VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

JNANASAGARA CAMPUS, BALLARI – 583 105

Department of Studies in Chemistry

SYLLABUS

Master of Science
(I-IV Semester)

With effect From
2021-22

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

JNANASAGARA CAMPUS, BALLARI-583105

Department of Studies in Chemistry

Programme: Master of Science (M.Sc.) in Chemistry

Programme Overview:

Duration: 2 Years (4 semesters)

Master of Science (M.Sc.) in Chemistry programme provides fundamental and applied knowledge in Chemistry with hands-on training through laboratory practicals and foster career in teaching, research or industry.

Program Educational Objectives (PEOs):

- Post graduates will demonstrate capability to understand, analyse, develop, and execute the chemical solutions for the current societal requirements through experimental and experiential learning.
- Post Graduates exhibit professionalism and organizational goals with commitment to ethics, team work and respect for everyone.
- Students gets motivated for continuous learning and career development.
- Students impart educational skills and the knowledge in Chemistry in academia, research and industries .

Program Outcomes (POs):

- Discipline knowledge: Capable to apply knowledge of Chemistry and research to understand and solve the societal requirements.
- Solving of problems: Identify, analyse, interpret and develop solutions for problems related to Chemistry in Society.
- Design and Execute chemical systems for different applications

- Apply hands-on training and research knowledge to conduct investigations, interpretation and formulation of solution.
- Application of advanced methodologies in synthesis and analytical techniques for finding solution in various domains.
- Acquire the information on the environmental issues and apply the knowledge to monitor and provide solutions to overcome.
- Able to work individually as well as in teams by institutionalizing the ethical values.
- Motivate for continuous learning and acquire updates in the field.

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

M.Sc. I-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
FIRST	DSC1	21CHE1C1L	Concepts and Models in Inorganic chemistry	30	70	100	4	-	-	4	3
	DSC2	21CHE1C2L	Theoretical Organic Chemistry	30	70	100	4	-	-	4	3
	DSC3	21CHE1C3L	Kinetics and Electrochemistry	30	70	100	4	-	-	4	3
	DSC4	21CHE1C4L	Analytical methods and treatment of data	30	70	100	4	-	-	4	3
	SEC1	21CHE1S1LT	R and D and Quality control	20	30	50	1	1	-	2	2
	DSC1P1	21CHE1C1P	Inorganic chemistry Quantitative analysis	20	30	50	-	-	4	2	4
	DSC2P2	21CHE1C2P	Organic Chemistry qualitative analysis	20	30	50	-	-	4	2	4
	DSC3P3	21CHE1C3P	Kinetics and Electrochemistry	20	30	50	-		4	2	4
Total Marks for I Semester						**600**				**24**	

M.Sc. II SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
SECOND	DSC5	21CHE2C5L	Chemistry of Coordination compounds	30	70	100	4	-	-	4	3
	DSC6	21CHE2C6L	Reaction mechanisms in organic synthesis and Pericyclic reactions	30	70	100	4	-	-	4	3
	DSC7	21CHE2C7L	Electro, Quantum and Photochemistry	30	70	100	4	-	-	4	3
	DSC8	21CHE2C8L	Spectroscopic and Thermal methods	30	70	100	4	-	-	4	3
	SEC2	21CHE2S2LP	Research Methodology	20	30	50	1	-	2	2	2
	DSC5P4	21CHE2C5P	Preparation and analysis of Coordination compounds	20	30	50	-	-	4	2	4
	DSC6P5	21CHE1C6P	Synthesis of organic compounds	20	30	50	-	-	4	2	4
	DSC7P6	21CHE1C7P	Catalysis and photochemistry Practicals	20	30	50	-	-	4	2	4
Total Marks for II Semester						**600**				**24**	

M.Sc. III-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem Exam	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	2
		21CHE3G1BL	B. Separation and purification techniques								
		21CHE3G1CL	C. Environmental Chemistry and Waste management								
	SEC3	21CHE3S3P	Semi micro Qualitative Inorganic analysis	20	30	50	4		4	2	4
	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**	

M.Sc. IV-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
FOURTH	DSC11	21CHE4C11L	Bioinorganic and Organometallic chemistry	30	70	100	4	-	-	4	3
	DSC12	21CHE4C12L	Thermodynamics	30	70	100	4	-	-	4	3
	DSE3	21CHE4E3AL	A. Modern Organic synthesis	30	70	100	4	-	-	4	3
		21CHE4E3BL	B. Natural products of Biological Importance								
		21CHE4E3CL	C. Bioorganic chemistry								
	DSE4	21CHE4E4AL	A. Advanced Chromatographic and Microscopic techniques	30	70	100	4	-	-	4	3
		21CHE4E4BL	B. Applied Analysis								
		21CHE4E4CL	C. Environmental and Biochemical Analysis								
	GEC2	21CHE4G2AL	A. Chemistry for daily life	20	30	50	2	-	-	2	2
		21CHE4G2BL	B. Water and food quality and laws								
		21CHE4G2CL	C. Agro and Environmental Chemistry								
	DSC11P9	21CHE4C11P	Spectral interpretation of data	20	30	50	-	-	4	2	4
	Project	21CHE4C1R	Project work	30	70	100		-	8	4	4
Total Marks for IV Semester						**600**				**24**	

(I-IV semester)- Total Marks: 2400 and Total credits: 96

DSC – Department Specific Core, DSE – Discipline Specific Elective, SEC – Skill Enhancement Course, GEC – Generic Elective Course, IA – Internal Assessment, SEE – Semester End Examination, L – Lecture, T – Tutorial, P – Practical.

M.Sc. Chemistry First Semester

Course: Concepts and Models in Inorganic Chemistry	Course Code: 21CHE1C1L
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 30 Marks	**Semester End Examination:** 70 Marks

Course Objectives:

1. Acquisition of skills in Inorganic Chemistry.
2. To impart essential theoretical knowledge on atomic structure, periodic properties and chemical bonding.
3. To develop the ability to correlate the chemical and physical properties of elements and their compounds with their positions in the periodic table.
4. Understand the theories in Inorganic Chemistry

Unit-I: Periodic properties and Ionic bond

Review of periodic properties- atomic size, ionization potential, electron affinity and electro negativity.

Ionic Bond:

Ionic bond-properties of ionic compounds, ionic radii, factors affecting ionic radii, radius ratio rules, types and structures of simple ionic compounds, lattice energy, Born-Lande equation, Kapustinskii equation, Born-Haber cycle-applications, size effects, polarizing power and polarizability of ions, Fajan's rule, covalent character in ionic compounds, solubility of ionic solids and hydration energy. **[8 hrs]**

Unit-II: Covalent Bond and Metallic Bond

VBT approach, VSEPR-shapes of molecules, concepts of resonance and hybridization, Energetics of hybridization, partial ionic character, covalent coordinate and multicentre bonding, M.O theory-LCAO approach, σ, δ and π molecular orbits. M.O treatment of homonuclear and heteronuclear diatomic molecules, Bond order in delocalized π- bonding systems, Ex: CO_3^{2-}, NO_3^- and SO_3. Metallic bonding – electron sea model, VBT.

Coordination numbers, factors affecting coordination numbers, stereochemistry of coordination compounds. Non-stoichiometry, metal-metal bonding and cluster compounds.

[12hrs]

Unit-III: Chemistry of S and P-Block Elements

Alkali metals, alkaline earth metals and their complexes, crown ethers, oxides of alkali metals. Synthesis, properties and structure of boron hydrides, boranes, borazines, boron-phosphorus and boron-arsenic compounds.Oxides and oxy acids of nitrogen, phosphorus, sulphur and halogens.Interhalogen compounds and noble gas compounds, silicates and zeolites.

[12 hrs]

Unit-IV: Chemistry of d and f Block Elements

Chemistry of 3d,4d and 5d elements- trends in properties and spectral and magnetic behavior; stability of oxidation states and Catalytic properties. Chemistry of lanthanides and actinides-trends in physical and chemical properties, lanthanide contraction- causes and

consequences.stereochemistry, magnetic and spectral behavior, synthesis and separation of trans-uranium elements, super heavy elements, Applications of Lanthanides. **[12hrs]**

Unit-V: Acid – Base Concept

Introduction different definitions, types of reactions, solvent systems and leveling effect.Generalized acid-base concept-basicity of metal oxides, hydration and hydrolysis.Measurement of acid – base strengths. Steric affects-back strain, front strain and internal strain. Solution effects with respect to liquid ammonia, anhydrous sulphuric acid, acetic acid and liquid sulphur dioxide, acetic acid, HF, N_2O_4, super acids and molten salts. HSAB-classification & strength of hardness and softness.Irving-William's series.Theoretical basis of hardness and softness. **[12hrs]**

REFERENCES

1. Inorganic Chemistry by Catherine E. Housecroft& Alan G. Sharpe 2nd Edition (2021)
2. Inorganic Chemistry by James E House (2021).
3. Inorganic Chemistry -5th Edition by Shriver & Atkins(2020).
4. Basic Inorganic Chemistry – 3rd edition, F.A Cotton, G.Wilkinson and P.L.Gaw, John wiley and sons (2002).
5. Inorganic chemistry – James E Huheey, Harper and Row Publishers (2004)
6. Concepts and Models of Inorganic Chemistry – 3rd edition, B.E Douglas, D.H. Mc Daniel and Alexander, Wiley (2001)
7. Inorganic Chemistry – 2nd edition, D.F Shriver, P.W.Atkins and C.H.Langtore Oxford University Press (1994).
8. Chemistry of Elements – N.N. Greenwood and A.Earnshaw, Pergaman (2000).
9. Inorganic Chemistry – 2nd edition, C.E Housecraft and A.G Sharpe, Pearson Education Ltd. (2005).
10. Concise Inorganic Chemistry – J.D. Lee, ELBS 3rd edition (2017).

Course outcomes:

1.	Identify the nature of bonding exists between various elements.
2.	Apply fundamental chemical theories in interpretation of complex systems
3.	Interpret and apply the properties of s, p, d and f block elements for different applications.
4.	Apply the theories of acid base in Chemical reactions

Course: Theoretical Organic Chemistry	Course Code: 21CHE1C2L
Teaching Hours/Week (L-T-P): 4 - 0 - 0	**No. of Credits:** 04
Internal Assessment: 30 Marks	**Semester End Examination:** 70 Marks

Course Objectives:

1. To understand basic and fundamental theoretical aspects of organic chemistry.
2. To study the nature of bonding and aromaticity in organic compounds.
3. Evaluate the molecular geometry, hybridization and polarity of organic molecules.
4. To acquire the knowledge of substitution reactions occurring in organic molecules.
5. To understand electron delocalization and its effect on stability and reactivity

Unit-I: Nature of bonding in organic compounds and aromaticity

Concepts of bonding, hybridization-geomerty and shape of simple molecules.Delocalized chemical bonding, conjugation, Cross conjugation, resonance hyperconjugation, bonding in fullerenes, Tautomerism.

Aromaticity in the benzenoid and non-benzenoid compounds.Alternant and non-alternant hydrocarbons, *Hückel's* rule.The energy level of π M.O., Annulenes, anti-aromaticity, aromaticity, Homo aromaticity.

Bonds weaker than covalent, addition compound, crown ether complexes, and cryptands, Inclusion compound, cyclodextrins, Catananes& rotaxanes. **[8hrs]**

Unit-II: Stereochemistry

Elements of symmetry, concepts of chirality, optical isomerism, projection formulae, *Fisher*, *Sawhorse*, *Newman* and *Flying* wedge formulae and their inter-conversion, optical isomerism due to one or more than one chiral centers. Threo and erythro isomer, enantiomers, diastearic isomers, and epimers.

Optical activity in the absence of chiral carbon – Biphenyls and spiranes,

Optical isomerism of nitrogen compounds, conformational analysis of (cyclic and acyclic systems) – ethane, butane, mono & di-substituted cyclohexanes.

Geometrical isomerism – isomerism in ketoximes, aldoximes and Beckmann rearrangement.

[12hrs]

Unit-III: Aliphatic nucleophilic and electrophilic substitution reactions

Aliphatic Nucleophilic Substitution:

S_N2, S_N1, mixed S_N2 and S_N1 and SET mechanisms. The neighboring group mechanism, neighboring group participation by π and σ bonds.Common carbocation rearrangements.The $S_Ni$mechanism.Nucleophilic substitution at an allylic, aliphatic, trigonal, and vinylic carbon.Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis, ambident nucleophile, and regioselectivity.

Aliphatic Electrophilic Substitution:

Bimolecular mechanisms-$S_E2$and S_E1, electrophilic substitution accompanied by double bond shifts. Effect of substrates and the solvent polarity on the reactivity. **[12hrs]**

Unit-IV: Aromatic nucleophilic and electrophilic substitution reactions.

Aromatic Nucleophilic Substitution:

S_NAr, S_N1, benzyne, and $S_{RN}1$ mechanisms, Reactivity-effect of substrate structure and attacking nucleophile.The VonRichter, Sommelet-Hauser, and smiles rearrangements.

Aromatic Electrophilic Substitution:

The arenium ion mechanism, orientation,and reactivity, energy profile diagrams.The ortho/para ratio, ipso attack, orientation in other ring systems.

Quantitative treatment of reactivity in substrates and electrophiles. *Vilsmeyer* reaction, *Gattermann-Koch* reaction. **[12hrs]**

Unit-V: Reactive Intermediates and Named reactions

Types of mechanism, methods of determination of reaction mechanism-cross over experiments, product analysis, intermediates, isotopic labelling, stereochemical studies, thermodynamic and kinetic studies.

Reactive intermediates: Generation, stability, and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes, and nitrenes.

Named reactions and rearrangements: Aldol, Perkin, Dickman condensation, Hofmann, Schmidt, Lossen, Curtius rearrangements, Reimer-Tiemann reaction, Wittig reactions and (Mechanism with examples). **[12hrs]**

REFERENCES:

1. March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structureby Michael B. Smith , Jerry March 6th edition (2021).
2. Organic Chemistry by Paula Bruice 8th edition (2016).
3. Reaction mechanism in organic chemistry – S.M Mukharji & S.P Singh (1984).
4. Stereochemistry of Organic Compounds, Second Ed., D. Nasipuri, New Age International, (2005).
5. Stereochemistry of Organic Compounds, E. L. Eliel and S. H. Wilen, Wiley India, (2008).
6. Organic Chemistry, J. Clayden, N. Geeves and S. Warren, Oxford University Press, (2012).
7. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman, (1985).
8. Advanced Organic Chemistry: Reactions, Mechanism, and Structure, March, Jerry, 6th edition, John Wiley, (2007).
9. Advanced Organic Chemistry, Carry, F. A.; Sundberg, R.J., 3rd edition, Plenum, (1990).
10. A Guide Book to Mechanism in Organic Chemistry, Sykes, Peter, 6th edition, Longman, (1989).
11. Organic Chemistry ,Morrison, R. T.; Boyd, R. N., 6th edition, Prentice Hall, (1992).
12. Organic Reactions and their Mechanisms,Kalsi, P. S., 2nd edition, New Age International Publishers, (2000).
13. Named reaction in organic chemistry – Surrey 2nd edition(1961).
14. Retrosynthesis to Asymmetric synthesis, Authors: Šunjić, Vitomir, Petrović Peroković, Vesna

Course outcomes:

1.	Acquire the basic and fundamental aspects of organic chemistry reactions.
2.	Interpret the molecular geometry, hybridization and polarity of organic molecules
3.	Recognize the existence of stereoisomerism and conformational analysis
4.	Capable to predict the mechanism of substitution reactions
5.	Apply the knowledge in nomenclature, identification of organic compounds

Course: Kinetics and Electrochemistry	Course Code: 21CHE1C3L
Teaching Hours/Week (L-T-P): 4- 0 - 0	**No. of Credits:** 04
Internal Assessment: 30 Marks	**Semester End Examination:** 70 Marks

Course objectives:

1. To understand physical phenomenas like Chemical thermodynamics and Chemical kinetics.
2. To study the nature of kinetics of reactions and electrochemical reactions.
3. Evaluate the basics and applications chemical thermodynamics.
4. To acquire the knowledge of catalysis and electrochemistry in solution state.
5. To understand basics of corrosion, corrosion control and its applications,

Unit- I:Chemical Thermodynamics:

A brief resume of laws of thermodynamics, Concepts of entropy and enthalpy, concept of fugacity and free energy, entropy and free energy changes and spontaneity of processes. Variation of free energy with T & P. Maxwell's relations, thermodynamic equations of state, limitations of Van't Hoff's equation, Nernst Heat theorem & its applications.

Application of Thermodynamics:

Partial molar quantities, partial molar volume and free energy (chemical potential), their significance and determinations. Gibbs- Duhem and Duham-Margules equations (statement and derivation)

Thermodynamics of Ideal Solutions:

Deductions of Raoult's law for ebullioscopy, cryoscopy and osmotic pressure. Thermodynamic treatment of Le-Chatelier principle.

Thermodynamics of Non-ideal Solutions: Activity, activity coefficient-standard states.

[12hrs]

Unit-II: Chemical Kinetics

Theories of Reaction Rates:

Activated complex theory and its applications in solution reaction. Theory of unimolecular reactions- Lindeman, Hinsel-Wood and RRKM theory

Chemical Kinetics:

Complex reactions- parallel, consecutive and reversible reactions. Chain reactions (H_2-halogen reactions). Branched chain reactions- general rate expression. Photochemical (H_2-halogen reactions)

Reactions in Solution:

Ionic reactions - salt and solvent effects. Substituent effects on the rates of reactions, linear free energy relationships - Hammett and Taft equations.

[12 hrs]

Unit-III: Catalysis

Homogeneous catalysis-equilibrium and steady state treatments, activation energies of catalyzed reactions. Acid-base catalysis, measurements of catalytic activity. Kinetics of enzyme catalyzed reactions-Michaelis- Menten equation. Effect of pH, temperature & inhibitors. Industrial applications of catalysts.

Surface Reaction Kinetics:

A review of adsorption isotherms, Gibb's adsorption isotherm, multilayer adsorption-BET equation (derivation)- application in surface area determination. Harkin-Jura equation (derivation)-application. Heterogeneous catalysis-catalytic activity at surfaces.

[12 hrs]

Unit-IV: Electrochemistry - I

Electrochemistry of Solutions:

Ionic atmosphere, physical significance of k (Cuppa), Faraday's laws of electrolysis, Debye-Huckel limiting law, Debye-Huckel equation for appreciable concentration. Huckel and Bronsted equation. Qualitative verification of Debye-Huckel equation, Ostwald's dilution law, Bjerrum theory of ion association- triples ion- conductance minima.

[8 hrs]

Unit-V:Corrosion Science

Corrosion- Introduction, definition, examples. General mechanism, Factors affecting corrosion reactions. Types of corrosion with examples. Electrochemical theory of corrosion of iron metal, Hydrogen embritlement and passivation of metals

Corrosion control: Metal coatings (Galvanisation and Tinning process), inhibitors. Cathodic Protection, Anodic protection and Electrochemical methods of protection.

Industrial Corrosion: Corrosion in Boiler, Acidic corrosion, Alloying and dealloying. Corrosion in petrochemical industries.

[12hrs]

REFERENCES:

1. The Laws of Thermodynamics Peter Atkins (2010)
2. *Atkins' Physical Chemistry 11th Edition* Peter Atkins, Julio de Paula, James Keeler (2018).
3. PhysicalChemistry,Atkins(ELBS), 5^{th}Ed (1995).
4. PhysicalChemistry-G.M.Barrow,McGrawHill,Int.St.Ed(1988).
5. FundamentalsofPhysicalChemistry-MaronandLando, CollierMacmillan, (1974).
6. ThermodynamicsforChemists-S.Glasstone, East-west,(1973).
7. Themodynamics-RajaramandKuriokose(East-West) (1986).
8. ChemicalKinetics-K.J.Laidler,HarperandRow,(1987).
9. Electrochemistry-Glasstone,AffiliatedtoEast-West, Press,(1942).
10. PrinciplesandApplicationsofElectrochemistry-Crow, Chapmanhall,London, (1988).
11. Engineering Chemistry, P.C. Jain and Monica Jain, Dhanpat Rai Publications, New Delhi (2015).
12. Introduction to Corrosion Science, E. Mc Cafferty, Springer, (2010).

Course outcomes:

1.	Able to analyse Thermodynamics as well as kinetics of reactions.
2.	Evaluate the kinetics of chemical reactions with step wise mechanisms
3.	Apply of thermodynamics to ideal and non ideal solutions
4.	Integrate the knowledge of catalysis, multilayer adsorption and surface reactions
5.	Interpret the electrochemical behaviour in solution state and surface
6.	Analyse and solve the corrosion process

Course: Analytical Methods and Treatment of data	Course Code: 21PHY1C4L
Teaching Hours/Week (L-T-P): 4- 0 - 0	**No. of Credits:** 04
Internal Assessment: 30 Marks	**Semester End Examination:** 70 Marks

Course Objectives:

1. To understand the concepts of classical methods of analysis like titirmetry, gravimetry.
2. To gain knowledge of purity and separation techniques
3. To acquire basics of electroanalytical techniques
4. To inculcate the skills for chemical analysis and treatment of data

Unit – I: Errors and Sampling

Analytical techniques and methods, method validation, Limitations of analytical methods. Classifications of errors, accuracy, precision, minimization of errors, significant figures and computations, mean, relative and standard deviation, distribution of random errors, relativity of results. Confidence interval, comparison of results, comparison of the means of two samples, Significance tests Q-test, F-test, Paired t-test for the number of replicate determinations, comparison of more than two means (analysis of variance),.Correlation and regression, linear regression, Least square method. Analysis- Calibration, standard addition, internal standardisation, internal normalization, external standardisation. Quality control and quality assurance. Importance of sampling, the basis of sampling, sampling procedure, sampling statistics, sampling and physical state, crushing and grinding, hazards in sampling. **[12 hrs]**

Unit – II: Titrimetic analysis:

Acid base titrations:

Principle, role of solvent in acid-base titrations, effect of concentration. Titration curves for strong acid - strong base, weak acid – strong base, weak base –strong acid, Poly protic acids, poly equivalent bases, determination of equivalence point – theory of acid base indicators, colour change range of indicators.Applications for nitrogen, nitrates and carbonates andorganic functional groups like carboxylic acid, sulphonic acid, amine, ester, hydroxyl, carboxyl groups.

Oxidation –Reduction Titrations:

Redox process-balancing redox equations, titration curves .Redox indicators, detection of end point, visual indicators and potentiometric end point detection. Quantitative applications-adjusting the analyte's oxidation state, determination of chemical oxygen demand (COD) in natural and waste waters and other applications. Titrations of mercaptans and ascorbic acid with I_3^- and titration of organic compounds using periodate. Karl Fischer reagent for water determination.

Complexometric Titrations:

Introduction, complexation reaction, titration curves, types of EDTA titrations, titrations of mixtures, selectivity, masking and demasking agents, metal ion indicators, some practical considerations.Applications of EDTA titrations- hardness of water, magnesium and aluminium in antacids, magnesium, manganese and zinc in a mixture. **[12hrs]**

Unit- III: Precipitation and Gravimetric analysis:

Precipitation Titrations:

Precipitation reactions, titration curves, factors influencing the sharpness of end points, completeness of the reaction. Chemical indicators - Volhard, Mohr and Fajan's methods. Precipitation titrations involving silver nitrate. Applications.

Organic Reagents in Inorganic Analysis:

Organic precipitants, general properties, reagents as precipitants (DMG, 8-hydroxy quinoline, acetyl acetone, etc).

Gravimetric analysis:

Introduction, precipitation methods, the colloidal state. Requirements & conditions of precipitations, co-precipitation, post precipitation, nature of the precipitate, super saturation, precipitation from homogeneous solution and effect of excess of precipitant, temperature, pH and complex formation on completeness of precipitation, washing the precipitate and peptization. Fractional precipitation, organic precipitants, volatilization or evolution methods. Filtration, washing, drying and ignition of precipitates. **[8 hrs]**

Unit-IV: Separation Techniques

Basic separation techniques in analysis, classification.

Solvent Extraction:

Principle, distribution law. Choice of solvents for extraction, factors affecting extraction-pH and oxidation state, masking and salting out agents. Techniques-batch, continuous and multiple extractions and synergic extraction. Applications

Paper and thin layer Chromatography:

General principles and mechanism, classification of chromatographic methods-paper, thin layer, column and liquid chromatography. Selection of stationary and mobile phases, preparation of micro and macro plates, development, spray reagents, identification and detection, reproducibility of Rf values, qualitative, quantitative analysis and applications of TLC.

Ion Exchange Chromatography:

Definitions, requirements for ion exchange resin, principle, basic features of ion exchange reactions, types of ion exchange resins, ion exchange capacity, resin selectivity. Synthesis and factors affecting the selectivity. Process of elution and Applications in preparative, purification and recovery processes.

[12 hrs]

Unit – V: Electroanalytical techniques

Introduction and requirements

Conductometry:

Theory- Measurement of Conductivity - Basis for Conductometric titrations. Conductometry as an analytical tool.

Potentiometry:

Principles, Reference electrodes, indicator electrodes, selective electrodes, Membrane electrodes. Glass electrodes for the measurement of cations other than hydrogen,pH measurement, measurement of cell emf - potentiometric titrations.Solid state electrodes, liquid membrane electrodes. Ion-selective field effect transistors (ISFETS). Gas sensing electrodes. Chemical and environmental applications. Potentiometric titrations- acid-base, precipitation and redox titrations. Null-point potentiometry.

Voltametry :

Polarography - Direct current and AC Polarography - Theory - Dropping Mercury Electrode-Quantitative technique - Measurement of Wave Heights - Pulse Polarography - Rapid Scan Polarography. Applications-electrochemical reversibility and Stripping Voltametry - Cyclic Voltametry-Principles and applications. Modified electrodes. Voltammetry with micro electrodes.

Amperometry : Pricnciples, amperometric titrations with examples. Biamperometry.

Electrogravimetry: Theory, completeness and nature of the deposit, instrumentation, electrolytic separation of metals and applications. **[12 hrs]**

REFERENCES:

1. Analytical Chemistry 2.1David Harvey, DePauw University (2016).
2. Analytical Chemistry by Gary D. Christian,7th Edition , (2014).
3. Fundamentals of Analytical Chemistry D.A Skoog, D.M West, Holler and Crouch, Saunders College Publishing, 8th edition, (2005).
4. Analytical Chemistrym G.D Christian, John Wiley and Sons Inc, 5th edition, (2001)
5. Vogel's Test book of Quantitative Chemical Analysis, J. Mendham, R.C Denny, J.D Barnes and M.J.K Thomas, 6th edition, (2003).
6. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, (2000).
7. Instrumental Methods of Analysis, H.H Willas, L.L Merritt and J.A Deay, 7th edition, (1988).
8. Instrumental Methods of Analysis, W.M Dean and Settle, 7th edition, (1986).

Course outcomes:

1.	Apply basic analytical methods for chemical analysis
2.	Evaluate and treat the analytical data
3.	Apply the separation techniques in separation and purification
4.	Design and interpret the analytical data

Course: R &D and Quality control	Course Code: 21CHE1S1LP
Teaching Hours/Week (L-T-P): 1- 1 - 0	**No. of Credits:** 02
Internal Assessment: 20 Marks	**Semester End Examination:** 30 Marks

Course Objectives:

1. Students acquire basic knowledgeable industries and research**.**
2. To understand the functioning of Research and Development and quality control.

Unit-I: Research and Development

Industry: Types of chemistry related industries; Sections and responsibilities

Research & Development:

Importance, Process development & product development, In-house failure and addressing; Design & executions of reactions.

Chemistry software: Chemdraw ; Scifinder; Computational Chemistry(Docking)

Production: Control & Execution; Testing of In-house failure products.

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[10 hrs]

Unit-II: Quality Control & Quality Assurance

Quality Control:

Functions & Responsibilities , Method development and validation, analytical parameters –LOD, LOQ

Quality Assurance:

Functions & Responsibilities. 6 sigma concept and ISO accreditation. Total Quality Management perspective, methodologies and procedures; Roadmap to TQM, ISO 9000, KAIZEN, Quality Circles, Models for organizational excellence

Application of Software tools and Case Studies.

Intellectual Property rights and Pharmaceuticals

[10 hrs]

Unit-III: Safety practices and Environmental treatment plant

Safety Apparels in Industries: Precautions, Safety Apparels, handling of toxic and explosives, first aid in case of emergency and medications.

Environment treatment plant: Regulatory requirements, control, monitoring and treatment of treatment liquid and solid waste treatment; Recovery, incineration and Toxic metals treatment.

Preparation for the interview:

How to face an interview?.

[8 hrs]

REFERENCES:

1. Research Design: Qualitative, Quantitative and Mixed Methods Approaches by Creswell (2014).
2.Research Methods: A Practical Guide For Students And Researchers 1st Edition.
3.Perfect Quality Assurance & Quality Control Paperback – Import, 19 by Ram Babu Sao November (2016).
4. Essential environment Jay H. Withgott 09 September (2021).

5. How to Write the Perfect Resume: Stand Out, Land Interviews, and Get the Job You Want by Dan Clay.

Course outcomes:

1.	Design new reactions
2.	Analyse and interpret the analytical data
3.	Skills for industries

Course: Inorganic Chemistry Quantitative analysis	Course Code: 21CHE1C1P
Teaching Hours/Week (L-T-P): 0 - 0 - 4	**No. of Credits:** 02
Internal Assessment: 20 Marks	**Semester End Examination:** 30 Marks

Course Objectives:

1. Hands-on training for quantitative estimation using volumetric and gravimetric analysis.
2. Understand the importance of determination of common metallic traces affecting the biological system.
3. Understand and appreciate common useful methods of detection of traces of elements.

List of Experiments:

1. Determination of iron using $KMnO_4$ (0.02M) and ceric ammonium sulphate (0.02M) as titrants.
2. Determination of calcium using $KMnO_4$ (0.02M) as titrants.
3. Determination of copper volumetrically using KIO_3.
4. Estimation of calcium and magnesium carbonates in dolomite solution using EDTA titration.
5. Estimation of lead using EDTA titration.
6. Gravimetric analysis of sulphate with barium.
7. Gravimetric analysis of iron.
8. Determination of nickel gravimetrically using dimethyl glyoxime.
9. Separation and determination of two metal ions, iron and nickel by volumetric and gravimetric methods.
10. Separation and determination of two metal ions, copper and iron by volumetric and gravimetric methods.
11. Separation and determination of two metal ions, calcium and iron, by volumetric and gravimetric methods.
12. Determination of Aluminium by EDTA method.

REFERENCES

1. A text book of quantitative inorganic analysis- A.I.Vogel, 3rd edition, 5th edition. .
2. Quantitative chemical analysis – Daniel, C.Harris, 7th edition,(2006).

Course Outcomes:

1.	Analyse binary and complex mixtures of metallic ions by volumetric and gravimetric methods
2.	Design procedure for the quantification of inorganic compounds in various samples
3.	Analyze an experimental procedure and suggest improvements.
4.	Interpret the analytical data to comply with regulatory standards

Course: Qualitative Analysis of Organic Binary Mixtures	Course Code: 21CHE1C2P
Teaching Hours/Week (L-T-P): 0- 0 - 4	**No. of Credits:** 02
Internal Assessment: 20 Marks	**Semester End Examination:** 30 Marks

Course Objectives:

1. Expose to simple synthetic procedures in the laboratory.
2. Correlate theoretical concepts for preparing, purifying, and identifying organic molecules.
3. Comply with safety rules in conducting laboratorial experiments.
4. To identify the components through various steps, derivative preparation, checking the purity of components.

List of Experiments

1. Systematic qualitative analysis and separation of organic binary mixtures (solid + solid) and their identification through various steps, derivative preparation, checking the purity of components by melting point (minimum 10 mixtures).

NOTE: In the examination, a candidate has to separate the binary mixture and analyze one component indicated by the examiner.

REFERENCES

1. Macroscale and Microscale Organic Experiments, K. L. Williamson, D. C. Heath, 7th Ed., (2011).
2. Qualitative Analysis of Organic Compounds byA.I. Vogel 4thEdition.
3. Vogel's Textbook of Practical Organic Chemistry, Ed. 5, Longman, (1989).
4. Experiments and Techniques in Organic Chemistry, Pasto, Johnson and Miller, Prentice Hall, (1992).
5. Systematic Qualitative Organic Analysis, H. Middleton, Edward Arnold.
6. Handbook of Organic Analysis-Qualitative and Quantitative, H. Clark, Adward Arnold.

Course outcomes:

1.	Analyse and separate complex organic mixtures
2.	Design experimental approach for purification of organic compounds
3.	Develop methodology for synthetic reaction and characterization
4.	Hands on training in determining melting point , boiling point, TLC etc

Course: Kinetics and Electrochemistry Practicals	Course Code: 21CHE1C3P
Teaching Hours/Week (L-T-P): 0- 0 - 4	**No. of Credits:** 02
Internal Assessment: 20 Marks	**Semester End Examination:** 30 Marks

Course Objectives:

1. Study Kinetics of chemical reactions
2. To understand varied solvents interaction by phase formation mechanism
3. Analysis of samples using conductometric techniques

List of Experiments

1. Study of kinetics of hydrolysis of an ester using HCl/H_2SO_4 at two different temperatures, determination of rate of constants and energy of activation.
2. Study of kinetic reactions between $K_2S_2O_8$ and KI, first order, determination of rate constants at two different temperatures and Energy of activation.
3. Conductometric titration of mixture of HCl and CH_3COOH against NaOH.
4. Conductometric titration of mixture of HCl and CH_3COOH and $CuSO_4$ against NaOH.
5. Conductometry-To determine the degree of hydrolysis and hydrolysisconstant of aniline hydrochloride.
6. Conductometric titration of potassium iodide with mercuric perchlorate.
7. Phase diagram for Three component liquid system, acetic acid, benzene and water.
8. Kinetics of dissociation of trichloroacetic acid.

REFERENCES

1. Experimental Physical Chemistry: A Laboratory Textbook, A. Halpern & G. McBane III Ed. W. H. Freeman (2006)
2. Practical Physical Chemistry- A.J.Findlay (2007).
3. Experimental Physical Chemistry-F.Daniel et el (2006).
4. Selected Experiments in Physical Chemistry- Latham (1974).
5. Experimental Physical Chemistry- Janes and Parichard 3rd edition (1974).
6. Experimental Physical Chemistry- Shoemaker 5th edition (1989).
7. Experimental Physical Chemistry- Yadav, Goel Publishing House.
8. Experimental Physical Chemistry- Das R.C and Behera B., Tata Mc Graw Hill.

Course outcomes:

1.	Skills in analysis of physical properties of materials and reactions
2.	Analyse and interpretation of physical properties
3.	Designing of methods for ionic substances
4	Evaluate the kinetics of reaction

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

JNANASAGARA CAMPUS, BALLARI-583105

Department of Studies in Chemistry

SYLLABUS

Master of Science

(I-IV Semester)

With effect from:

2021-22

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

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
SECOND	DSC5	21CHE2C5L	Chemistry of Coordination compounds	30	70	100	4	-	-	4	3
	DSC6	21CHE2C6L	Reaction mechanisms in organic synthesis and Pericyclic reactions	30	70	100	4	-	-	4	3
	DSC7	21CHE2C7L	Electro, Quantum and Photochemistry	30	70	100	4	-	-	4	3
	DSC8	21CHE2C8L	Spectroscopic and Thermal methods	30	70	100	4	-	-	4	3
	SEC2	21CHE2S2LP	Research Methodology	20	30	50	1	-	2	2	1.5
	DSC5P4	21CHE2C5P	Preparation and analysis of Coordination compounds	20	30	50	-	-	4	2	4
	DSC6P5	21CHE2C6P	Synthesis of organic compounds	20	30	50	-	-	4	2	4
	DSC7P6	21CHE2C7P	Electro, photochemistry and Catalysis Practicals	20	30	50	-	-	4	2	4
Total Marks for II Semester						**600**				**24**	

Dept Name: Chemistry

Semester-II

DSC5: Chemistry of Coordination compounds

Course Title: **Chemistry of Coordination compounds**	Course code: 21CHE2C5L
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 general characteristics of the d and f block elements, organometallic compounds, metal carbonyls and metal clusters, thorough knowledge of the different theories to explain the bonding in coordination compounds.
2. To study the nature of various metal complexes and calculate various parameters.
3. Study the existence of stereoisomerism in transition metal complexes.
4. To study the magnetic and spectral properties of metal complexes.
5. To understand electron delocalization and its effect on stability and reactivity

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

1. The subject is designed to strengthen the basic knowledge in the field of complex chemistry and to impart recent advances in the transition metal complex chemistry.
2. Acquisition of knowledge of Geometry, Magnetic and Spectral Properties of Metal Complexes.
3. Will gain in-depth knowledge of d and f block elements, coordination compounds and organometallic compounds which is essential for future career and competitive exams.

Unit	Description	Hours
1	**Metal-Ligand Bonding** **Review of bonding theories:** **Valence Bond Theory (VBT):** Coordinate covalent bonding in metal complexes, applications of VBT in tetrahedral, Square-planar and Octahedral complexes, Limitations of VBT. **Crystal Field Theory (CFT): S**alient features, crystal field splitting of d orbitals in octahedral, tetrahedral, tetragonal and square planar fields. Magnitude of Δ, factors affecting Δ, crystal field stabilization energy (CFSE),effects of crystal field splitting. Spectrochemicalseries, nephelauxetic series, short comings of CFT, evidences for covalence character, John-Teller distortion in metal complexes. **Molecular Orbital Theory (MOT): T**reatment of co-ordination compounds involving σ and π bondings.	12
2	**Spectral Properties of Complexes:** Term symbols for d^n ions, spectroscopic ground states, selections rules, nature	8

	of spectral bands-band shapes and bond intensities, band widths, effect of spin orbit coupling, Orgel diagrams, Tanabe-Sugano diagrams, Racah parameters, interpretations of spectra of octahedral, distorted octahedral, tetrahedral and square planar complexes. Calculations of nephelauxetic parameter, Charge transfer bands, Interference of charge transfer bands.	
3	**Geometry and Magnetic Properties of Metal Complexes:** **Geometry**: Stereochemistry, coordination numbers 3 to 8, isomerism in metal complexes, geometrical isomerism, optical isomerism, coordination isomerism, ionization isomerism, linkages isomerism. **Magnetic Properties of Metal Complexes:** Types of magnetic behavior, classical magnetism, orbit coupling, measurement of magnetic susceptibility-Gouy and Faraday methods, diamagnetic corrections, ferro and anti-ferro and ferri magnetism, spin cross-over systems.	12
4	**Metal-Ligand Equilibria in Solution:** Step-wise and over-all formation constant and their relationships, trends in step-wise constant, kinetic and thermodynamic stability of metal complexes, factors affecting the stability of metal complexes with reference to the nature of the metal ion and ligand, chelate and macro cyclic effects and their thermodynamic origin, determination of binary formation constants by pH meter, spectrophotometry, polarography and by ion exchange methods.	12
5	**Reaction Mechanisms in Transition metal Complexes:** Energy profile of a reaction, inert and labile complexes. Kinetics of octahedral substitution and Mechanistic aspects, substitution reactions in square planar complexes, trans effect, molecular rearrangements of four and six coordinated complexes. **Electron Transfer Reactions (Redox Reactions):** Inner and outer sphere mechanisms, one electron, two electron, complimentary and non complimentary electron-transfer reactions.	12

References:

1. Shriver and Atkin's Inorganic Chemistry, Atkins, Overton, Rourke, Weller, Armstrong, 5th Ed, Oxford University press, (2012).
2. Concise Coordination Chemistry, R Gopalan and V Ramalingam, Vikas Publishing House Pvt Ltd., New Delhi, (2005).
3. Basic Inorganic Chemistry, F.A.Cotton, G.wilkinson and P.L.Gau, Jhon Wiley and sons, Inc, 6th edition, (1999).
4. Inorganic Chemistry,J.E.Huheey, E.A.Keiter and R.L.Keiter, 4thedn,(1993).
5. Chemistry of the Elements, N.N.Greenwood and A.E.Earnshaw, Buttrerworth Heilemann, (1997).
6. Essential Trends in Inorganic Chemistry, D.M.P.Mingos, Oxford univ press,(1998).
7. Chemistry of Complex Equilibria, M.T Beck, Rinhold, London, (1990).
8. Magnetochemestry, R.L.Carlin, Springer VerlagVolume92, Issue3 ,März,(1988).
9. Coordination Chemistry, Fred Basolo and Ronald C. Johnson, Wiley, New

York, (1984).

Date Course Coordinator Subject Committee Chairperson

DSC6: Reaction mechanisms in organic synthesis and Pericyclic reactions

Course Title: **Reaction mechanisms in organic synthesis and Pericyclic reactions**	Course code: 21CHE2C6L
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 instruct students on the fundamental concepts of organic chemistry as well as their applications.
2. To understand the heterocyclic compounds and natural compounds which comprise the major part of organic chemistry.
3. To gain the useful knowledge on various reaction mechanism and structural activity of organic compounds.
4. To acquire advance knowledge of carbon-carbon and carbon-hetero atomic bonds.
5. To study the various useful organic reagents used in pharmaceutical industries for synthesis of drugs.
6. To acquint with principles of pericyclic reactions and their progress forward or backwards.
7. Cycloaddition reactions and Sigmatropic reactions and rules governing them.

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

1. Get familiarize with heterocyclic compounds, natural products and reagents in organic synthesis. Heterocyclic compounds play an important role in pharmaceuticals.
2. Interpret the concept of reaction mechanism in the transformation from reactant to product.
3. Interpret the mechanistic and stereochemical aspects of carbon-carbon bonds and carbon-hetero atomic bonds.
4. Able to use various reagents in organic synthesis and functional group transformation.
5. Capable to design pericyclic reaction and carry out these types of reaction.

Unit	Description	Hours
1	**Reaction mechanism and structure reactivity** **Reaction mechanism**: Types of mechanism, types of reactions, thermodynamics and kinetic requirement. Kinetic and thermodynamics control, *Hammond's* postulate, *Curtin-Hammett* Principle, Potential energy diagrams, transition states and intermediates, method of determining mechanisms, isotope effects. **Free radical reactions**: Types of free radical reactions, free radical substitution mechanism at an aromatic substrate, neighboring group assistance. Reactivity for aliphatic and aromatic substrates at a bridge-head. Reactivity of the attacking radicals. The effect of solvents on reactivity. Coupling of alkynes and arylation of aromatic compounds by diazonium	12

	salts.*Sandmeyer* reaction.Free Radical Rearrangement. *Hunsdiecker* reaction. **Elimination reactions:** The E2, E1, and E1cB mechanisms and their spectrum. Orientation of the double bond. Reactivity effects of substrate structure, attacking the base, the leaving group, and the medium.	
2	**Reactivity of carbon-carbon multiple bonds:** Mechanistic and stereochemical aspects of addition reaction involving electrophiles, nucleophiles, and free radicals. Regio, and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring.Hydrogenation of double and triple bonds, hydrogenation of aromatic ring. Hydroboration.Michael reaction.Sharpless asymmetric epoxidation.	8
3	**Reactivity of carbon-hetero multiple bonds** Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters, and nitriles. Addition of *Grignard* reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. *Wittig* reaction.Mechanism of condensation reactions involving enolates-Aldol, *Knoevenagel*, *Claisen, Mannich,* Benzoin, *Perkin,* and *Stobbe*reactions.Hydrolysis of esters and amides, ammonolysis of esters.	12
4	**Reagents in Organic Synthesis** Use of following reagents in organic synthesis and functional group transformation **1.** Dicyclohexylcarbodiimide (DCC) **2.** Woodward and Prevost hydroxylation **3.** 2,3-Dichloro-5,6-dicyano-1,4-benzoquinone (DDQ) **4.** Phase transfer catalysis **5.** Crown ethers **6.** Dess–Martin periodinane (DMP) **7.** Merrifield resin **8.** Peterson's synthesis **9.** Wilkinson's catalyst **10.** Gilman's reagent **11.** Ziegler–Natta catalyst .	12
5	**Pericyclic reactions** Definition, classifications of Pericyclic reactions. Molecular orbital symmetry, Frontier orbital of ethylene, 1,3 butadiene, 1.3.5-Hexa triene, and allyl systems. Woodward and Hoffmann correlation diagram. FMO & PMO approach, electrogatic reactions-conrotator, and disrotatory motions, 4n, 4n+2, and allyl systems. Cycloaddition – antrafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes. 1, 3 dipolar cycloadditions and cheleotropic reactions. Sigmatropic rearrangements, superfacial and antrafacial shifts of H., shifts involving carbon moieties, 3, 3-and 5, 5 – sigmatropic rearrangements, Claisen, Cope, and Azo cope rearrangements.	12

References:

1. March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 7th

Edition, Michael B. Smith, WILEY, (2013).

2. Advanced Organic Chemistry PART A and PART B., F. A. Carey and R. J. Sundburg, Springer (2007).
3. Organic Chemistry, J. Clayden, N. Geeves and S. Warren, Oxford University Press, (2012).
4. Organic Chemistry, Morrison, Boyd and Bhattcharjee, &th Edition, Pearson, (2010).
5. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman, (1985).
6. Pericyclic Reactions, S. M. Mukherji, Macmillan, India, (1980).
7. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan., (1984).
8. Advanced Organic Chemistry: Reaction Mechanism, R Bruckner, Harcourt (India) Pvt. Ltd., (2001).
9. Reactions Mechanism in Chemistry, Vol. I, II, III, Mukherji, S.M.; Singh, S.P. Macmillan, (1985).
10. Stereochemistry of Organic Compounds, Nasipuri, D. 2nd edition New Age International Publishers, (1994).
11. Stereochemistry of Organic Compounds, Kalsi, P.S. 2 edition, New Age International,
12. Stereochemistry: Conformation and Mechanism, Kalsi, P.S., 2nd edition, Wiley Eastern Limited, (1993).
13. Textbook of Organic Chemistry-R.J.Moorism and Boyd 7^{th} edition.
14. Textbook of Advanced Organic Chemistry-Arun Bhal,(2010).

Date Course Coordinator Subject Committee Chairperson

DSC7: Electro, Quantum and Photochemistry

Course Title: **Electro,Quantum and Photochemistry**	Course code: **21CHE2C7L**
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 theoretical and basic aspects of basics and applied electrochemistry
2. To acquire knowledge of quantum chemistry.
3. To learn the concept of photochemistry

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

1. Acquire fundamental and basic knowledge of electrochemistry and apply for electrochemical systems
2. Able to understand the photochemistry principles and reactions
3. Able to apply quantum chemistry approaches in different reactions.

Unit	Description	Hours
1	**Theortical Electrochemistry and Energy sources** Debye-Huckel theory of strong electrolytes, Debye Huckel – Onsager equation, Debye – Huckel limiting equation for activity coefficients. Debye-Falkenhagen effect, Electrical double layer and its thermodynamics. A brief survey of Helmholtz – Perrin, Gouy – Champman and Stern electrical double layer, liquid junction potential and its determination. Molar ionic conductance and Stokes's law. **Electrochemical energy sources** – Batteries, characteristics, classification-primary, secondary. Fuel cells: working principle (H_2-O_2, CH_3OH-O_2), Applications	8
2	**Irreversible Electrode Process:** Introduction, reversible and irreversible electrodes, Ohmic overvoltage, concentration overvoltage, activation overvoltage. Hydrogen over voltage and oxygen over voltage. Effect of temperature, current density and pH on over voltage. Experimental determination of over voltage. Equations for concentration over potential, diffusion current, stationary current, ionic product of water, Solubility product.Polarography-half wave potential, application in qualitative and quantitative analysis. Energy barrier and electrode kinetics, Buttler-Volmer equation, Tafel equation.	12

3	**Quantum Mechanics:** Wave-particle duality of material particles, de Broglie equation, Heisenberg uncertainty principle. Concept of operators (operator – operand), algebra of operators, commutative and non commutative operators, linear operators, Laplacian operator, Hamiltonian operator, Eigen value, Eigen function, Hermitian operator. Postulates of quantum mechanics, Schrodinger wave equation for particles. Applications of Schrodinger equation for particle in one and three dimentional box. Application of Schrodinger equation to rigid rotator and harmonic oscillator. Perturbation theory, method-first order and second order correction, application to He – atom (first order correction only)-calculation of first ionization, potential and binding energy. Variation theorem statement and derivation.	12
4	**Photochemistry:** Introduction to photochemistry, photochemical laws, Absorption and emission, Jablonski diagram, Singlet and triplet states, Origin of energy difference between singlet and triplet states, selection rules for electronic transition. Laws of photochemistry, Franck-Condon principle, fluorescence, phosphorescence, Factors affecting Fluorescence and Phosphorescence, Life time of an excited state. Stark-Einstein law of photochemical equivalence, Photosynthesis, quantum yield and its determination, factors affecting quantum yield, Excimer and exciplex, Quenching.	12
5	**Applied Photochemistry:** Term symbols and its significance, Photochemical reactions, Photo oxidation and photo reduction, Effect of light intensity on the rate of photochemical reactions. Photosensitization, photochemical kinetics of: decomposition of CH_3CHO, formation of HCl. Photochemical reactions and its types, Photochemical formation of smog, Stern-Volmer equation (derivation). Photodegradation: photocatalyst-ZnO, TiO_2, principle, application of ZnO/TiO_2. Actinometry-uranyloxalate and potassium ferrioxalate actinometres. Flash Photolysis and its applications, Quantum efficiency. Photochemistry of carbonyl compounds.	12

References:

1. Atkins' Physical Chemistry, Peter Atkins and Julio Paula, Oxford University Press; 10th Ed,(2014).
2. Physical Chemistry- A molecular approach, Donald Mcquarie and John Simon, Viva, 1st Ed, (2010).
3. Physical Chemistry, Ira N Levine, Tata Mcgraw-Hill Education; 6 Ed. (2011).
4. Elements of physical chemistry–Lewis and Glasstone.
5. Physicalchemistry–P.W.Atkins, ELBS,fourth edition (1990).
6. Introductiontoelectrochemistry-S.Glastone.
7. Modernelectrochemistry, Vol I&II, J.O.M.Bockris and A.K.N.Reddy, (1970).
8. Quantum Chemistry, Ira N Levine, Pearson Education, 7th Ed. (2013).

9. Introductory Quantum Chemistry, A. K. Chandra, Tata McGraw-Hill (1998).
10. Quantum Chemistry, R. K. Prasad, New Age International (2001).
11. Quantum Chemistry, Ira N Levine, Pearson Education, 7th Ed. (2013).
12. Fundamentals of Photochemistry ,K. K. Rohatgi and K. K. Mukherjee;, 3rd ed. New Age International (P) Ltd, (2014).
13. Modern Molecular Photochemistry of Organic Molecules ,N. J. Turro, V. Ramamurthy and J. C. Scaiano, 1st ed. University Science, Books, CA, (2010).
14. Photochemical Synthesis, Ninomiya, T. Naito, 1st ed. Academic Press, New York, (1989).

Date Course Coordinator Subject Committee Chairperson

DSC8: Spectroscopic and Thermal methods

Course Title: **Spectroscopic and Thermal methods**	Course code: **21CHE2C8L**
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 theoretical and basic aspects of symmetry and group theory related to spectroscopy
2. To study interaction of electromagnetic radiation with matter.
3. To apply spectroscopic techniques for quantitative analysis
4. To acquire knowledge on thermal methods of analysis

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

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

Unit	Description	Hours
1	**Group Theory and Symmetry:** Symmetry elements & Symmetry operations, groups, subgroups, cyclic groups, conjugate relationships, classes, molecular point groups, Hermann-Maugin symbols for point groups. Schoenflies notations, matrix representations of symmetry operation, matrix representations of groups. Reducible and Irreducible representations, characters of representations. The great orthogonality theorem, character tables (Cs, Ci, C2, C2v, C2h and C3v) and Multiplication tables (C_{2v}, C_{2h}, C_{3v})– their construction. Mullikan symbols, molecular models. Determination of vibration modes, hybridization, molecular orbitals on the basis of group theory.	12
2	**Electromagnetic radiation and quantitative aspects:** Characterization, quantization of energy levels, regions of electromagnetic radiation, spectrum – interaction electromagnetic radiation with matter – representation of spectra, intensity and width of spectral lines. Quantitative aspects of absorption – Beer- Lambert's law, Terminology associated with absorption measurements. Theory of molecular absorption.Vibration- rotation fine structure of electronic spectra. Criteria for spectrophotometric determinations with examples (Fe, Mo and Ni). Limitations of the law.	8
3	**UV-Visible Spectroscopy:** Types of absorption bands, modes of electronic transitions, simple chromophoric –auxochrome theory. Solvent effect and choice of solvent. Prediction of λ-max value by using Wood-Ward and Fieser rules for conjugated diens, trienes and cyclic α, β unsaturated aldehydes and ketones,	12

	benzene and substituted benzene rings. Instrumentation (single beam and double beam spectrophotometers). Quantitative and Qualitative applications of UV-Visible spectroscopy in structural and molecular weight determination, Determination of stoichiometry and stability of the complexes, Analysis of binary mixtures(Cr and Mn), measurements of dissociation constants of acids and bases. Photometric titrations and kinetic studies. Method of colour measurement for of NH_3, Cr, Cu, Fe, Mn.	
4	**Inorganic spectral Methods:** **Flame Photometry and Atomic Absorption Spectrometry:** Principles and Theory - Instrumentation - Flames - Burners - Nonflame Techniques - Spectral and Chemical Interferences - Experimental Aspects. Total consumption and premix burners, role of temperature on absorption, emission and fluorescence. Comparative study of the basic components and difference in the instrumental design for atomic absorption and flame photometry. Analytical applications of AAS- determination of mercury. **Atomic Emission Spectrometry and Inductively Coupled Plasma:** Principles and Instrumentation - Excitation source, Limitations of AES, interferences. Effect of organic solvents. Principles of Plasma Spectroscopy - Excitation Source in ICP -Applications. **Nephelometry and Turbidometry:** Tyndall, Rayleigh and Raman Scattering - Principles, Instrumentation and Applications. Light scattering in nephelometry and turbidimetry.Choice between nephelometry and turbidimetry, tubidimetry and colorimetry, nephelometry and fluoromtry. Theory effects of concentration, particle size and wavelength on scattering. Applications: Determination of $SO4_{2-}$, Turbidimetric titrations.	12
5	**Thermal Methods of Analysis** **Thermo Gravimetric Analysis:** Introduction, thermogravimetric analysis(TGA) – types of thermo gravimetric analysis, principles, Automatic thermogravimetric analysis, instrumentation, types of recording thermobalances, sample holders, factors affecting the results – heating rate, furnace instrument control/data handling. Applications- purity and thermal stability, evaluation of correct drying temperature, analysis of complex mixture and determination of kinetic parameters of thermal degradation. **Differential Thermal Analysis (DTA):** Theory , variables affecting the DTA, general principles, instrumentation, applications – analysis of the physical mixtures and thermal behavior study, determination of decomposition point. Simultaneous DTA-TGA curves, factors affecting results, and applications. **Differential Scanning Calorimetry (DSC):** Basic principle, differences between DTA and DSC, instrumentation – power compensated DSC, heat flux DSC, applications – studies of thermal transistors and isothermal crystallization, pharmaceutical industry for testing the purity of the samples. **Thermometric titrimetry** (Acid-Base, precipitation, Complexation, redox	12

	and non- aqueous titrations) and direct injection enthalpimetry-principle, instrumentation, applications.	

References:

1. Atomic and Molecular Spectroscopy: Basic Concepts and Applications, Rita Kakkar, Cambridge University Press, (2015).
2. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York, (2005).
3. Analytical Chemistry, G.D. Christian, 5th ed, John Wiley & Sons, Inc, India (2001).
4. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, prentice Hall, Inc. New Delhi, (1993).
5. 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).
6. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, (1990).
7. Principles and Practicals of Analytical Chemistry, F. W. Fifield and Kealey, 3rd edition, Blackwell Sci., Ltd. Maiden, USA, (2000).
8. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, (2000).
9. Introduction to Instrumental Analysis, Robert. D. Braun, Pharm. Med. Prem. India, (1987).
10. Instrumental Method of Analysis, W. M. Dean and Settle, 7th edition, CBS Publishers, New Delhi,(1986).
11. Instant Notes of Analytical Chemistry, Kealey and Haines, Viva books Pvt. Ltd., (2002).
12. Basic Concepts of Analytical Chemistry, S.M.Khopkar, New Age Intrenational 3rd edition, (2008).
13. Chemical Applications of Group Theory, F. A. Cotton, John Willey & Sons, 3rd Ed. (2008).
14. Symmetry and Spectroscopy of Molecules, K. Veerareddy, Revised II Ed., New age international, 2020.

Date Course Coordinator Subject Committee Chairperson

SEC 2: Research Methodology

Course Title: **Research Methodology**	Course code: 21CHE2S2LP
Total Contact Hours: 28 (01 L-0-2P)	Course Credits: 02
Formative Assessment Marks: 20	Duration of ESA/Exam: 1h
Summative Assessment Marks: 30	

Course Outcomes (COs):

1. To Understand the importance and requirement of research
2. To do literature survey and data collection

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

1. Capable to cultivate research knowledge skills
2. Apply the knowledge and data collection methods in experiments and research work

SEC 2: Research Methodology

Unit	Description	Hours
1	**Introduction to Research** Nature and importance of research- Aims, Objectives and Principles: Fundamental research vs. applied research with examples: Qualitative vs Quantitative research: Theoretical research vs. experimental research with examples: Selection of a research problem and Sources of literature – Journals, Conferences, Books. Types of sources: Literature Survey engines- Scopus, web of Science, Google Scholar, PubMed, NCBI, Scihub, etc. Science citation index: Citations, h-index, i10 index, impact factor.	8
2	**Methods of Data Collection** Data Collection Methods- Framing a hypothesis, designing controlled experiments, choosing the sample-size, sampling bias, importance of independent replicates, conducting an experiment, maintaining a lab-notebook to record observations: Identifying experimental errors. Case-studies on well-designed experiments vs. poorly designed experiments. Correlations vs. Causation .Good laboratory Practices. Safety practices in laboratories; Introduction to Chemdraw, Chemsketch and other basic softwares.	8
3	**Data analysis (Practical)** **Data Presentation and Writing:** Technical presentation, technical writing, Formatting citations ; MS Excel for plotting the data (pie chart, plots, bar charts) **Analysis using software tools:** Descriptive Statistics: Mean, standard deviation, variance, plotting data and	12

	understanding error-bars. Curve Fitting: Correlation and Regression. Distributions: Normal Distribution, Gaussian distribution, skewed distributions. Inferential Statistics: Hypothesis testing and understanding p-value. Parametric tests: Student's t-test, ANOVA. Tests to analyse categorical data: Chi-square test.	

References (indicative)

1. C.R. Kothari, Research Methodology: Methods and Techniques, II Ed. New Age International Publishers, (2009).
2. Shanthibhushan Mishra, Shashi Alok, Handbook of Research Methodology, I Ed, 2017, Educreation Publishers.
3. Basic Statistical Tools in Research and Data Analysis (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5037948/).
4. Introduction to statistical methods with MATLAB (MATLAB and Simulink Training (mathworks.com).

DSC5 P4: Preparation and analysis of Coordination compounds

Course Title: **Preparation and analysis of Coordination compounds**	Course code: 21CHE2C5P
Total Contact Hours: 56 (0-0-4P/week)	Course Credits: 02
Formative Assessment Marks: 20	Duration of ESA/Exam: 4 h
Summative Assessment Marks: 30	

Course Outcomes (CO's):

1. To provide practical training on preparation of different types of metal complexes.
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	Preparation of Mercury tetrathiocyanatocobaltate(III) and analysis of cobalt.	
2	Preparation og Chloropentammine cobalt (III) chloride and analysis of Cobalt and chloride	
3	Preparation of Nickel (II) salicylaldoxime and analysis of nickel.	
4	Preparation of Copper (II) acetyl acetone and analysis of copper.	
5	Preparation of Tris thiourea copper (I) sulphate complex and analysis of copper.	
6	Preparation of Hexammine cobalt (III) chloride and analysis of cobalt.	
7	Preparation of Potassium bisoxalato cuprate (II) dehydrate and analysis of copper.	
8	Preparation of Potassium trisoxalatoferrate (III) and analysis of iron.	
9	Preparation of Nickel (II) Schiff's base complex and analysis of nickel	

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.

DSC6 P5: Synthesis of organic compounds

Course Title: **Synthesis of organic compounds**	Course code: 21CHE1C6P
Total Contact Hours: 56 (0-0-4P/week)	Course Credits: 02
Formative Assessment Marks: 20	Duration of ESA/Exam: 4 h
Summative Assessment Marks: 30	

Course Outcomes (CO's):

1. Train and expose to simple synthetic procedures in the laboratory.
2. To introduce different experiments to develop the skills and strategic approaches for organic Synthesis.
3. To determine physical constants and purification of synthesized organic compounds by Recrystallization techniques.
4. To demonstrate synthesis and TLC to monitor a reaction.

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

1. Students learn various synthetic methodologies and able to detect the functional group by preparation of a suitable derivative.
2. Developed skills provide confidence of handling simple laboratory synthetic experiments in research and industries.
3. Develop hands on expertise to design and conduct the experiments independently

SL No	List of experiments	Hours
1	To determine corrected melting points of an unknown organic compound (calibration of thermometer).	
2	Preparation of Adipic acid from cyclohexanol (oxidation).	
3	Reimer Tiemann reaction (preparation of Salicylaldehyde β-hydroxynaphthaldehyde)	
4	Preparation of acetanilide from Acetophenone.(Beckmann Rearrangement)	
5	Preparation of 7-hydroxy-4-methyl coumarin(Pechmann reaction) from resorcinol	
6	Preparation of benzyl alcohol and benzoic acid (*Cannizzaro's* reaction).	
7	N- Bromo succinimide (Bromination).	
8	Dibenzal acetone from benzaldehyde (*Claisen-Schmidt* reaction).	
9	Cinnamic acid from benzaldehyde (*Knoevenaegal* reaction).	
10	Preparation of Acetanilide, bromoacetanilide, bromoaniline.	
11	Diphenylmethane from benzylchloride (*FriedelCraft's* reaction).	
12	Preparation of Benzanilide (*Schotten-Baumann* reaction).	
13	O-Benzoylbenzoic acid (*Friedel Craft's* reaction).	
14	Preparation of indigo from Anthranilic acid.	

References:

1. Macroscale and Microscale Organic Experiments, K. L. Williamson, D. C. Heath, 7th Ed., 2011.
2. Comprehensive practical organic chemistry preparation and quantitative analysis-Ahluwalia.V.K.and Renu Agarwal, University Press, Hyderabad (LCS edition 2000).
3. Comprehensive practical organic chemistry-quantitative analysis-V.K.Ahluwalia and university press-Hyderabad.
4. Advanced practical organic chemistry – N.K.Vishnu, second revised edition, Vikas Publication (2000).
5. Advanced practical organic chemistry – D.P.Agarwal, Goel Publishing house, Meerut (U.P).
6. Quantitative & qualitative organic analysis, A.I.Vogel (CBS Publishers, New Delhi-2002).

DSC7 P6: Electro, photochemistry and Catalysis Practicals

Course Title: **Electro, photochemistry and Catalysis Practicals**	Course code: 21CHE1C7P
Total Contact Hours: 56 (0-0-4P/week)	Course Credits: 02
Formative Assessment Marks: 20	Duration of ESA/Exam: 4 h
Summative Assessment Marks: 30	

Course Outcomes (CO's):

1. To gain hands-on expertise in the study of electrochemical techniques like potentiometry.
2. To obtain skills and conduct the spectroscopic experiments

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

1. Capable to correlate the theoretical approach with practical aspects.
2. Acquire expertise in instrumental techniques for industrial and research career.

SL No	List of experiments	Hours
1	Potentiometric titration of KI vs $KMnO_4$ solution.	
2	Potentiometric titration of Fe(II) vs Ce(IV).	
3	To obtain the absorption spectra of colored complexes, verification of Beer's law	
4	Spectrophotometric titration of FeS_{O4} against KMn_{O4}.	
5	Adsorption of acetic acid on charcoal	
6	Adsorption of Oxalic acid on activated charcoal	
7	Potentiometric determination of available chlorine in bleaching powder.	
8	Determination of dissociation constant of weak acid by conductance method	
9	Conductometric determination of equivalent weight and $K_a$for a weak acid.	
10	Estimation of metal ions in solution using spectrophotometer. (Fe, Ni, etc)	

References:

1. Experimental Physical Chemistry- Athavale V.D, New Gae International Publishers, 2001.
2. Experiments in Physical Chemistry- Carl W Garland; Joseph W Nibler; David P Shoemaker, Mcgraw Hill, 8th Ed, 2009
3. Findlay's Practical Physical ChemistryB P Levitt, Longman, Green and Co,9th Ed, 1973.
4. Experimental Physical Chemistry-F.Daniel et el., 7th Ed, Mcgraw hill, 1970
5. Selected Experiments in Physical Chemistry- Latham, 1964.
6. Advanced Practical Physical Chemistry- Yadav, Krishna Prakashan Media, 2015.

Date Course Coordinator Subject Committee Chairperson

CBCS Question Paper Pattern for PG Semester End Examination with Effect from the AY 2021-22

Disciplines Specific Core (DSC) and Discipline Specific Elective (DSE)

Paper Code: **Paper Title:**

Time: 3 Hours **Max. Marks: 70**

Note: Answer any *FIVE* of the following questions with Question No. 1 (Q1)Compulsory, each question carries equal marks.

Q1. 14 Marks

Q2. 14 Marks

Q3. 14 Marks

Q4. 14 Marks

Q5. 14 Marks

Note: Question No.1 to 5, *one question from each unit* i.e. (Unit I, Unit II, ….). The Questions may be a whole or it may consists of sub questions such as a,b, c etc…

Q6. 14 Marks

Note :Question No.6, *shall be from Unit II and III,* the Question may be a whole or it may consists of sub questions such as a,b, c etc…

Q7. 14 Marks

Note: Question No.7*, shall be from Unit IV and V*, the Question may be a whole or it may consists of sub questions such as a,b, c etc…

Q8. 14 Marks

Note: Question No-8 shall be from *Unit II, Unit III , Unit IV and Unit V*.

The question shall have the following sub questions and weightage. i.e a – 05 marks, b – 05 marks, c – 04 marks.

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Skill Enhancement Courses (SECs)

Paper Code: **Paper Title:**
Time: 1 Hours **Max. Marks: 30**

There shall be Theory examination of Multiple Choice Based Questions [MCQs] with Question Paper set of A, B, C and D Series at the end of each semester for SECs for the duration of One hour (First Fifteen Minutes for the Preparation of OMR and remaining Forty-Five Minutes for Answering thirty Questions). The Answer Paper is of OMR (Optical Mark Reader) Sheet.

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Question Paper Pattern for Subjects with Tutorial

For the subjects with Tutorial component, there is no Semester-End Examination (SEE) to the component C3. The liberty of assessment of C3 is with the concerned faculty. The faculty must present innovative method of evaluation of component C3 before the respective BoS for approval and the same must be submitted to the Registrar and Registrar(Evaluation) before the commencement of the academic year.

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VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY
JNANASAGARA CAMPUS, BALLARI-583105

Department of Studies in Chemistry

SYLLABUS

Master of Science
(I-IV Semester)

With effect from:
2021-22

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

M.Sc. III-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem Exam	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	15	35	50	2	-	-	2	2
		21CHE3G1BL	B. Separation and purification techniques								
		21CHE3G1CL	C. Environmental Chemistry and Waste management								
	SEC3	21CHE3S3P	Semi micro Qualitative Inorganic analysis	20	30	50	-	-	4	2	4
	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**	

M.Sc. IV-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
FOURTH	DSC11	21CHE4C11L	Bioinorganic and Organometallic chemistry	30	70	100	4	-	-	4	3
	DSC12	21CHE4C12L	Thermodynamics	30	70	100	4	-	-	4	3
	DSE3	21CHE4E3AL	A. Modern Organic synthesis	30	70	100	4	-	-	4	3
		21CHE4E3BL	B. Natural products of Biological Importance								
		21CHE4E3CL	C. Bioorganic chemistry								
	DSE4	21CHE4E4AL	A. Advanced Chromatographic and Microscopic techniques	30	70	100	4	-	-	4	3
		21CHE4E4BL	B. Applied Analysis								
		21CHE4E4CL	C. Environmental and Biochemical Analysis								
	GEC2	21CHE4G2AL	A. Chemistry for daily life	15	35	50	2	-	-	2	2
		21CHE4G2BL	B. Water and food quality and laws								
		21CHE4G2CL	C. Agro and Environmental Chemistry								
	DSC11P9	21CHE4C11P	Spectral interpretation of data	20	30	50	-	-	4	2	4
	Project	21CHE4C1R	Project work	30	70	100		-	8	4	4
Total Marks for IV Semester						**600**				**24**	

(I-IV semester)- Total Marks: 2400 and Total credits: 96

DSC – Department Specific Core, DSE – Discipline Specific Elective, SEC – Skill Enhancement Course, GEC – Generic Elective Course, IA – Internal Assessment, SEE – Semester End Examination, L – Lecture, T – Tutorial, P – Practical.

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 h
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 region, applications of IR spectroscopy in the structural elucidation of organic.	10

	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 h
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 (P) Ltd (1 January 2015)

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: 3H
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.	11

	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.	
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: 3H
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),	12

	structure determination from PXRD, Xray photoelectron spectroscopy. 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: 3H
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.	12

	Importance of colloids, Applications of colloid and surface science in petroleum recovery, coating and painting, food, pharmaceutical and cosmetic industry.	

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:**	12

	Chemical investigation, Analytical applications, Age determinations, Radio dating, Neutron Activation Analysis, Application in medical field.	
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 Press; 2nd edition,1997.
13) V.J. Bortolot, Daybreak Corporation; "The Limits of TL", Michel Brent, Archaeology Magazine, Volume 54, Number 1, 2001.

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 h
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 resourcesand 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 and challenges of smallgasifiers, 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	12

	photochemical process. Microwave technology on Chemistry, Microwave heating, and Microwave assisted reactions.	
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 h
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,	11

	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.	
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, HydrolysisMethanolysisCyclization, 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, Posttreatment, Graphitization of Synthetic Carbon, Acheson Process, Castner Process,Pyrolytic Carbon and Pyrolytic Graphite, Glassy Carbon and 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: 15	Duration of ESA/Exam: 2h
Summative Assessment Marks: 35	

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: 15	Duration of ESA/Exam: 2h
Summative Assessment Marks: 35	

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: 15	Duration of ESA/Exam: 2h
Summative Assessment Marks: 35	

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: 4h
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 h
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 h
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

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

Dept. Name: Chemistry
Semester-IV

DSC11: Bioinorganic and Organometallic chemistry

Course Title: Bioinorganic and Organometallic chemistry	Course code: 21CHE4C11L
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. Understand the various aspects and concepts of bioinorganic chemistry.
2. Study the synthesis, properties and stability aspects of organometallic compounds.
3. Understand biologically important metal ions.

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

1. Gain advanced knowledge on biological functions of metal ions and their importance.
2. Able to understand the transportation of oxygen in biology.
3. Understand the synthesis and practical applications of organometallic compounds

Unit	Description	Hours
I	**Metal Ions in Biological Systems:** Outline of metal ions in biology, Essential and types metals, active transport of Na and K, ionophore. **Metal Functions in Metalloprotein:**Dioxygen Transport, Electron Transfer, Structural Roles for Metal Ions. **Metalloprotein as enzymes** – carboxy peptidase, (catalases, peroxidases, cytochrome P450, copper oxidases), vitamin B_{12} coenzyme, enzyme action inhibition and poisoning. Synthetic model compounds, Interactions of Metal Ions and Nucleic Acids, Metal-Ion Transport and Storage, Metals in Medicine, **Metalloenzyme Function:** Hydrolytic Enzymes, Two-Electron Redox Enzymes, Multielectron Pair Redox Enzymes, Rearrangements. **Metals in medicine** – Metal deficiency (Fe, Mn, Cu and Zn), chelation therapy and metal complexes as drugs.	12
II	**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 and transferrin, Electron transfer proteins – cytochromes and iron sulphur proteins. **Iron-Containing Proteins and Enzymes:** **Introduction:** Iron-Containing Proteins with Porphyrin, Ligand Systems, Myoglobin and Hemoglobin, Myoglobin and Hemoglobin Basics, Structure of the Heme Prosthetic Group, Behavior of Dioxygen Bound to Metals , Structure of the Active Site in Myoglobin and Hemoglobin, Binding of CO to Myoglobin, Hemoglobin, and Model Compounds. **The Frontiers of Bioinorganic Chemistry:** Choice and Uptake of Metal Ions, Control and Utilization of Metal-Ion Concentrations, Metal Folding and Cross-Linking, Binding of Metal Ions to Biomolecules, Electron-Transfer Proteins, Substrate Binding and Activation, Atom- and Group-Transfer Chemistry, Protein Tuning of the Active Sites.	11

III	**Group I and II Metals in Biological Systems:** **Homeostasis and Group I Biomolecules:** Homeostasis of Metals (and Some Nonmetals), Phosphorus as Phosphate, Potassium, Sodium, and Chloride Ions, Calcium Homeostasis. **Group II Biomolecules:**Magnesium and Catalytic RNA, Analyzing the Role of the Metal Ion, The Group-I Intron Ribozyme, The Hammerhead Ribozyme, Calcium-Dependent Molecules. **Biological nitrogen fixation**: in-vivo and in-vitro nitrogen fixation.	11
IV	**Organometallic Reaction mechanisms** Fundamental reactions, substitution in carbonyl complexes, Mechanisms, Insertion reactions, CO, SO_2, olefin insertions, oxidative additions, one electron, addition of oxygen, reductive elimination, CH activation. **Hydrogenation**: Hydrogenation of olefins (oxo reaction-cobalt and rhodium oxo catalysts), carbonylation of alcohols – Monsanto acetic acid process, Wacker process. **Catalysis** Use of Organometallic Compounds as catalysts – Catalytic behavior – Homo catalysis – Anchoring of Catalysts **Polymerization of olefins and acetylenes**: Ziegler – Natta catalysis systems. Fischer – Tropsch reaction, Water Gas Shift reactions.	11
V	**Chemistry of Inorganic materials:** Synthesis of bulk materials, Chemical deposition, defects and ion transport, metal oxides, nitrides and fluorides, chalcogenides, chevrel phases and thermoelectric, Framework structures, hydrides and hydrogen storage materials, Inorganic pigments, molecular materials and fullerides. **Organometallic polymers:** Polymers with organometallic moieties as pendant groups, moieties in the main chain, ferrocene based condensation polymers, condensation polymers based on rigid polymers.	11

References:

1. The Inorganic Chemistry of Biological process – M.N. Hughes, 2nd Edn. John Wiley and sons, 1988.
2. Bioinorganic Chemistry – R.N. Hay, Ellis Horwood Ltd., 1984.Biological Inorganic Chemistry – An Introduction, R.R. Crichton, Elsevier, 2008.
3. Transition Metal Complexes as Drugs and Chemotherapetic Agents – N. Farrel Kluwer Academic Publication, 1989.
4. Inorganic Chemistry – I.E. Huheg, R.L. Keiter and A.L. Keiter, 4th Edn, Addison Wesley, 2000
5. Bioinorganic Chemistry – A.K. Das, Books & Allied (P) Ltd., 2007.
6. Organometallic Chemistry – R.C. Mehrothra and A. Singh, 2nd Edn., New Age, International Publications, 2006.
7. Fundamental Transition Metal Organometallic Chemistry – Charles M Lukehart, Brookes, Govel Publishing Company, 1985
8. The Organometallic Chemistry of the Transition metals: R H. Crabtree, 4th Edn., Wiley Interscience,2005.
9. Basic Organometallic Chemistry – B.D. Gupta and A.J. Elias, Universities Press, 2010.
10. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine: Bioinorganic Chemistry, University Science Books., 1994/2010
11. R.C. Mehrothra ad A. Singh: Organometallic Chemistry, New Age International, 2nd Edn.. 2004.
12. F.A. Cotton and G. Wilkinson: Advanced Inorganic Chemistry, 6th Edition, Wiley, 1999.
13. Concepts and Models of Inorganic Chemistry, Douglas, McDaniel, Alexander, 3rd Ed., Wiley India, 2012.

Date Course Coordinator Subject Committee Chairperson

DSC12: **Thermodynamics**

Course Title	Course code: 21CHE4C12L
Total Contact Hours:56	Course Credits:04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3H
Summative Assessment Marks:70	

Course Outcomes (CO's)

1. Understand the various aspects and concepts of Thermodynamics.
2. Study the Statistical, Chemical, Classical and Nonequilibrium Thermodynamics.
3. Review of some importance and applications of Thermodynamics.

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

1. Gain through knowledge on basics of thermodynamics.
2. Able to compare different parts of Thermodynamics.
3. Understand the practical applications of Thermodynamics.

Unit	Description	Hours
I	**Chemical Thermodynamics** A brief resume of laws of thermodynamics (combined form of $1^{st}$and 2^{nd}laws), entropy as a measure of unavailable energy, concept of fugacity and free energy, entropy and free energy changes and spontaneity of processes. Variation of free energy with T & P. Maxwell's relations, thermodynamic equations of state, limitations of Van't Hoff' s equation, Nernst Heat theorem & its applications. Thirdlaw of thermodynamics, determination of third law of entropies.	**11**
II	**Classical Thermodynamics:** Brief resume of concepts of laws of thermodynamics, chemical potential and entropies. Partial molar properties – partial molar free energy, partial molar volume, partial molar heat content, their significance. Determination of these quantity concept of fugacity and its determine by graphical method and compressibility factor method. Non-ideal systems – excess functions for non-ideal solutions. Relationship between mole fraction, molality and molarity activity co-efficients. Determination of activity co-efficient by EMF and solubility methods.	**11**
III	**Statistical Thermodynamics:** Concepts of distribution, most probable distribution, Maxwell-Boltzmann distribution law. Partition functions – translational, rotational, vibrational and electronic partition functions. Calculation of thermodynamic properties in terms of partition functions. Fermi – Dirac Statistics – distribution law and applications to metal. Bose-Einstein statistics – distribution law and application to solids. Ensemble averaging, postulates of ensemble averaging. Canonical, grand canonical and micro canonical ensembles with corresponding distribution laws (using Lagranges method of undetermined multipliers).	**11**
IV	**Application of Thermodynamics:** Entropy and free energy of mixing, partial molar quantities, partial molar volume and free energy (chemical potential), their significance and determinations. Gibbs- Duhem and Duham-Margules equations. **Thermodynamics of Ideal Solutions**: Deductions of laws of Raoult's ebullioscopy, cryoscopy and osmotic pressure. Quantitative treatment of Le-Chatelier principle. **Thermodynamics of Non-ideal Solutions**: Activity, activity coefficient-standard states.	**11**
V	**Non-equilibrium thermodynamics**: Thermodynamic criteria for non-equilibrium states, Assumptions of non-equilibrium	**12**

	thermodynamics, uncompensated heat, entropy production and entropy flow, entropy balance, Onsager formalism, relation between forces and fluxes, transformations of generalized fluxes and forces, microscopic reversibility and Onsager's reciprocity relations. Electrokinetic phenomena, diffusion, electric conduction, irreversible thermodynamics for biological systems, coupled reactions.	

References:

1. Molecular thermodynamics – Donald A. Mc Quarrie, John D. Simon University Science Books, California, 1999.
2. Thermodynamics of Chemistry – S. Glastone, Affiliated East-West Press, New Delhi, 1960.
3. Statistical Thermodyanics – M.C. Gupta, Wiley Eastern Ltd., 1993.
4. Text Book of Physical Chemistry – Samuel Glastone, McMillan Indian Ltd., 2nd Edn. 1974.
5. Elements of Physical Chemistry – S. Glastone, McMillan Indian Ltd., 2nd Edn., 1963.
6. Modern Thermodynamics, A , Diego Casadei, Wolrd Scientific Publisher, 2016.
7. Thermodynamics and Statistical Mechanics of Macromolecular Systems, Michael Bachman, Cambridge, 2014.
8. A Textbook of Physical Chemistry, Dynamics of Chemical Reactions, Statistical Thermodynamics, Macromolecules and Irreversible Processes (Vol. 5), by K.L. KAPOOR

Date Course Coordinator Subject Committee Chairperson

DSE3: A. Modern Organic synthesis

Course Title:Modern Organic synthesis	Course code: 21CHE4E3AL
Total Contact Hours:56	Course Credits:04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3H
Summative Assessment Marks:70	

Course Outcomes (CO's)

1. Understand basic concepts of heterocyclic transformation and rearrangements.
2. Predict the mechanism of Stereoselectivity and Retrosynthesis
3. Study thoroughly the basic concept of photochemistry
4. Understanding biochemistry of natural compounds

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

1. Acquire knowledge on heterocyclic reaction mechanism.
2. Acquint with important mechanism of Stereoselectivity and Retrosynthesis.
3. Gain knowledge on photochemical reactions of organic compound.
4. Able to gain knowledge of basic biochemistry of natural compounds

Units	Description	Hours
I	**Heterocyclic transformations and rearrangements** Heterocyclic Transformations: (i) Coumarins to benzofurans (ii) Sydonones to Pyrazoles (iii) Chromones to Pyrazoles (iv) Furans to Pyridines. **Heterocycles in Functional Group Transformations:** (i) Alkanes from Thiophenes. (ii) Cycloalkanes from Pyrazolines. (iii) Dienes from Pyrroles. (iv) Alcohols from isoxazodiolines. **Rearrangements in Heterocycles:** (i) Dimoroth Rearrangement (ii) Boulton-Katritzky Rearrangement (iii) Fischer Indole cyclisation (iv) Patterno-Buchi reaction.	**11**
II	**Stereoselectivity and Retrosynthesis, Stereoselectivity:** Classification, terminology, and the principle of Stereoselectivity, Strategy of stereoselective synthesis. Acyclic stereo selection.Enantioselective synthesis, diasteroselection in cyclic compounds. Catalytic hydrogenation, alkylation, stereoselective formation of the double bond, stereoselective cyclization of polyenes. Protection and deprotection of functional groups. **Retrosynthesis**: Introduction, retrosynthetic strategies for target molecules: group-oriented strategies, functional group interconversion (FGI), functional group addition (FGA), and functional group removal. **Disconnection approach:** Disconnection of bonds in ring systems and bonds joining ring atoms to functional groups or other residues. Retro Diels-Alder reaction. Retroanalysis of Benzocaine, Indole-3-acetic acid, cyanohydrins, 6-methyl quinoline.	**12**
III	**Organic Photochemistry**	

	Interaction of electromagnetic radiation with matter, types of excitations, Jablonski diagram, the fate of excited molecule, quantum yield, transfer of excited energy. **Intramolecular reactions of the olefinic bond:** Geometrical isomerism, cyclization reactions, rearrangement of 1,4 – and 1,5 – dienes. **Intramolecular reactions of carbonyl compounds:** Saturated, cyclic, and acyclic. α, β-unsaturated compounds, Norrish Type I and II reactions, and photochemistry of cyclohexadienones. **Intermolecular cycloaddition reactions:** Dimerisations and oxetane formation. Patterno Büchi Reaction. Isomerization, addition, and substitutions of aromatic systems.	**11**
IV	**Steroids and Sex hormones** Introduction, classification, sterols, sex hormones, androgens, estrogens. Non-steroidal estrogens and their clinical applications. **Synthesis and mode of action of hormones:** Androsterone, testosterone, and estrone. **Synthesis and therapeutic applications of non-steroidal hormones:** diethylstilbestrol, hexestrol and dienestrol. **Progestins**: progesterone and norethynodrel.	**11**
V	**Genetic code and structure Cell membrane** **Genetic code:** protein synthesis and role of various types of RNA, micro RNA and its functions, inhibitors of protein synthesis, enzyme induction, Operon concept. DNA replication, recombinant DNA technology, and genetic engineering, Plasmids, Vectors, gene cloning gene libraries, screening of gene libraries, Insertion of foreign DNA into cells, Methods to study gene expression, Polymerase chain reaction (PCR). **Cell membrane structure:** Fluid mosaic model of membrane structure, Membrane fluidity, Mechanism of organic solute transport, Lonophores, and their applications, Membranes channels, Liposomes.	**10**

REFERENCES:

1. An Introduction of the Chemistry of Heterocyclic Compounds – R.M. Achenson, 4th Edn., John Wiley & Sons. 2008
2. The Principles of Heterocyclic Chemistry – A.R. Katritzky and J.J. Logowski, 2013
3. Heterocyclic Chemistry – R.K. Bansal, 3rd Edn., New Age International Publishers (2002).
4. Organic Chemistry: Carey. 2019
5. Stereochemistry: Conformation and Mechanism 7th ed. Edition– P. S. Kalia, 2009
6. Stereochemistry of Organic Compounds: Principles and Applications – D. Nasipuri, 1991.
7. Designing Organic Syntheses: A Programmed Introduction to the Synthon Approach – S. Warren, Wiley. Wiley; 1st edition, 1978
8. Burger's Medicinal Chemistry, Drug Discovery, and Development– Burger, 2010.
9. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry – Wilson and Gisvold. Lippincott Williams and Wilkins; 12th revised North American ed edition, 2010.
10. Bentley's Textbook Of Pharmaceuticals (Old Edition)– B.A. Rawlins Elsevier/bsp Books Pvt. Ltd. (bsp), 2010
11. The Organic Chemistry of Drug Design and Drug Action Hardcover-R. B. Silverman, Academic Press; 3rd Edn.,2014.
12. Textbook of organic medicinal and pharmaceutical chemistry, Ed. Robert E. Dorge, Lippincott,

Philadelphia, ©1977.
13. Fundamentals of photochemistry, K.K. RohtagiMukhjerji, Wiley – Eastern, Wiley Eastern Ltd., New Delhi, Bangalore, Bombay 1978.
14. Organic Photochemistry (Cambridge Texts in Chemistry and Biochemistry), J. Coxon and B. Halton, Cambridge University Press; 2nd edition, 2011.
15. Molecular reactions and photochemistry, Depuy and Chapman.Prentice Hall, 1972.
16. Molecular Biotechnology, Glick and Pasteynak, American Society for Microbiology; 4th edition, 2010.
17. Physical Biochemistry, Frifielder, 1983
18. Principles of Biochemistry, A. L. Lehninger, WH Freeman; 7th ed. 2017.
19. Recombinant DNA: Short Course, J.D.Watson, WH Freeman; 3rd ed. 2006.

Date Course Coordinator Subject Committee Chairperson

DSE3: B. Natural products of Biological Importance

Course Title: Natural products of Biological Importance	Course code: 21CHE4E3BL
Total Contact Hours:56	Course Credits:04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3H
Summative Assessment Marks:70	

Course Outcomes (CO's)

1. Understand the structure and biochemistry of Proteins, Peptides and Nucleic acids.
2. Study structure and function of Lipids, Vitamins and Polysaccharides
3. Gain knowledge onenzymatics mechanism and biogenesis of natural compounds

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

1. Gain knowledge on structure and determination of protein, peptides and nucleic acids.
2. Students able to understand the mechanism of enzyme reactions.
3. Able to synthesize selected natural products.

Units	Description	Hours
I	**Proteins and Peptides** **Proteins**: Structure determination: C and N terminal residue determination, primary, secondary, tertiary, and quaternary structure determination, denaturing and denaturing of proteins. **Peptides**: Structure and conformation of the peptide bond, peptide synthesis: Solution phase and Merrifield's solid-phase synthesis, Racemization and use of HOBt, Synthesis of oxytocin and vasopressin.	11
II	**Nucleic acids**: Introduction, structure and synthesis of nucleosides and nucleotides, protecting groups for the hydroxy group in sugar, the amino group in the base and phosphate functions. Methods of formation of internucleotide bonds: DCC, phosphodiester approach and phosphoramide methods. **Polysaccharides:** Different classes, structure and function of polysaccharides, homo and heteropolysaccharides, mucopolysaccharides, proteoglycans, bacterial polysaccharides, mucins blood group substances, lectins and their functions.	11
III	**Lipids, Vitamins and Coenzymes:** **Lipids**: Simple and complex lipids, triacylglycerol phospholipids, plasmalogens, cardiolipids, glycolipids, gangliosides and cerebrosides. **Vitamins and Coenzymes:** Classification- Fat soluble and water-soluble vitamins (source, biological functions and deficiency disorders), coenzyme forms of the vitamin B complex.	11
IV	**Chemistry of enzymes:** Introduction, nomenclature, classes and general types of reactions catalyzed by enzymes. Properties of enzymes: i) Enzyme efficiency/catalytic power ii) Enzyme specificity; Fischer's 'lock and key' and Koshland 'induced fit' hypothesis. Concept and identification of active site. **Factors affecting enzyme kinetics**: Substrate concentration, enzyme concentration, temperature, pH, product concentration etc. Reversible and irreversible inhibition. **Mechanism of enzyme action:** transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Mechanism of chymotrypsin catalyzed hydrolysis of a peptide bond.	12

V	**Biogenesis and biosynthesis of natural products:** **Biogenesis**: Precursors, primary and secondary metabolites. Acetate hypothesis. Mevalonate and Shikimic acid pathways. General principles involved in the biosynthesis of amino acids, alkaloids, steroids and terpenoids. **Biosynthesis of selected natural products:** L-tryptophan, cholesterol, ephedrine, citronellol.	11

References

1) L. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984.

2) K. Albert, L. Lehninger, D.L. Nelson, M.M. Cox, Principles of Biochemistry, CBZ publishers, 1st edition, New Delhi, 1993.

3) Harper's Biochemistry, Ed. R.Harper, 22nd edition, Prentice Hall Press, New York, 1990.

4) Encyclopedia of Chemical Technology – Kirck-Othmer series, 4 December 2000

5) Harper's Review of Biochemistry – P.W. Martin, P.A. Mayer and V.W. Rodfwell, 15th edition, LANGE Medical Publications, 1981.

6) Maurzen Asian Edition, California, 1981.

7) Immobilized biocatalysts, Winfried Hartmeister, Springer Berlin, Heidelberg,1988

8) Molecular Biotechnology, Glick and Pasteynak, American Society for Microbiology; 3rd edition, 2002

9) Principles of Biochemistry, A. L. Lehninger, WH Freeman; 7th ed. 2017 edition, 2017

10) Biochemistry, L.Stryer, WH Freeman; 8th ed. Edition, 2015

11) Biochemistry, VoietasVoiet, Wiley; 5th edition, 2018

12) Bioorganic, Bioinorganic and Supramolecular chemistry, P.S. Kalsi and J.P. Kalsi. New Age International Publishers, New Age International Pvt Ltd Publishers, 2008

13) The Organic Chemistry of Enzyme-Catalysed Reactions, Academic Press, By Richard B. SilvermanJ. Am. Chem. Soc. 2000, 122, 33, 8103–810, 2000

14) Enzymes: Practical Introduction to structure, mechanism and data analysis, By Robert A. Copeland, Wiley-VCH, Inc.,2000.

15) The Organic Chemistry of Biological Pathways By John McMurry, Tadhg Begley by Robert and company publishers. WH Freeman; 2nd edition, 2015

16) Bioorganic Chemistry- A practical approach to Enzyme action, H. Dugas and C. Penny. Springer Verlag, 1931.

17) Biochemistry: The chemical reactions in living cells,By E. Metzler. Academic Press. Academic Press; 2nd edition, 2003

18) Concepts in biotechnology by D. Balasubrarnanian& othersUniversities Press, 2004

Date Course Coordinator Subject Committee Chairperson

DSE3: C. Bioorganic chemistry

Course Title: Bioorganic chemistry	Course code: 21CHE4E3CL
Total Contact Hours:56	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3H
Summative Assessment Marks:70	

Course Outcomes (CO's)

1. Understand the chemistry of living cell.
2. Study enzymatic reactions and their biotechnological applications.
3. Gain knowledge onPharmacokinetics and pharmacodynamics of drug design.

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

1. Aquint knowledge on how chemical reactions occur at the cellular level.
2. Acquire skills and information on technological applications of enzyme actions in biology.
3. Gain knowledge on inventive process of finding new medications based on the knowledge of a biological target

Units	Description	Hours
I	**Introduction to Bioorganic Chemistry**: Overview of Bioorganic Chemistry- Historical Connection Between Organic and Biological Chemistry; Weak Interactions in Organic and Biological World; Proximity Effect in Organic Chemistry; Molecular Recognition. **Chemistry of the Living Cells:** Analogy Between Biochemical and Organic Reaction, Chemistry of the Peptide Bond, Nonribosomal Peptide Bond Formation, Asymmetrie Synthesis of a-Amino Acids, Asymmetrie Synthesis with Chiral Organometallic Catalysts.	11
II	**Enzymes and enzyme-catalyzed reactions** **Enzymes**:Multifunctional Catalysis and Simple Models, Introduction and historical perspective, α-Chymotrypsin , chemical and biological catalysis. **Enzymes properties:** Remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labeling and enzyme modification by site-directed mutagenesis. **Enzyme kinetics:** Michaelis-Menten and Lineweaver- Burk plots, reversible and irreversible inhibition. **Kinds of Reactions Catalysed by Enzymes:** Nucleophilic displacement on a phosphorus atom, multiple displacement reactions and the coupling of ATP cleavage to endergonic processes. Transfer of sulfate, addition and elimination reaction, enolic intermediates in isomerization reactions, -cleavage and condensation, some isomerization and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation.	12
III	**Coenzymes and biotechnological applications** **Co-Enzyme Chemistry:**Oxidoreduction, Pyridoxal Phosphate, Suicide Enzyme Inactivators and Affinity Labels, Thiamine Pyrophosphate, Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzyme. **Structure and biological function of coenzyme**: Thiamine pyrophosphate, Pyridoxal phosphate, NAD+, NADP+, FMN, FAD, lipoic	10

	acid, vitamin B_{12}. Mechanism of reaction catalyzed by the above cofactors,Biotin.	
IV	**Drug design** Introduction to drug designing, combinatorial chemistry approach, lead-based methods, the discovery of lead compounds, drug discovery without a lead-denevo drug designing, Prodrug, concepts for drug design, conceptual pharmacokinetics in drug designing.	10
V	**Pharmacokinetics and pharmacodynamics** **Pharmacokinetics**: The dynamics of drug absorption, distribution, biotransformation and elimination. Concepts of linear and non-linear compartment models.Significance of Protein binding. **Pharmacodynamics**: Mechanism of drug action. The relationship between drug concentration and effect Receptors.Structural and functional families of receptors. Quantitation of drug receptors interaction and elicited effects	12

References:

1, Hermann Dugas: Bioorganic Chemistry-A chemical Approach to Enzyme Action; 3rd Edition. Springer; 3rd ed. 1996. CBS Publishers and Distributors Pvt. Ltd., 2nd printing edition 1999.

2. Page, M.I.; Williams, A. Enzyme Mechanisms, Royal Society of Chemistry. 1987

3. Silverman, Richard B. Organic Chemistry of Enzyme Catalyzed Reaction.Academic Press; 2nd edition, 2002

4. Bertini, I.; Gray, H.B.; Lippard, S. J.; Valentine, J.S. Bioinorganic Chemistry, University Science Books.University Science Books,U.S. , 1994

5. Drug Designs - A series of monographs in medicinal chemistry edited by A. J. Ariens. Istedition, Vol. I, II, V, VIII & IX (only relevant chapters).1st Edition - 1978

6. Hand book of Clinical Pharmacokinetics by Gibaldi and Prescott.ADIS Health Science Press, 1983

7. Applied biopharmaceutics and Pharmacokinetics by Leon Shargel and Andrew B.C.YuMcGraw Hill / Asia; 7th edition, 2016.

Date Course Coordinator Subject Committee Chairperson

DSE4: A. Advanced Chromatographic and Mass spectroscopic techniques

Course Title: Advanced Chromatographic and Microscopic Techniques	Course code: 21CHE4E4AL
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. Understand the importance of inorganic spectral methods and structural aspects.
2. Study the advanced and instrumental separation techniques

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

1. Combining the different spectral information to gain additional analytical skills.
2. Confirmation of molecular structures from the available data.

Unit	Description	Hours
1	**Instrumental methods 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. **Gas Liquid Chromatography:** Principle, instrumentation, apparatus-columns, sample application, mobile phase, stationary phase, detectors, thermal conductivity, flame ionization and mass spectrometry, factors affecting separation, retention volume, retention time and applications. **HPLC Principles:** Instrumentation- columns, stationary phase and matrices, column packing, sample application, mobile phases, pumps, detectors ,advantages and applications.	12
2	**Mass Spectroscopy:** Introduction – Basic theory, ionsation, types of ions – molecular ion, fragment ion, meta stable ion and isotope ions, base peak, instrumentation. Fragmentation processes, representation of fragmentation, basic fragmentation types and rules factors affecting fragmentation and reaction pathways. Intensity of M^+ peaks of alkanes, alkenes, alkynes, alcohols, amines, aldehydes and other compounds. Ion analysis, ion abundance, Fragmentation patterns of glucose, myrcene, nicotine, retro Diels-Alder fragmentation. Mc Laffarty rearrangement, nitrogen rule, some simple examples of fragmentations, applications of mass spectrometry. Application in structure elucidiation and evaluation of heats of sublimation & ionization potential. High resolution mass spectroscopy. GC-MS and LC-MS. Composite problems involving the applications of UV, IR, 1H and 13C-NMR and mass spectroscopic techniques. Structural elucidation of organic molecules.	11

3	**Molecular Luminescence:** Principles of Fluorescence and Phosphorescence - Fluorimetry in Chemical Analysis - Instrumentation in Fluorimetry - Fluorescence and Chemical Structure and - Fluorescence in quenching and inner filter effect - Phosphorescence Spectroscopy – Jablonski diagram- Phosphorescence and Chemical Structure - Phosphorimetry in Quantitative Analysis. **Chemiluminescence:** Principles, measurement of Chemiluminescence - Quantitative Analysis - Titrations - Electrochemiluminescence. **Polarimetry and Related Methods :** Polarized light - Applications of Polarimetry - Optical Rotatory Dispersion and Circular Dichroism –cotton effect, Instrumentation in ORD and CD.	11
4	**Electron Spin Resonance Spectroscopy:** Introduction - Presentation of spectrum – ESR transitions and selection rules Hyperfine splitting in various structures – Factors affecting "g" values. Zero field splitting and Kramer's degeneracy Anisotropy in Hyperfine coupling constant – Nuclear Quadrupole interactions – Spin Hamiltonian – Electron delocalization instrumentations and applications to simple inorganic and organic free radicals and to inorganic complexes. **Mössbauer Spectroscopy** Introduction – Mössbauer effect – Resonance absorption of gamma rays conditions for Mössbauer spectroscopy – Mössbauer parameters – Isomer shift – electric quadruple interaction – Magnetic interactions – Instrumentation & applications to $Fe_3(CO)_{12}$, Prussian blue, Oxyhemerythrin, Hexacyano ferrates, Netroprusside and Tin halides. Application to the study of Fe2+ and Fe3+ compounds, Sn2+ and Sn4+ compounds(nature of M-L bond, coordination number and structure), detection of oxidation states and inequivalent Mössbauer atoms **Nuclear Quadruple Resonance Spectroscopy:** Introduction – Nuclear Quadruple Moment – Electric field gradient – Asymmetry parameter – Nuclear Quadruple transition – Effect of external magnetic field – Applications.	11
5	**Electroseparation techniques:** **Supercritical fluid chromatography:** Introduction, Properties of supercritical fluids, Instrumentation, and applications. **Electrophoresis:** Principle, classification, capillary electrophoresis, Instrumentation, Application to capillary zone electrophoresis, gel electrophoresis. **Electrosmosis:** Principles, Instrumentation and applications. **Field flow fractionation:** Separation mechanisms, Methodology, Advantages over chromatographic methods.	11

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. Spectroscopy of Organic compounds – P.S. Kalsi, Wiley Eastern Ltd. (India) / New Age International Publications, New Delhi (8h Edn.), 2020
5. Organic Spectroscopy – William Kemp 3rd Edn. ELBS, 1993

6. Application of absorption spectroscopy of organic compound – John R Dyer, Prentice Horll India, EEE, Recent Edn., 1965.
7.Instrumentatal Method of Chemical analysis – G.R. Chatwal and S.K. Anand, Himalaya Publication House, Delhi (Recent Edn.), 2011.
8. Instrumental methods of chemical analysis. – B.K. Sharma – Goel Publishing House – Meerut, 2014.
9. Molecular structures and Spectroscopy – G. Aruldhas, Prentice Hall India, New Delhi, 2008.
10. Spectroscopic methods in organic chemistry – D.H. Williams, I. Fleming – Tata McGraw Hill, 2007.

Date Course Coordinator Subject Committee Chairperson

DSE4: B. Applied Analysis

Course Title: Applied Analysis	Course code: 21CHE4E4BL
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. Understand the importance of analysis of various daily usable items like food, water, etc
2. Approach of various methods of analysis.
3. To know the methods of analysis for daily life

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

1. Apply fundamental and basic knowledge to analysis of various substance used in daily life.
2. Able to apply analytical techniques for different applications.

Unit	Description	Hours
1	**Food analysis**: Objectives of food analysis. Sampling procedures. Detection and determination of sugars and starch. Methods for protein determination. Oils and fats and their analysis – iodine value, saponification value and acid value. Rancidity - detection and determination (peroxide number). Tests for common edible oils. Analysis of foods for minerals - phosphorus, sodium, potassium and calcium. General methods for the determination of moisture, crude fibre and ash contents of food. Analysis of milk for fat and added water. Non-alcoholic beverages -determination of chicory and caffeine in coffee; caffeine and tannin in tea. Alcoholic beverages -methanol in alcoholic drinks and chloral hydrate in toddy. Food additives - chemical, preservatives - inorganic preservatives - sulphur dioxide and sulphites, their detection and determination. Organic preservatives - benzoic acid and benzoates, their detection and determination. Flavouring agents - detection and determination of vanilla and vanillin. Coloring matters in foods - classification, certified colors, detection of water soluble dyes, color in citrus fruits, beet dye in tomato products, mineral color. Pesticide residues in foods - determination of chlorinated organic pesticides. Control food quality - codex alimentarius, Indian standards.	12
2	**Water pollution and analysis:** Water resources, origin of wastewater, types of water pollutants; their sources and effects, chemical analysis for water pollution control - objectives of analysis, parameters of analysis, sample collection and preservation. Environmental and public health significance and measurement of colour, turbidity, total solids, acidity, alkalinity, hardness, chloride, residual chlorine, chlorine demand, sulphate, fluoride, phosphates and different forms of nitrogen in natural and waste/polluted waters, heavy metal pollution - public health significance of Pb, Cd, Cr, Hg, As, Cu, Zn and Mn, general survey of the instrumental techniques for the analysis of heavy metals in aquatic systems, organic loadings – significance and measurement of DO, BOD, COD, TOD, and TOC, phenols, pesticides, surfactants and tannin and lignin as water pollutants and their determination.	8
3	**Kinetic methods of analysis:** I Introduction, basis of kinetic methods, rate law expressions. Classifying chemical	12

	kinetic methods – direct-computation integral methods, direct-computation rate methods, curve-fitting methods. Instrumentation. Quantitative applications – enzyme catalyzed reactions, non-enzyme catalyzed reactions, non-catalytic reactions. Determining Vmax, Km for enzyme catalyzed reactions. Elucidating mechanism for the inhibition of enzyme catalysis. Determination of enzymes, LDH, GOT and GPT. Determination of substrates – urea, uric acid, blood glucose and blood alcohol. Analysis of closely related compounds - neglect of reaction of slow reacting component method and logarithmic extrapolation method.	
4	**Automated methods of analysis:** An overview. Principles of automation. Automated instruments: process control. Continuous analyzers. Discrete autoanalyzers. Instruments used in automated process control. Automatic instruments - discrete and continuous flow sampling instruments. Flow injection analysis – principles - dispersion co-efficient. Factors affecting peak height, sample volume, channel length and flow rate, and channel geometry. Applications -limited dispersion applications, medium dispersion applications, stopped flow methods and flow injection titrations. Discrete automatic systems - centrifugal fast scan analyzer, automatic organic elemental analyzers. Analysis based on multilayer films-general principles, film structures, instrumentation,performance and applications – blood urea nitrogen, blood glucose and potassium.	12
5	**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. 82Biological significance, analysis and assay of enzymes (pepsin, monoaminoxidase, tyrosinase); and hormones (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.	12

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 edition, 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.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Instrumental Methods of Analysis by H.H. Willard, L.L. Merritt and J.A. Dean, 7th edition, 1988.
7. Principles and Practice of Analytical Chemistry, F.W. Fifield and Kealey, 3rd edition, Blackwell Sci., Ltd. Malden, USA, 2000.
8. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
9. Introduction to Instrumental Analysis, Braun, Pharm. Med. Press, India, 2nd Edn., 2019.

10. Instrumental Methods of Analysis, W. M. Dean and Settle, 7th edition, CBS Publishers, New Delhi, 1986.
11. Instant Notes of Analytical Chemistry, Kealey and Haines, Viva books Pvt. Ltd., 2002.
12. Soil Chemical Analysis, M.L. Jackson, Prentice Hall of India Pvt. Ltd., New Delhi, 1973.
13. Clinical Chemistry, Principles and Procedures, J.S. Annino, 2nd edition, Boston: Little,Brown, 1960.
14. Clinical Chemistry, Principles and Techniques, R.J. Henry, D.C. Cannon and J.W.Winkleman, Eds., 2nd edition, Hagerstorm, M.D: Harper and Row, 1974.
16. Fundamentals of Clinical Chemistry, N.W. Tietz, Ed., 2nd edition, Philaddphia: W.B.Saunders, 1976.
17. Food Analysis, A.G. Woodman, McGraw Hill. 1971.
18. Chemical Analysis of Foods, H.E. Cox and Pearson, 1962.
19. Analysis of Foods and Food Products, J.B. Jacob, 2013
20. A First Course in Food Analysis, A.Y. Sathe, New Age Internationals (P) Ltd., Publishers, Bangalore, 1999.

Date Course Coordinator Subject Committee Chairperson

DSE4: C. Environmental and Biochemical Analysis

Course Title: Environmental and Biochemical Analysis	Course code: 21CHE4E4CL
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. Study sources and effects of air, soil pollution
2. Understand the analysis of food and fuel analysis.

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

1. Able to analysedifferent types of pollutants in air, water and soil.
2. Capable to analyse food and fuels.

Unit	Description	Hours
1	**Environmental Segments and Air Pollution:** Air pollutants, prevention and control, Greenhouse 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.	12
2	**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.	12
3	**Soil Analysis:** Physical properties of soils – soil texture and soil structure. Chemical properties of soil – types of soil collides, types of clays and their swelling and adsorption properties, cation exchange capacity and its determination, acid soils – types of soil acidity, liming, measurement of pH and conductivity of soil – saline and alkaline soils, analysis of major constituents of soil – organic matter, nitrogen, sulphur, potassium and calcium. **Fuel Analysis:** Solid, liquid and gaseous fuels; ultimate and proximate analysis, heating values, grading of coal; liquid fuels; flash point, aniline point, octane number and cetane number, carbon residue; gaseous fuels; producer gas and water gas, calorific valves.	12

4	**Food Analysis:** Estimation of moisture, ash, crude protein, fat, crude fiber, carbohydrate, calcium, potassium, sodium and phosphate in foods; Analysis of common adulterants in food; Milk and milk products – alcohol test, fermentation test, dye reduction tests (methylene blue and resazurin), tests to distinguish butter and margarine, phosphate test for pasteurization, estimation of added water; Beverages – caffeine and chicory in coffee, methanol in alcoholic drinks; estimation of saccharin, coal tar dyes, aflatoxins in foods; pesticide analysis in food products – extraction and purification of sample, gas chromatography for organophosphates, thin-layer chromatography for chlorinated pesticides.	12
5	**Noise pollution:** Sources, effects, measurement, Allowed limits and control **Radioactive pollution:** Sources, effects, measurement, Allowed limits and control and storage **Soil pollution:** Classification of pollutants and their characteristics, sources, prevention and control. Environmental laws to control water and air pollution	10

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.
8. A Text Book of Soil Chemical Analysis – P. R. Hesse, CBS Publishers, 1994

Date Course Coordinator Subject Committee Chairperson

GEC 2: A. Chemistry for daily life

Course Title: Chemistry for daily life	Course code: 21CHE4G2AL
Total Contact Hours:28	Course Credits:02
Formative Assessment Marks: 15	Duration of ESA/Exam: 2H
Summative Assessment Marks:35	

Course Outcomes (CO's)

1. Understanding the importance of Chemistry in daily life
2. Inform on Drug chemistry and chemistry of soaps
3. Study the use of some chemical products

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

1.Know the role of Chemistry in our daily uses

2.Understand the applications of Chemistry in household activites

3.Get information about drugs and its side effects

UNIT	Description	Hours
I	**Chemistry of soaps**: Soaps, Detergents, surfactants, Diamond. Chemistry in Jewellary: Electroplating, metals and metal alloys. Chemistry of Batteries: cells, wax candals, mosquito coils and common salt. Chemistry of Cosmetics: Cosmetics formulation, perfumes, and fragrances, deodorants, Colour cosmetics, sun protections, Preservatives and its effects, Food toxicity	10
II	**Chemistry in Household** Chemistry and uses of Paints, pigments, Varnishes and coatings, cleaners, stain removears, pesticides, Fire extinguishers, cement, glasses, fertilizers Fuel Chemistry: Fuels, Introduction, fossil fuels with example, biomass energy, Energy sources: Solar energy, wind energy, tidal energy, hydal energy, nuclear energy. Chemical toxicity	10
III	**Chemistry of drugs and water** Drugs, classification, uses and side effects of pain relief drugs, antibiotics, antacids, Stimulants, ointments, syrups, tablets and capsules, Anesthetic drugs, energetic drugs. **Water Chemistry**: Importance, sources, types, underground and surface water, water contents, water born deceases, water purification	08

References

1) Chemistry in daily life by Kirpal Sing, PHI learning Pvt Ltd., 2012.
2) Engineering Chemistry by Dr. Suba Rameshm and Dr. S. Vairam, Wiley Publication, 2013
3) Drugs and pharmaceutical sciences Series, Marcel Dekkar, Vol.II, INC, New York, 2002.
4) Hand book of Fertilizer Technology By Swaminathan and Goswamy, 6th Edn., 2001.
5) Medicinal Chemistry (VEdition) by Asthoush Kar, New Age International publisher,2010.
6) Food 6 facts and principles by N. Shakuntala Manay and S. Swamy, 4th ED. New Age International, 2008.

Date Course Coordinator Subject Committee Chairperson

GEC 2: B. Water and food quality and laws

Course Title: Water and food quality and laws	Course code:21CHE4G2BL
Total Contact Hours:28	Course Credits:02
Formative Assessment Marks: 15	Duration of ESA/Exam: 2H
Summative Assessment Marks:35	

Course Outcomes (CO's)

1. To develop theoretical aquatic chemistry basis and use the principles for the evaluation of water quality.
2. To analyse how aquatic chemistry principles can be applied in natural water resources and in treatment of drinking water and wastewater.
3. To know the chemistry and analysis of food

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

1. Apply fundamental and basic knowledge to analysis of water.
2. Able to apply analytical techniques for food quality and asssesments.
3. Understanding of different laws related to protection of environment.

Unit	Description	Hours
I	**Analytics of water** Analytical aspects of water: Sources, conservation of water, impurities in water and their effects. Chemistry involved in sedimentation, coagulation and sterilization. Softening of water, lime-soda, ion-exchange process and numerical problem. Boiler troubles, causes and effects, methods of prevention. **Chemistry of water**: the water molecule, properties of pure water, fresh water and sea water. Composition of waters: surface water, ground water and sea water. Water analysis: Measurement of temperature, transparency, turbidity, determination of pH, electrical conductivity, salinity, chlorinity, dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, Water quality control, Composition of natural waters, Sea water environment, Human impact on water resources, Methods of evaluation of water quality: sampling and storage, Water conservation-development of watersheds, Rain water harvesting and ground water recharge.	10
II	**Food Quality and assessment** Definition of food quality, food safety, Functions of food, Responsibility for food quality and safety, Types of adulteration, Introduction to food contaminants, Types of food contaminants, Methods of preventing food contaminants	08
III	**Regulations and Laws of water and food** The water (Pollution and control of pollution) Act, 1974, The Water (Prevention and Control of Pollution) Cess Act, 1977, Indian standards for drinking water (IS:10500, 2012). Laws & regulations, Quality management system in India, Introduction to food laws, National and International food laws, Governing bodies, Introduction to safety assessment and safety evaluation, Definition of safety assessment, Definition of safety evaluation, Laws & regulations, Quality management system in India, Laws & regulations.	10
References: 1. Environmental Chemistry – A.K. De, (Wiley Eastern).		

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

Date Course Coordinator Subject Committee Chairperson

GEC 2: C. Agro and Environmental Chemistry

Course Title: Agro and Environmental Chemistry	Course code: 21CHE4G2CL
Total Contact Hours: 28 (02 L)	Course Credits: 02
Formative Assessment Marks: 15	Duration of ESA/Exam: 2h
Summative Assessment Marks: 35	

Course Outcomes (COs):

1. Understand the importance of safe environment
2. Study the Sources and consequences of environmental pollution
3. Gain knowledge on the composition and importance of fertilizers, pesticides for agriculture

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
3. Able to properly use agro-products

Unit	Description	Hours
1	**Agricultural products** Micronutrients and macronutrients in soil, Importance of Nutrients for plants Different nutrients for different products Fertilizers; Different types, Composition and applications, Effects of excess use of fertilizers, pollution by fertilizers Bio-based fertilizers and advantages	9
2	**Insecticides:** Composition and applications, side effects **Pesticides:** Composition and applications, side effects **Weedicides:** Composition and applications, side effects **Preservative chemicals:** Composition and side effects **Chemicals used for Ripening:** Composition, uses and side effects **Food adulteratives and contaminants:** Difference and side effects with examples Rancidity of oil	9
3	**Soil pollution:** Causes, Soil erosion, loss of fertility and remedies **Air pollution:** Sources, greenhouse effect, causes and consequences, Control and remedies **Water pollution:** Sources, Effects, Control and procedure for purification	10

References:

1. Environmental Chemistry – A.K. De, New Age International, 8th Edn., 2016
2. Environmental Chemistry – S.K. Banerji, (Prentice Hall India), 1993.
3. Chemistry of Water Treatment – S. D. Faust and O. M. Aly, (Butterworths), 1983.
4. Environmental Chemistry – I. Williams, John Wiley, 2001.
5. Food Analysis – A. G. Woodman, McGrawHill, 1971.
6. Foods: Facts and Principles – Shadaksharaswamy and Manay, Wiley Eastern, 1987.
7. A Text Book of Soil Chemical Analysis – P. R. Hesse, CBS Publishers, 1994

Date Course Coordinator Subject Committee Chairperson

DSC11P9: Spectral interpretation of data

Course Title: Spectral interpretation of data	Course code: 21CHE4C11P
Total Contact Hours: 56 (0-0-4P/week)	Course Credits: 02
Formative Assessment Marks: 20	Duration of ESA/Exam: 4h
Summative Assessment Marks: 30	

Course Outcomes (COs):

1. Practical approach for the interpretation of spectra of organic and inorganic compounds.
2. Train to predict the structure of compounds using spectral data

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

1. Able to interpret the spectral data which helps in the structural elucidation of compounds.
2. It strengthens the spectral analytical knowledge for Research, Industrial and teaching assignments.

SL No	List of experiments	Hours
1	a. Preparation and Spectral analysis of few complexes and organic compounds (UV- Visible, IR, TGA). b. Interpretation of Spectral data (IR, NMR,& Mass)	

References:

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

Date Course Coordinator Subject Committee Chairperson

Project: Project work

Course Title: Project Work	Course code: 21CHE4C1R
Total Contact Hours: 112 (0-0-8P/week)	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 4 h
Summative Assessment Marks: 70	

Course Outcomes (CO's):

1. Students are exposed to research to motivate them for research career.
2. Trained for undertaking chemistry project works

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

1. Students gain expertise in research oriented work to develop the research knowledge in the concerned field.
2. It helps them to work in group as well as develop skills.

SL No	List of experiments	Hours
1	**Project work either In-house or Research Institutes**	112

Date Course Coordinator Subject Committee Chairperson

CBCS Question Paper Pattern for PG Semester End Examination
with Effect from the AY 2021-22

Disciplines Specific Core (DSC) and Discipline Specific Elective (DSE)

Paper Code: **Paper Title:**

Time: 3 Hours **Max. Marks: 70**

Note: Answer any *FIVE* of the following questions with Question No. 1 (Q1) Compulsory, each question carries equal marks.

Q1. 14 Marks

Q2. 14 Marks

Q3. 14 Marks

Q4. 14 Marks

Q5. 14 Marks

Note: Question No.1 to 5, *one question from each unit* i.e. (Unit I, Unit II, ….). The Questions may be a whole or it may consists of sub questions such as a,b, c etc…

Q6. 14 Marks

Note :Question No.6, *shall be from Unit II and III,* the Question may be a whole or it may consists of sub questions such as a,b, c etc…

Q7. 14 Marks

Note: Question No.7, *shall be from Unit IV and V*,the Question may be a whole or it may consists of sub questions such as a,b, c etc…

Q8. 14 Marks

Note: Question No-8 shall be from *Unit II, Unit III , Unit IV and Unit V*. The question shall have the following sub questions and weightage. i.e a – 05 marks, b – 05 marks, c – 04 marks.

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Skill Enhancement Courses (SECs)

Paper Code: **Paper Title:**

Time: 1 Hours **Max. Marks: 30**

There shall be Theory examinations of Multiple Choice Based Questions [MCQs] with Question Paper set of A, B, C and D Series at the end of each semester for SECs for the duration of One hour (First Fifteen Minutes for the Preparation of OMR and remaining Forty-Five Minutes for Answering thirty Questions). The Answer Paper is of OMR (Optical Mark Reader) Sheet.

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Question Paper Pattern for Subjects with Tutorial

For the subjects with Tutorial component, there is no Semester-End Examination (SEE) to the component C3. The liberty of assessment of C3 is with the concerned faculty. The faculty must present innovative method of evaluation of component C3 before the respective BoS for approval and the same must be submitted to the Registrar and Registrar(Evaluation) before the commencement of the academic year.

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