: B. Green Chemistry

Course Title: Green Chemistry	Course code: 21CHE3E2BL
Total Contact Hours: 56	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 Hours
Summative Assessment Marks: 70	

Course Outcomes (CO's):

1. Understand the importance of green chemistry
2. Incorporate the principles of green chemistry.
3. Acquire knowledge on renewable energy resources and reagents used for Green synthesis.

At the end of the course, students will be able to:

1. Apply fundamental and basic knowledge of green chemistry in daily life.
2. Able to apply the green chemistry principles in academic, industrial and research

Unit	Description	Hours
I	**Principles & concept of green chemistry:** Introduction, Concept and Principles, development of Green Chemistry, Atom economy reactions, Selection of starting materials, Choice of Catalysts, Choice of Solvents, Designing biodegradable products, Green reaction conditions, Green catalysis, Ionic liquids, Supercritical fluids, Fluorous phase reactions, Energy Requirements for Synthesis, Use of Protecting Groups. Maximum Incorporation of the Reactants, Prevention or Minimization of Hazardous Products, Selection of Starting Materials, Designing of Manufacturing Plants, Strengthening of Analytical Techniques. Heterogeneous catalysis: Advantages and disadvantages and Applications	10
II	**Renewable resources:** Biomass use and biomass potentials **,**Biomass utilization options and conversion technologies, Renewable energy, Fossil fuels, Energy from Biomass, Solar Power, Other forms of renewable energy, Fuel Cells, Alternative economics, Syngas economy, hydrogen economy, Bio refinery chemicals from fatty acids, Polymer from Renewable Resources, Some other natural chemical resources. **Bioenergy systems and chains:** Existing state-of-the-art systems and their performance. Impacts of biomass utilization and potential contribution to sustainable development **Biomass gasification:** Small scale gasification, Overall appraisal of the potentials andchallenges of small gasifiers, Larger scale (CFB) biomass gasification, Gasification for co-firing, Biomass gasification for different markets.	12
III	**Measuring and controlling environmental performance** Importance of measurement, lactic acid production, safer Gasoline, introduction to life cycle assessment, four stages of Life Cycle Assessment (LCA), Carbon foot printing, green process, Matrics-eco labels, Integrated Pollution and Prevention and Control(IPPC)-REACH (Registration, Evaluation, Authorization of Chemicals) **Emerging green technology and alternative energy sources** Design for Energy efficiency-Photochemical reactions, Advantages, Challenge faced by photochemical process. Microwave technology on Chemistry, Microwave heating, and Microwave assisted reactions.	12

IV	**Reagents in Green Chemistry:** **Green reagents:** Dimethylcarbonate,Polymer Supported Peracids, Polymer Supported Chromic Acid,PolymericThioanisolyl Resin, Poly-N-Bromosuccinimide (PNBS) **Green Catalysts:** Acid Catalysts, Oxidation Catalysts, Basic Catalysts, Polymer Supported Catalysts, **Phase Transfer Catalysis in Green Synthesis:** Applications ofPTC in Organic Synthesis, Polymer Supported Phase Transfer Catalysts, Nitriles from Alkyl or Acyl Halides, Alkyl FluQrides from Alkyl Halides, Generation of Dihalocarbenes, Generation of Vinylidene Carbenes **Microwave Induced Green Synthesis:** **Microwave Assisted Reactions in Water**:Hofmann Elimination, Hydrolysis, Oxidation of Toluene, Oxidation of Alcohols, **Microwave Assisted Reactions in Organic Solvents:** Esterification: Reaction of Carboxylic Acid and Alcohol, Esterification: Reaction of Carboxylic Acids andBenzyl Ethers Using $LnBr_3$	12
V	**Green Chemistry Using Bio Catalytic Reactions** **Biocatalysis:** Toxicity measures Need of Green Chemistry in day to day life.The biocatalysis conversions,4 Enzymes Catalysed Hydrolytic Processes, Enantioselective Hydrolysis of Meso Diesters, Hydrolysis of N-acylarnino Acids **Major classes of enzyme reactions**: Oxi-doreductases, Transferases, Hydrolases, Lyases. **Applications:**Sonochemistry and Green Chemistry, Electrochemical Synthesis, Examples of Electrochemical synthesis.	10

References:

1) V. K. Ahluwalia, M. Kidwai, New trends in Green Chemistry, New Age Publications, 2004.
2) P.T. Anastas and J.C. Warner, Green Chemistry, Theory and Practice, Oxford University Press, 2000.
3) Mike Lancaster , Green Chemistry and Introductory text, Royal Society of Chemistry; 2nd edition, 2010
4) P.T.Anastas and J.C Warner,Green Chemistry theory and Practice, Oxford University press, Oxford, 1988.
5) P.Tundo*et. al.*, Green Chemistry, Wiley –Blackwell, London, 2007.
6) T.E Graedel, Streamlined Life cycle Assessment, Prentice Hall, NewJersey,1998.
7) V.K. Ahluwalia,Methods and Reagents of Green Chemistry: An Introduction by Green Chemistry. www.clri.org
8) https://www.unido.org/sites/default/files/2014-10/Gasification_FINAL_0.pdf

Date Course Coordinator Subject Committee Chairperson

DSE2: C. Industrial Inorganic Chemistry

Course Title: Industrial Inorganic Chemistry	Course code: 21CHE3E2CL
Total Contact Hours: 56	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 Hours
Summative Assessment Marks: 70	

Course Outcomes (CO's):

1. Understand the importance and industrial developments based on inorganic chemistry
2. Acquire knowledge on chemistry of agricultural, and building materials
3. Acquint with knowledge for local industries

At the end of the course, students will be able to:

1. Able to acquire the skills required by local industry.
2. Have the basic information on chemicals which are used in daily life

Unit	Description	Hours
I	**Introduction:** Importance of the chemical industry; Primary inorganic materials; Bulk and commodities chemicals; Fine and specialty chemicals; Water and hydrogen; H_2O_2 and inorganic peroxido compounds. **Production of Potable Water**: Break-Point Chlorination and Ozonization, Flocculation and Sedimentation, Removal of Dissolved Inorganic Impurities, Activated Charcoal Treatment, Production of Freshwater from Seawater and Brackish Water, Production by Multistage Flash Evaporation, Production using Reverse Osmosis.	12
II	**Nitrogen and nitrogen compounds:** Ammonia, Synthetic ammonia manufacture, Ammonia synthesis catalyst, Conversion of synthesis gas to ammonia, Ammonia applications, Hydrazine, Manufacture of hydrazine, Rasching process, Urea process, Bayer process, H_2O_2 process, Applications of hydrazine. **Phosphorus and its compounds:** Phosphorus andinorganic phosphorouscompounds, raw materials, products, phosphoric acids, phosphoric acid salts, phosphorous, products manufacture from phosphorous. **Sulfur and sulfur compounds:** Sulphur from elemental deposits, sulphur from H_2S and SO_2, Sulphur from pyrites, manufacture of H_2SO_4 from SO_2, Applications of Sulfuric Acid. **Halogen and halogen compounds:** Fluorspar, Organo fluoro compounds by electrochemical fluorination. Chlorine and Sodium hydroxide manufacture- Mercury process, Diaphragm process, Membrane process, manufacture of hydrogen chloride Electrolysis of HCl, Non-electrolytic process for manufacture of Cl_2, Applications of Chlorine-Oxygen Compounds. Applications of iodine and iodine compounds, Applications for Bromine and Bromine Compounds.	11

III	**Mineral fertilizers;** General Information and Economic Importance. **Nitrogen-Containing fertilizers**: Economic Importance, General Information, Importance of Superphosphate, Triple Superphosphate, Ammonium Phosphates, Manufacture of Thermal (Sinter, Melt)Basic Slag (Thomas) Phosphates. **Phosphorus-Containing Fertilizers**: Superphosphate, Triple Superphosphate, Nitrophosphates- Economic importance of fertilizers **Potassium-Containing fertilizers:** Occurrence of Potassium Salts, Economic Importance, Manufacture of Potassium Chloride, Potassium Sulfate, Potassium Nitratefertilizers. **Metals and their compounds:** Metallic lithium and its compounds; Metallic sodium, sodium borates; Potassium and its compounds, KOH and K_2CO_3.	11
IV	**Alkaline earth metals and its compounds:** General Information and Economic Importance, Beryllium and magnesium; Calcium, strontium and barium; Manganese, manganese compounds and their applications. Industry important organo-silicon compounds, Organohalosilanes, Organoalkoxysilanes, Acyloxysilanes, Oximino- and Aminoxy-Silanes, Amidosilanes, Silazanes, Organohydrogensilanes, Halo-organosilanes. **Silicones:** Linear and Cyclic Polyorganosiloxanes, Manufacture, Hydrolysis Methanolysis Cyclization, Industrial Realization of Polymerization, Silicone Oils, Room Temperature Vulcanizable Single Component Silicone Rubbers, Hot Vulcanizable Peroxide Cross linkable Silicone Rubbers, Silicone Copolymers, Block Copolymers and Graft Copolymers. **Inorganic solid:** Zeolites and catalysts, inorganic fibers; Construction materials; Enamel and ceramics.	12
V	**Carbon modifications:** General Information and Economic Importance, diamond, graphite, carbonization and graphitization; Glassy and foamed carbon; carbon black-Manufacture-Pyrolysis in Presence of Oxygen, Pyrolysis Processes in the Absence of Oxygen, Post treatment, Graphitization of Synthetic Carbon, Acheson Process, Castner Process, Pyrolytic Carbon and Pyrolytic Graphite, Glassy Carbonand Foamed Carbon, Graphite Foils and Membranes, **Fillers** - General Information and Economic Importance, Natural Fillers, Beneficiation of Natural Fillers, Synthetic Fillers, Silicas and Silicates, Pyrogenic Silicas, Wet Chemically Manufactured Silicas and Silicates, Post-treatment of Silicas, Glasses, Cristobalite, Aluminum Hydroxide, Carbonates, Sulfates, applications; Metallic hard materials. **Inorganic pigments:**General Information and Economic Importance,TiO_2, lithopone, ZnS, ZnO and Fe_2O_3; Corrosion protection pigments; Luminescent and magnetic pigments; Conclusions.	12

References:

1. Industrial Inorganic Chemistry by K H Buchel, H -H Moretto, D Werner; Wiley-VCH, 2nd Ed., 2008
2. Inorganic Chemistry: An Industrial and Environmental Perspective by T W Swaddle, AP 1997.
3. Industrial Inorganic Chemistry by Mark Anthony Benvenuto, de Gruyter,2015.
4. B.K. Sharma, Industrial Chemistry, Goel Publishing house, 2000.

Date Course Coordinator Subject Committee Chairperson

GEC 1: A. Analytical Techniques

Course Title: Analytical Techniques	Course code: 21CHE3G1AL
Total Contact Hours: 28 (02 L)	Course Credits: 02
Formative Assessment Marks: 20	Duration of ESA/Exam: 1 Hour
Summative Assessment Marks: 30	

Course Outcomes (COs):

1. Study the basics and fundamentals of analytical techniques
2. Acquire knowledge on spectroscopic techniques for the analysis of simple compounds

At the end of the course, students will be able to:

1. Capable to predict the structure of simple compounds
2. Helps in scientific career

Unit	Description	Hours
1	**Introduction:** Qualitative and quantitative analysis; Concentration terms; Sampling and its Importance **Titrimetric analysis:** Aid base titration-Principle, Indicators Applications for acidity and alkalinity, aspirin Redox titration- Principle, Indicator, Applications for determination of Fe, Vitamin C Precipitation titration- Principle, Indicator, Applications for determination of chloride Complexometric titration: Principle, Indicator, Applications for determination of hardness of water	9
2	**Spectroscopic techniques:** Interaction of electromagnetic radiation with matter, Beer-Lambart's law-Limitations; **UV-Vis-Spectroscopy**: Principle, Instrumentation and applications for determination of composition of metal to ligand; metal ions like Fe, Ti and biological samples **FTIR spectroscopy**: Principle, sample preparation, Instrumentation and applications for determination of functional groups of hydrocarbons, alcohols, carbonyl compounds, amines, etc **Fluorescence Spectroscopy:** Principle and applications	9
3	**NMR Spectroscopy**: Principle, sample preparation, chemical shift, factors affecting chemical shift, Interpretation of spectra and applications for simple molecules **Mass spectroscopy:**Principle, fragmentation process, factors affecting fragmentation, base peak and molecular ion peak, nitrogen rule, Interpretation of spectra and applications for simple molecules. Problems to predict the structure of simple molecules using all the spectroscopic data.	10

References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York, (2005).
2. Analytical Chemistry, G.D. Christian, 5th ed, John Wiley & Sons, Inc, India (2001).
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th Edn, prentice Hall, Inc. New Delhi, 1993.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint. Pearson Education Pvt. Ltd., New Delhi, (2003).
5. Spectroscopy of Organic compounds – P.S. Kalsi, New Age International Publications, New Delhi (6th Edn.), 2007.

Date Course Coordinator Subject Committee Chairperson

GEC 1: B. Separation and Purification Techniques

Course Title: Separation and Purification Techniques	Course code: 21CHE3G1BL
Total Contact Hours: 28 (02 L)	Course Credits: 02
Formative Assessment Marks: 20	Duration of ESA/Exam: 1 Hour
Summative Assessment Marks: 30	

Course Outcomes (COs):

3. Study the basics principles of separation techniques
4. Understand the importance of separation techniques for qualitative and quantitative analysis

At the end of the course, students will be able to:

1. Capable to separate the simple products in a mixture
2. Able to adopt the skills of separation

Unit	Description	Hours
1	**Distillation:** Importance, Principle, methodology, distillation of high boiling solvents, applications **Centrifugation:** Principle and advantages of refrigerator centrifugation **Electrophoresis:** Principle, types of electrophoresis, mobility, Gel and capillary electrophoresis and applications	8
2	**Introduction:** Importance of separation, Classification **Solvent extraction:** Principle, Distribution law, types, methodology, application for the extraction of Fe, Cu **Thin layer Chromatography:** Principle, methodology, RF value, application in identification and monitoring of the reaction **Column chromatography**: Principle, methodology, application in identification and monitoring of the reaction	12
3	**Gas chromatography:** Mobile phase, stationary phase**,** Principle, Components and instrumentation, applications in the analysis of volatile compounds**,** Assay **High Performance liquid chromatography:**Principle, Components and instrumentation, applications in the analysis of volatile compounds**,** Assay and purity	8

References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York, (2005).
2. Analytical Chemistry, G.D. Christian, 5th ed, John Wiley & Sons, Inc, India (2001).
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, prentice Hall, Inc. New Delhi, (1993).
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint. Pearson Education Pvt. Ltd., New Delhi, (2003).

Date Course Coordinator Subject Committee Chairperson

GEC 1: C. Environmental Chemistry and Waste management

Course Title: Environmental Chemistry and Waste management	Course code: 21CHE3G1CL
Total Contact Hours: 28 (02 L)	Course Credits: 02
Formative Assessment Marks: 20	Duration of ESA/Exam: 1 Hour
Summative Assessment Marks: 30	

Course Outcomes (COs):

1. Understand the importance of safe environment
2. Study the Sources and consequences of environmental pollution
3. Importance of management of environment and waste disposal

At the end of the course, students will be able to:

1. Capable to introduce and educate people about the environment
2. Practice and adopt the skills for safe environment

Unit	Description	Hours
1	**Introduction:** Layers of environment, ecosystem, Sources of pollution **Food :** Adulteration and contamination with examples; Milk, butter, Oil, etc **Pharmaceutical products:** Prescription, storage, uses and side effects **Water pollution:** Sources-heavy metal ions, industrial waste, mining waste, domestic and fertilizers, insecticides; Potable water and its requirements	12
2	**Soil pollution:** Causes, Soil erosion, loss of fertility and remedies **Air pollution:** Sources, greenhouse effect, causes and consequences, Control and remedies; Acid rain and its effects; Fog and photochemical fog; Importance of ozone **Preservation of environment:** Forestry, laws of safe environment	8
3	**Waste management:** Types of waste**:** Importance and side effects Recyclability and reusability Disposal of Domestic waste, Industrial waste and construction waste and agricultural waste; Conversion of domestic waste as manure and production of electricity Conversion of solid waste to useful products Reusability of water	8

References:

1. Principles of Instrumental Analysis, Skoog, Holler and Nieman, Harcourt Afca, 2001.
2. Environmental Chemistry – A.K. De, (Wiley Eastern).
3. Environmental Chemistry – S.K. Banerji, (Prentice Hall India), 1993.
4. Chemistry of Water Treatment – S. D. Faust and O. M. Aly, (Butterworths), 1983.
5. Environmental Chemistry – I. Williams, John Wiley, 2001.
6. Food Analysis – A. G. Woodman, McGrawHill, 1971.
7. Foods: Facts and Principles – Shadaksharaswamy and Manay, Wiley Eastern, 1987.
1. A Text Book of Soil Chemical Analysis – P. R. Hesse, CBS Publishers, 1994

Date Course Coordinator Subject Committee Chairperson

SEC 3: Semi-micro Qualitative Inorganic Analysis

Course Title: Semi-micro Qualitative Inorganic Analysis	Course code: 21CHE3S3P
Total Contact Hours: 56 (0-0-4P/week)	Course Credits: 02
Formative Assessment Marks: 20	Duration of ESA/Exam: 4 Hours
Summative Assessment Marks: 30	

Course Outcomes (COs):

1. To be able to identify and separate less familiars ions such as Ti, W, Se, Mo, Ce, Th, Zr, V in addition to common cations and anions
2. Understand the concept of identification of cations and anions

At the end of the course, students will be able to:

1. Able to adopt the separation skills and identification techniques of various inorganic acidic and basic radicals
2. Acquire the skill to analyze and separate common interfering anions such as borate, acetate, phosphate, oxalate, etc.

SL No	List of experiments	Hours
1	**Semi micro Inorganic qualitative analysis (minimum of eight mixtures with three cations (one rare element) and two anions)** (L^{i+}, Mo^{++}, W^{4+}, Zr^{4+}, Ce^{4+}, Ti^{4+}, U^{6+}, Cations and $C_2O_4^{2-}$, CH_3COO^- , BO_3^- , PO_4^{3-} , F^- Anions)	56

References:

1. Vogel's Qualitative analysis, G Svehla and Sivasankar, Pearson press, 7th Ed 2012
2. Quantitative chemical analysis – Daniel, C.Harris, 7th edition, 2006.
3. Vogel's Textbook of Quantitative Chemical analysis, Mendham, Denney, Barnes, Thomas, Sivasankar, 6th Ed, Pearson publishers, 2009
4. A text book of quantitative inorganic analysis- A.I.Vogel, 3rd edition, 1966.
5. Vogel's text book of quantitative chemical analysis – J.Basset, R.C.Denney, G. H. Jeffere and J. Mendhom, 5th edition, 1989.
6. Vogel's Qualitative Inorganic Analysis, revised, G. Svehla, Longman, 7th Ed, 1996.
7. Practical Inorganic Chemistry, Marr and Rocket, 1972.

Date Course Coordinator Subject Committee Chairperson

DSC9 P7: Instrumentation/ Physical Chemistry Practicals

Course Title: Instrumentation/ Physical Chemistry Practicals	Course code: 21CHE3C9P
Total Contact Hours: 56 (0-0-4P/week)	Course Credits: 02
Formative Assessment Marks: 20	Duration of ESA/Exam: 4 Hours
Summative Assessment Marks: 30	

Course Outcomes (CO's):

1. To provide practical training on preparation of different types of metalcomplexes.
2. To determine the concentration of metal ion in the solutions in different types of reactions.

At the end of the course, students will be able to:

1. Able to estimate the amount of metal ion in given solutions
2. Gain hands on experience and knowledge about the synthesis of various metal complexes of different shapes.
3. Able to gain knowledge on hybridization and structures of complexes.

SL No	List of experiments	Hours
1	Flame emission spectrophotometric determination of sodium in pond/lake waters.	4
2	Spectrophotometric determination of Fe	4
3	Spectrophotometric determination of V	4
4	Spectrophotometric determination of Ti.	4
5	Flame emission spectrophotometric determination of potassium in pond/lake waters.	4
6	Determination of Ni spectrophotometrically.	4
7	Separation and determination of total cation concentration by ion exchange chromatography and EDTA	4
8	Separation and determination of total cation concentration by ion exchange chromatography and EDTA.	4
9	Separation of organic compounds by TLC -Acetanilide and Benzoic acid	4
10	Separation of organic compounds by TLC-Benzamide and benzoic acid	4
11	Fluoresence/FT-IR spectroscopic analysis	8

References:

1. Vogel's Qualitative analysis, G Svehla and Sivasankar, Pearson press, 7th Ed 2012
2. Quantitative chemical analysis – Daniel, C.Harris, 7th edition, 2006.
3. Vogel's Textbook of Quantitative Chemical analysis, Mendham, Denney, Barnes, Thomas, Sivasankar, 6th Ed, Pearson publishers, 2009
4. A text book of quantitative inorganic analysis- A.I.Vogel, 3rd edition, 1966.
5. Vogel's text book of quantitative chemical analysis – J.Basset, R.C.Denney, G. H. Jeffere and J. Mendhom, 5th edition, 1989.
6. Vogel's Qualitative Inorganic Analysis, revised, G. Svehla, Longman, 7th Ed, 1996.
7. Practical Inorganic Chemistry, Marr and Rocket, 1972.

Date Course Coordinator Subject Committee Chairperson

DSC10 P8: Quantitative analysis of Organic functional groups

Course Title: Quantitative analysis of Organic functional groups	Course code: 21CHE3C10P
Total Contact Hours: 56 (0-0-4P/week)	Course Credits: 02
Formative Assessment Marks: 20	Duration of ESA/Exam: 4 Hours
Summative Assessment Marks: 30	

Course Outcomes (CO's):

1. Training on quantitative analysis of functional groups in organic compounds
2. Helps to understand the structure and purity.

At the end of the course, students will be able to:

1. Acquire the skills for Quantitative analysis of functional groups by titrimetric methods
2. Able to identify the structure and also purity of compound.

SL No	List of experiments	Hours
1	Estimation of Hydroxyl Group (Alcohols and Phenols)	8
2	Estimation of Acetyl Group (O-acetyl)	4
3	Estimation of Methoxyl Group –Zeisel's Method	4
4	Estimation of carboxyl group	8
5	Estimation of Esters	4
6	Estimation of Amines	4
7	Estimation of Amide Group	4
8	Estimation of Urea	4
9	Estimation of Nitro Group	4
10	Estimation of Acid and ester/ Acid and amide mixture.	12

References:

1. Advanced physicochemical experiments – J. Rose, 1964
2. A Text Book of Quantitative Inorganic Analysis – A.I. Vogel, 5th Edn, 1989.
3. Instrumental Analysis Manual – Modern Experiments for Laboratory – G.G. Guilbault and L.G. Hargis, 1970
4. Quantitative Chemical Analysis – Daniel C. Harris, 7thEdn., 2006.
5. Comprehensive Practical Organic Chemistry- VK Ahluwalia, Renu Aggarwal, 2001

Date Course Coordinator Subject Committee Chairperson

<u>Note:</u> Students should undergo premiere Institutional and Industrial trip for 3-4 days in 3rd Semester for exposure to industries and research institutions.