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

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

Department of Chemistry

Jnana Sagara, Ballari - 583105

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

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	1.5
	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	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 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.	8
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.	12

	Coupling of alkynes and arylation of aromatic compounds by diazonium 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	12

	conjugated diens, trienes and cyclic α, β unsaturated aldehydes and ketones, 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.	12

	Thermometric titrimetry (Acid-Base, precipitation, Complexation, redox 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:**	12

	Descriptive Statistics: Mean, standard deviation, variance, plotting data and 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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