VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY
JNANASAGARA CAMPUS, BALLARI-583105

Department of Studies in

INDUSTRIAL CHEMISTRY

SYLLABUS

Master of Science
(II Semester)

With effect from
2021-22

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	21 ICH2C5L	Coordination Chemistry	30	70	100	4	-	-	4	3
	DSC6	21 ICH2C6L	Chemistry of Natural products, Reagents in Organic synthesis and Heterocyclic Compounds	30	70	100	4	-	-	4	3
	DSC7	21 ICH2C7L	Electro and Photochemistry	30	70	100	4	-	-	4	3
	DSC8	21 ICH2C8L	Instrumental methods of analysis	30	70	100	4	-	-	4	3
	SEC2	21 ICH2 S2 P	Research Methodology	20	30	50	1	-	2	2	1
	DSC 5P	21 ICH2 C4 P	Synthesis of Coordination compounds	20	30	50	-	-	4	2	4
	DSC6P	21 ICH2 C5 P	Organic synthesis	20	30	50	-	-	4	2	4
	DSC7P	21 ICH2 C6 P	Instrumental methods of analysis	20	30	50	-	-	4	2	4
Total Marks for II Semester						**600**				**24**	

Dept Name: Industrial Chemistry
Semester-II
DSC5: Coordination Chemistry

Course Title: Coordination Chemistry	**Course code:** 21 ICH2 C5 L
Total Contact Hours: 56	**Course Credits:** 04
Formative Assessment Marks: 30	**Duration of ESA/Exam:** 03
Summative Assessment Marks: 70	

Course Objective: The objective of this course is to prepare the students to get acquainted with thorough knowledge in coordination chemistry and bioinorganic chemistry. The students will also get information about the usefulness of nuclear chemistry in various fields.

Course Outcomes: At the end of the course the student would be able to,

1. Describe the bonding in transition metal complexes using crystal field and ligand field theories and the 18 electron rule.
2. Describe various metal-ligand interactions in terms of sigma- and pi-bonding interactions.
3. Explain the stability of d-metal complexes, their reactivity, and the mechanisms of ligand substitution reactions.
4. Mention the important applications of metal chelates.
5. Explain magnetic susceptibility and its importance in predicting the geometry of the complexes..
6. Characterize the complexes using Orgel and TS diagrams.
7. define the importance of inorganic elements in vital systems.
8. Explain the importance of minerals for living organisms.
9. Interpret situations that may occur in the absence and excess of minerals.
10 Explain Metal ion binding to biomolecules and their function
11. Recognize and use the symbols for protons, neutrons, electrons, positrons, alpha particles, beta particles, and gamma rays.
12. Compare the penetrating power of alpha, beta, neutron, and gamma radiation.
13. Understand and calculate the mass defect for a nuclear reaction use Einstein's relation, $E = (\Delta m)c^{2}$.
14. Calculate energy changes in nuclear reactions calculate nuclear binding energies
14. Interpret binding energy per nucleon plots in terms of nuclear stability and the energy changes associated with fission and fusion reactions.
15. Explain the analytical applications and the biological effects of radiation:
16. Interpret the data to calculate the age of an object (radiochemical datin

DSC5: Coordination Chemistry

Unit	Description	Hours
Unit I	**Bonding in Metal complexes** **Metal-Ligand Bonding:** Concept of effective atomic number, electronic configuration of metal complexes by VBT, draw backs of VBT. Crystal Field Theory(CFT)-salient features, crystal field splitting of d orbitals in octahedral, tetrahedral, tetragonal and squarer planar fields Magnitude of Δ, factors affecting Δ, crystal field stabilization energy (CFSE), effects of crystal field splitting, energy of ligation, stabilities of oxidation states Co(III). Spectrochemical series, nephelauxetic series, short comings of CFT, evidences for covalence, John-Teller distortion in metal complexes and metal chelates. M.O treatment of coordination compounds involving σ and π bonding.	**10 hrs**
Unit II	**Magnetic and Spectral Properties of Coordination Compounds** **Magnetic properties of coordination compounds** Types of magnetic behaviour, magnetic susceptibility and its determination- Gouy, Faraday, VSM method. Diamagnetic correction, orbital contribution, spin-orbital coupling, ferro- and antiferromagnetic coupling, spincrossover. Magnetic properties of Lanthanide and Actinide metal complexes. **Electronic spectra of coordination compounds-** Spectroscopic ground states, selection rules, term symbols for d^n ions, Racah parameters, Orgel, Correlation and Tanaube-Sugano diagrams, spectra of 3d metal-aqua complexes of trivalent V, Cr, divalent Mn, Co and Ni, $[CoCl_4]^{2-}$ calculation of Dq, B and β parameters, CT spectra. Spectral properties of Lanthanide and Actinide metal complexes.	**13 hrs**
Unit III	**Reaction mechanism of Transition Metal Complexes** **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,. **Kinetics and Mechanism of Reactions of Coordination Compounds:** Introduction, inert and labile complexes. Mechanism of substitution reactions, classification of ligand substitution reactions in octahedral and square planar complexes, 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	**10 hrs**
Unit IV	**Bio-lnorganic Chemistry** Metal Ions in Biological Systems Essential and types metals Na+/K+ transport across cell membranes, ionophores, crown ethers, Na+/K+ pump. Iron storage and transfer- ferritin, transferrin and siderophores. Oxygen transport and oxygen uptake proteins- transport and storage of dioxygen; Heme proteins and oxygen uptake, structure and functions of haemoglobin and myoglobin, dioxygen binding, Bohr effect, Hill equation, role of distal and proximal histidine; Model complexes for dioxygen binding, non- porphyrin systems- hemerythrin and hemocyanin. Photosynthesis and nitrogen fixation: Nitrogenase: structural aspects and functions, abiological nitrogen fixation. Photosynthesis: Chlorophyll- structural features, role of Mg2+- Z scheme of photosynthesis-PSI and PSII	**10 hrs**
Unit V	. **Nuclear Chemistry** Nuclear Stability – Mass Defect and Binding Energy.. Radioactivity: Radioactive elements, general characteristics of radioactive decay, interaction of α, β and γ – rays with matter. Nuclear reactions Types of nuclear reactions, Nuclear fission **Applications of Radioactivity:** Synthesis of various useful isotopes, use of isotopes in the elucidation of reaction mechanism, structure determination, kinetics of exchange reactions, measurement of physical constants including the diffusion constants, isotope dilution techniques, NAA, PGNAA, neutron absoptiometry and age determination, radio isotopes in field of medicine	**12 hrs**

References:

1. J. E. Huheey, E. A. Keiter and R.L. Keiter, Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education, 2004.
2. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, Advanced

Inorganic Chemistry, John Wiley & Sons, Inc., New York, 2009.
3. J. D. Lee, Concise Inorganic Chemistry, Blackwell Science, Oxford, 2000.
4. P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, Shriver & Atkins:Inorganic Chemistry, Fourth edition, Oxford University Press, Oxford, 2000.
5. F. A. Carey G. Wilkinson, C. A. Murillo and M. Bochmann, Advanced Inorganic Chemistry, Wiley Interscience, 2003. 11
6. C. E. Housecroft and A. G. Sharpe, Inorganic Chemistry, Prentice Hall, 2005.
7.. R. M. Roat-Malone, Bioinorganic Chemistry – A Short Course, John Wiley & Sons, Inc., Hoboken, New Jersey, 2007.
8. S. J. Lippard, and J. M. Berg, Principles of Bioinorganic Chemistry, Univ. Science Books, 1994.
9. W. Kaim and B. Schwederski, Bioinorganic chemistry: Inorganic Elements in the Chemistry of Life – An Introduction and Guide, John Wiley & Sons, 1994.
10. Principles of Bioinorganic Chemistry by S. J. Lippard and J. M. Berg, Panima Publishing Corporation, 1stEdn.
11. G. Choppin, J. Rydberg and J. O. Liljenzin, Radiochemistry and Nuclear Chemistry, Butterworth-Heinemann, 3rd Edition, 2002.
12. W. D. Loveland, D. Morrissey and G. T. Seaborg, Modern Nuclear Chemistry, John Wiley & Sons, 2006.
13. Irving Kaplan, Nuclear Physics 2nd Edition Addison-Wesley Publishing Company
14. Inorganic Electronic spectroscopy, A. B. P. Lever, Elsevier. (1968).
15. Magnetochemistry, R.L. Carlin, Springer Verlag.
16. Electronic Absorption Spectroscopy and related Techniques, D. N. Sathyanarayana, University Press (2001).
17. Inorganic Chemistry A Unified Approach by W. W. Porterfield, Elsevier 2005 2nd edition.

Date Course Coordinator Subject Committee Chairperson

DSC6: Chemistry of Natural products, Reagents in Organic synthesis and Heterocyclic compounds

Course Title: Chemistry of Natural products, Reagents in Organic synthesis and Heterocyclic compounds	**Course code**: 21 ICH2 C6 L
Total Contact Hours: 56	**Course Credits:** 04
Formative Assessment Marks: 30	**Duration of ESA/Exam:** 03
Summative Assessment Marks: 70	

Course Objective: The objective of this course is to make the students to acquire important information regarding various organic compounds in nature which are part of our daily lives. Also, this course would impart knowledge about importance of heterocyclic compounds. Various reagents used in organic synthesis and applications of photochemistry to it.

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Course Outcomes: At the end of the course the student would be able to,

1. Explain different types of alkaloids, glycosides & terpenes etc and their chemistry and medicinal importance.
2. Learn the constituent present in crude drugs responsible for metabolic activities.
3. Explain the structure and properties of carbohydrates
4. Describe the reducing action of sugars.
5. Combine the structure and functions of lipids
6. Identify the structure of aminoacids
7. Classify proteins with functions illustrating the structures.
8. Describe the structure and functions of RNA and DNA
9. Describe the classification of heterocyclic compounds according to their different types Showing the multiple methods of preparation of heterocyclic compounds
10. Recognize the chemical properties of heterocyclic compounds and their reaction mechanisms.
11. Demonstrate an understanding of excited states and apply group theory to photochemical problems
12. Describe and apply photochemical reactions of certain homologous series of organic compounds

DSC6: Chemistry of Natural products, Reagents in Organic synthesis and Heterocyclic compounds

Unit	Description	Hours
Unit-I	**Chemistry of Natural products** **Alkaloids Terpenoids and steroids.** **Alkaloids** – classifications occurrence, general methods of structural elucidation, stereo Chemistry and synthesis of quinine, papareine, morphine. **Terpenoids** – occurrence general methods of structural elucidation, stereo Chemistry and synthesis of following representative molecules-citral, camphor and santonin. **Steroids** – cholesterol, ergo sterol-structure and synthesis.	**11hrs**
Unit-II	**Carbohydrates, Proteins and Nucleic acids** **Carbohydrates**-Determination of ring structures of monosaccharide and disaccharides with reference to glucose, fructose, maltose and sucrose. **Proteins** – Amino acids, peptides, peptide synthesis using blocking reagents, modern methods of peptide synthesis. Structure of proteins – primary. secondary & tertiary structure, sequence of amino acids in proteins, end group analysis. **Nucleic acids**- chemical and enzymatic hydrolysis of nucleic acids, purine & pyrimidine bases, double helix of DNA, base pairing via H-bonding, various types of RNA & their functions.	**11hrs**
Unit-III	**Heterocyclic Compounds** **Heterocyclic Chemistry:** IUPAC nomenclature of heterocyclic ring systems (3-7 memberd rings and simple fused systems) comparative aromaticity of pyrrole, furon, thiophene, pyridine. Methods of synthesis, electorphilic and nucleophilic substitutions reactions of pyrrole, furon, thiophene, pyridine ring systems. Compression of basecity of pyridine, piperidine and pyrrole. Fused heterocycles of 6 & 5 memberd rings-synthesis and reactions of indole, benzofurn, quinoline, isoquinoline with special references to Fischer indole synthesis, and Skraup synthesis, Bischler-Napier Laski synthesis, mechanism of electorphilic substitution reaction of indole, quinoline and benzofurn	**12 hours**

Unit-IV	**Reagents in Organic synthesis and their uses** Use of following reagents in organic synthesis and functional group transformation i) Dicyclohexylcarbodiimide (DCC) ii) Tri-n-butyltin hydride iii) Wood ward and Pre Vost hydroxylation iv) Osmium tetroxide v) DDQ vi) Selinium dioxide vii) Phase transfer catalysis viii) Crown ethers ix) Merrifield resin x) Peterson's synthesis , Carbonyls and Aromatic compounds. Miscellaneous photochemical reactions.	**12hrs**
Unit-V	**Organic Photochemistry** Concepts in Organic photochemistry- forbidden transitions, excited states, types of excitations, Frank-Condon principle. Chemical processes in excited molecules, hydrogen abstraction, cleavage of radicals, intra-molecular rearrangements, photo-isomerisation, photo-dimerisation and photo-sensitisation. Determination of reaction mechanisms. Photochemistry of Alkenes, Carbonyls and Aromatic compounds. Miscellaneous photochemical reactions	**11hrs**

References:

1. Natural Products Vol.I & II by O.P. Agarwal Goel publications – Meerut.
2. Burger's Medicinal Chemistry, M.E. – Wolff, Ed., John Wiley & Sons, New York
3. Chemistry of Natural Products, 1st Edition, S. V. Bhat, B. A. Nagasampagi and M. Sivakumar, 2008, Narosa Publishing House
4. Organic Chemistry, Vol.II by I.L. Finar, The English Language Book Society, London
5. Organic Chemistry-P.Y.Bruice (Pearson Education Pvt. Ltd., New Delhi),2002.
6. Organic Chemistry-Vol. -1,2 &3- Mukherji, Singh and Kapoor. (Wiley Eastern,) 1994.
8. Organic Chemistry-3rd Edn- F.A. Carey (Tata McGraw Hill, New Delhi) 1996
9. Organic Chemistry-R.T. Morrison and R.N. Boyd (Prentice Hall, New Delhi) 1994.
10. Organic Chemistry 4th Edn.–S.H. Pine et al (McGraw-Hill, London) 1987.
11. Advanced Organic Chemistry- R.A. Carey and R.J. Sundberg (Plenum, New York)1990.
12. Modern Concepts of Advanced Organic Chemistry-R.P. Narein (Vikas, Delhi) 1997.
13. A Text book of Organic Chemistry-Tewari, Vishnoi and Mehrotra (Vikas, New Delhi)1998.
14. A Text book of Organic Chemistry-3rd Edn.-R.K. Bansal, (New Age, New Delhi) 1997.
15. R. M. Acheson, An Introduction to the Chemistry of Heterocyclic Compounds, Interscience NY
16. Chemistry of Natural Products: A Unified Approach, N.R. Krishnaswamy, University Press (India) Ltd., Orient Longman Limited, Hyderabad, 1999. (Overall and for certain

aspects of, azadirachtin, morphine, reserpine,).
17. Introduction to Organic Chemistry, A Streitweiser, CH Heathcock and E.M/ Kosover IV Eeition, Me.Milan, 1992
18. Molecular reactions and Photochemistry by Charles Dupey and O. Chapman, Prentice Hall

Date Course Coordinator Subject Committee Chairperson

DSC 7: Electro, Quantum and Photochemistry

Course Title: Electro, Quantum and Photochemistry	**Course code**: 21 ICH2 C7 L
Total Contact Hours: 56	**Course Credits:** 02
Formative Assessment Marks: 20	**Duration of ESA/Exam:** 03
Summative Assessment Marks: 30	

Course Objective: A study of physical chemistry aspects related to the electrochemistry, quantum chemistry and photochemistry in the second semester should give the essential information on the topics of reversible and irreversible electrode process, electro analytical techniques, aspects on quantum chemistry, photochemistry, symmetry and group theory.

Course outcomes :

At the end of the advanced physical chemistry course, student should be able to

1. Differentiate between reversible and irreversible electrochemical process.
2. List the types of overvoltage and determine the overvoltage
3. Explain the theory and principles of polarography
4. Summerize the equations related to electrokinatic phenomenon
5. Estimate the quantum yields in the photochemical reaction
6. Explain the working principle of actinometers
7. Predict entropy of translational function.
8. Understand the statistical theories of thermodynamics
9. Describe the wave-particle duality
10 Apply schorodinger wave equation to one dimensional and three dimensional box.
11. Validate quantum chemistry with experimental observations
12. Demonstrate symmetry operations
13. Construct the character table
14. Apply group theory for Determination of vibration modes, hybridization, molecular orbitals

DSC7: Electro, Quantum and Photochemistry

Unit	Description	Hours
Unit-I	Electrokinetic Phenomena Introduction, reversible and irreversible electrodes. Polarization, 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, potential curves, thickness of diffusion layer, diffusion controlled current potential curves at a dropping mercury electrode, polarography, half wave potential, application in qualitative and quantitative analysis. Energy barrier and electrode kinetics, Buttler-Volmer equation, Tafel equation	**12hrs**
Unit-II	**Photochemistry** Introduction to photochemistry, quantum yield and its determination, factors affecting quantum yield, actinometry-uranyloxalate and potassium ferrioxalate actinometres, acetone and diethylketone actinometres. Term symbols and significance. Photosensitization: by mercury, dissociation of H_2, photochemical kinetics of: decomposition of CH_3CHO, formation of HCl. Photodegradation: photocatalyst-ZnO, TiO_2, principle, application of ZnO/TiO_2 in the photodegradation of dyes(IC), pesticides (DDT) and in industrial effluents. Effect of photodegradation on COD values	**10hrs**
Unit-IV	Statistical Thermodynamics-II Sackur-Tetrode equation for entropy of translation function. Relation between equilibrium constant and partition function. Different Distribution Laws:Types of Statistics : Maxwell – Boltzmann , Bose-Einstein and Fermi-Dirac statistics. Derivation of the equations for above three distribution Laws. Comparision of Bose-Einstein and Fermi-Dirac statistics with Maxwell – Boltzmann statistics. Problems and their Solutions. Non-equillbrium Thermodynamics : Thermodynamic criteria for non-equillibrium states-Phenomenological Laws and Onsager's reciprocity relations, Coupled and Non-coupled	

	reactions, Entropy production and entropy flow. Postulates and methodologies: Uncompensated heat and thermodynamics function production. de- Donder's inequality. Rate of entropy production. Transformations of the generalized fluxes and forces : eg., Chemical reaction, heat flow, Diffusion or material flow, flow of electric current.	**11hrs**
Unit-V	**Symmetry and Group Theory** Symmetry elements & Symmetry operations, groups, subgroups, cyclic groups conjugate relationships, classes, molecular 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 and their construction (C_{2v}, C_{2h}, C_{3v})– Mullikan symbols, molecular models. Determination of vibration modes, hybridization, molecular orbitals on the basis of group theory	**11hrs**

.**References:**Modern Electrochemistry, Vol I, IIA & IIB J.O.M. Bockries and A.K.N.Reddy (1998)

2. Electrochemistry,, Samuel Glasstone, East-West, New Delhi

3. Principles & Applications of Electrochemistry, D R Crow, 3rd Edn., Chapman & Hall,1987
4. Photochemistry, Carol E Wayne and Richard P Wayne, Oxford University Press, (1996)
5. Molecular Reactions and Photochemistry, C H Deputy and D S Chapman, Prentice Hall India, New Delhi (1st Edition) , 1972.
6. Concepts of Inorganic photochemistry, A. W. Adamson and P D Fleischaves Wiley
7. Quantum Chemistry, Ira N. Levine, 5th Edn., Prentice Hall of India Pvt. Ltd., 2006
8. Quantum Chemistry, A. B. Sannigrahi, 2nd Edn., Arunabha Sen Books and Allied Pvt. Ltd.,2010
9. Molecular Quantum Mechanics, P. W. Atkins, , Oxford University Press, New York, 2005.
10. Quantum Chemistry, Donald A McQuanie, Viva Books Pvt. Ltd., 2013
11. Thermodynamics for Chemists, S Glasstone, East-west Editon, New Delhi, 2003.
12. Chemical Thermodynamics-Basic Theory and Methods, 4th Edn., Klotz, Rosenbeg, Benjamin,1986
13. F. A. Cotton, *Chemical Applications of Group Theory*, Wiley Interscience, New York,2006.
14. P. H. Walton, *Beginning Group Theory for Chemistry*, Oxford University Press Inc., New York, 1998.
15. L. H. Hall, *Group Theory and Symmetry in Chemistry*, Mc Graw Hill, New York, 1969.
16. R. Mc Weeny, *Symmetry: An Introduction to Group Theory and its Applications,* Pergamon Press, London, 1963.

DSC 8: Instrumental methods of analysis

Course Title: Instrumental methods of analysis	**Course code**: 21 ICH2 C8 L
Total Contact Hours: 56	**Course Credits**: 04
Formative Assessment Marks: 30	**Duration of ESA/Exam:** 03
Summative Assessment Marks: 70	

Course Objective: A study of analytical chemistry aspects related to the chromatography, Electroanalytical and separation techniques ans X-Ray diffraction shall impart essential information on the topics which are very important and relevant.

Course outcomes:

At the end of the this course, students should be able to

1. Explain the basic principles of chromatography.
2. Classify the types of chromatography.
3. Define the basic parametres in chromatography.
4. categorize the types, basic components and properties of liquid chromatography. 5. 5. Describe the principles and working of GLC and HPLC along with their applications in pharmaceutical industries.
5. Describe the theory behind the technique of Atomic Absorption and Emission Spectroscopy
6. Identify and troubleshoot the interferences that occur during the analysis.
7. Decide about the suitable light source for the analysis.
8. Compare various current electroanalytical techniques
9. Comprehend the factors that must be controlled to obtain reliable and reproducible data from electroanalytical experiments.
10. Identify the most appropriate electroanalytical technique for a specific analysis
11. Interpret the data using current theoretical models
12. Describe the electrode reaction mechanism from data obtained using several electroanalytical techniques
13. Identify symmetry and space groups
14. Characterize the crystal using X-ray diffraction experiments
15. Analyze the collected experimental data•
16. Interpret the images of SEM and TEM.

DSC8: Instrumental methods of analysis

Unit I	Description	Hours
	: Chromatography Ion Exchange Chromatography: Definitions, requirements for ion exchange resin, synthesis and types of ion exchange resins, principle, basic features of ion exchange reactions, ion exchange capacity, applications of ion exchange chromatography in preparative, purification and recovery processes, process of elution. Gas Liquid Chromatography: Principle, apparatus, columns, simple application, mobile phase, stationary phases, detectors Applications. HPLC Principles: Instrumentation-columns, stationary phase and matrices, simple applications, mobile phase pumps, detectors.	**10hrs**
Unit-II	**: AAS, Flame photometry and FES** **Flame Photometry and Atomic Absorption Spectrometry:** Principles and Theory - Instrumentation - Flames - Burners - Non-flame Techniques - Spectral and Chemical Interferences - Experimental Aspects. **Atomic Emission Spectrometry and Inductively Coupled Plasma:** Principles and Instrumentation - Excitation source - Limitations of AES - Principles of Plasma Spectroscopy - Excitation Source in ICP –Applications	**12hrs**
Unit-III	**Electro-analytical Techniques** **Conductometry :** Theory- Measurement of Conductivity - Basis for Conductometric titrations - Conductometry as an analytical tool. **Potentiometry :** Principles - Reference electrodes - indicator electrodes, selective electrodes - measurement of cell emf - potentiometric titrations. **Voltametry :** Polarography - Direct current Polarography - Theory - Dropping Mercury Electrode- Quantitative technique - Measurement of Wave Heights - Pulse Polarography - Rapid Scan Polarography - Stripping Voltametry - Cyclic Voltametry. **Amperometry :** Principles, amperometric titrations with examples. **Elecrogravimetry:** Theory, completeness and nature of the deposit, instrumentation, electrolytic separation of metals and applications	**13hrs**

Unit-IV	: **Electro separation 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.** Electroosmosis: Principles, Instrumentation and applications. Field flow fractionation: Separation mechanisms, Methodology, Advantages over chromatographic methods.	**10hrs**
Unit-V	**XRD, and Photoelectron Spectroscopy** **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 - single crystal and polycrystalline diffraction studies. 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 ESC	**11hrs**

References:

1. D. A. Skoog and D. M. West, F. J. Holler and S. R. Crouch, *Fundamentals of Analytical Chemistry*, Brooks/Cole, Florence, 2004.
2. G. D. Christian, *Analytical Chemistry*, 6th edition, John Wiley & Sons, Singapore, 2008.
3. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, B. Sivasankar, *Vogel's Textbook of Quantitative Chemical Analysis*, Pearson Education Ltd., New Delhi, 2000
4. H. H. Williard, L. L. Merrit, J. A. Dean and F. A. Settle, *Instrumental Methods of Analysis*, Wadsworth Publishing Company, Belmont, California, 1986.
5. D. Harvey, *Modern Analytical Chemistry*, McGraw Hill Higher Education, New York, 2000
6. Modern methods of Chemical analysis-Pecsok, Shields, Cairns and McWilliams (2nd edition), John Wiley and Sons (1976).
7. Vogel's Textbook of Quantitative Inorganic Analysis, Bassett, Denney, Jeffery and Mendham, (4th edition) ELBS (1989).
8. Treatise on analytical Chemistry-Kolthoff, Elving and Krivan (2nd edition) John Wiley &Sons (1986).

9. Commercial methods of analysis-Snell and Biffen, McGraw Hill, (1944)
10. Hand Book Of Instrumental Techniques For Analytical Chemistry, Frank Settle, Prentice Hall PTR (1997)
12. Instrumental methods of Chemical Analysis, G. W. Ewing, 5th edition, McGraw-Hill, New York, 1988.
13. Electrochemical methods: A.J. Bard & l. R. Faulkner, 2nd edition, Wiley, New York, 2000.
14. An Introduction to X-ray Crystallography, M. M. Woolfson, Cambridge University Press-Vikas Publishing House, New Delhi (1980).
15. Principles of the solid State, H.V.kheere, Wiley Eastern Ltd., New Delhi (1993).
16. X-Ray structure determination: A practical guide, George H Sout and Lyle H Jenson, Macmillan Publishing Co.Inc and Collier Macmillan Publishers.

Date Course Coordinator Subject Committee Chairperson

Course: **Research Methodology**	**Course Code**: 21 ICH2 S2 P
Teaching Hours/Week(L-T-P):28	**No of Credits:**02
Internal Assessment: 20	**Semester End Examination:**50Marks

Course Objective: The Objective of the course **i**s to make the students to know about the research activities so that they can prepare and plan there future.

Course Out Comes: After the completion of the course the students wald be able to:

1. Explain the importance of research in the field of chemistry.
2. Earn the knowledge formualative the research plan
3. Interpret the research data
4. Acquire the knowledge of reporting scientific matters
5. Implement either of research
6. Understand the important of plants & copyrights

Unit	Description	Hours
Unit-I	**Research Methodology:** **COURSE CONTENTS UNIT I –RESEARCH FORMULATION AND DESIGN** Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis.	**14**
Unit-II	**INTERPRETATION AND REPORT WRITING** Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions	**07**
Unit-III	**Intellectual property rights (IPR)** – patents-copyrights-Trademarks-Industrial design geographical indication. Ethics of Research- Scientific Misconduct- Forms of Scientific Misconduct. Plagiarism, Unscientific practices in thesis work, Ethics in science	**07**

References

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2.Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p. 1
5. Wadehra, B.L. 2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.

DSC 5P Synthesis of Coordination Compounds

Course: Synthesis of Coordination Compounds	**Course Code**: 21 ICH2 C4 P
Teaching Hours/Week(L-T-P):28	**No of Credits:**02
Internal Assessment:20	**Semester End Examination:**50Marks

Course Objective : The objective of this course is to make the students to familiarize with the synthesis of complexes followed by analysis for its metal content and recording electronic spectrrum.

Course Outcomes :

After learning this course the student would be able to,

1. Prepare and analyze the complexes.
2. Record the electronic spectrum
3. Correlate the spectral data to account for its colour and structure.

Description	Hours
Experiments : Preparation and quantitative analysis of inorganic complexes: 1. Cis- and trans- potassium dioxalatodiaquachromium(III) complex [analysis of oxalate and chromium] 2. Hexamminecobalt(III)chloride [analysis of cobalt] 3. Preparation of pentamminechloro cobalt(III)chloride. Preparation of selective inorganic compounds (any four). Record the electronic spectra of any three complexes and identify transitions. (a). $VO(acac)_2$, (b). $Na[Cr(NH_3)_2(SCN)_4]$ (c). $K_3[Fe(C_2O_4)_3]$ (d). Prussian Blue (e). $[Co(Py)_2Cl_2]$ (f). $[Cu(NH_3)_4]SO_4.H_2O$	**56**

References :

1. Vogel's Text book of Qualitative Chemical Analysis, J. Bassett, G. H. Jeffery and J. Mendham, ELBS (1986).
2. Vogel's text book of Quantitative Chemical Analysis, 5th Edition, J. Bassett, G. H. Jeffery and J. Mendham, and R. C. Denny, Longman Scientific and Technical (1999).
3. Inorganic Semimicro Qualitative Analysis, V. V. Ramanujam; The National Pub. Co. (1974).
4. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Von Nostrand Reinhold Co., London (1972).

DSC 6P: Organic Synthesis

Course Title: Organic Synthesis	**Course code:** 21 ICH2 C5 P
Total Contact Hours: 56	**Course Credits**: 02
Formative Assessment Marks: 20	**Duration of ESA/Exam:** 03
Summative Assessment Marks: 30	

Course Objective : The objective of this course is to make the students to acquire expertize in preparing the organic compounds followed recrystallization and recording of IR spectrum of any two compounds.

Course Outcomes :

After learning this course the student would be able to,

1. Synthesize organic compounds and acquire the skill of purifying.
2. Explain the mechanism involved in the reaction.
3. Interpret the functional groups using IR spectra

Description	Hours
Experiments : **Organic Synthesis:** i. Eosin from phthalic anhydride. ii. Benzene azo-β-naphthol(Dye) iii. Bakelite (Polymer). iv. Acetyl salicylic acid (Aspirin). v. Synthesis of p-hydroxyacetanilide (Paracetamol). vi. Oil of wintergreen (Methyl Salicylate) 3. Quantitative Analysis (Any two): A. Determination of the percentage or number of hydroxyl groups in an organic compound by acetylation method. B. Estimation of amine/phenols using bromate bromide solution or acetylation method.	**56**

References: 1. 1. Laboratory manual of Organic Chemistry- B. B. Dey, M V Sitaraman and T RGovindachari, Allied Publishers, New Delhi, (1996). 2. Practical Organic Chemistry – Mann and Saunders, (1980). 3. Text Book of Practical Organic Chemistry- A. I. Vogel, (1996). 4. Test Book of Quantitative Organic Analysis- A. I. Vogel, (1996). 5. A Handbook of Organic Analysis – Clarke and Hayes, (1964). 6. Comprehensive practical organic chemistry : Preparation and quantitative Analysis, V. K. Ahluwalia, R. Aggarwal, Universities Press (India), 2000. 7. Comprehensive practical organic chemistry: Qualitative analysis, V. K. Ahluwalia, S.Dhingra, Universities Press (India), 2000. 8. An advanced course in practical chemistry, A. Ghoshal, B. Mahapatra and	

A. Kr. Nad, New central book agency, Calcutta, 2000. 9. Advanced practical organic chemistry, J. Mohan, Vol. I and II, Himalaya Publishing House, 1992. 10. Practical organic chemistry (Quantitative analysis), B. B. Dey, M. V. Sitaraman and T. R. Govindachari, Allied Publishers, New Delhi, 1992.	

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DSC 7P : Instrumental methods of analysis

Course Title: Instrumental methods of analysis	**Course Code :**21 ICH2 C6 P
Total Contact Hours: 56	**Course Credits**: 02
Formative Assessment Marks: 20	**Duration of ESA/Exam:** 03
Summative Assessment Marks: 30	

Course objectives:

In the second semester laboratory, students are expected to gain the hands on skill for handling spectrometer, potentiometer, skill on preparation of solutions with known concentrations. conductometer. complementary to the learning objective of discipline specific course, student should carry out the experiments related to determination of PKa Value of different chemical compounds. Students will also trained on determination of acid strengths, determination of Standard electrode potentials. Quantification of metal ions.

Course outcome:

At the end of the practical physical chemistry course, student should acquire a skill to

1. Handling of spectrometer
2. Determine the PKa values for phosphoric acid and acetic acid
3. Construct and verify the Beer's law
4. Acquire a skill on measurement of standard electrode potentials
5. Observe the rate of corrosion in acid medium
6. Compare the strengths of hydrochloric acid and phosphoric acid.
7. Demonstrate the extraction process
8. Determine the distribution coefficient.

Description	Hours
Experiments : 1. Potentiometric titration of KI versus $KMnO_4$ 2. Potentiometric Titrations of Fe(II) versus Ceric ammonium sulphate and determination of amount of Iron present in a solution 3. Spectrometric titration of Fe(II) Ions versus Potassium dichromate 4. Potentiometric titrations of available Chlorine in a bleaching powder 5. Determination of Dissociation constant of a weak acid conductometrically 6. Determination of pK_{a1} and pK_{a2} of Oxalic acid by potentometric titration 7. Determination of pK_{a1} and pK_{a2} and pK_{a3} of phosphoric acid by potentometric titration	

8. Determination of standard electrode potentials-Measurements of potentials-Danial cell 9. Determination of distribution coefficient using distribution of acetic acid and benzoic acid in water 10. Determination of distribution coefficient using distribution of acetic acid and benzoic acid in chloroform 11. Comparison of the strengths of HCl and H_2SO_4 by studying the kinetics of hydrolysis of methyl acetate 12. Corrosion studies on a metal in acid medium	**50**

References:

1. Practical Physical Chemistry- A.J.Findlay.
2. Experimental Physical Chemistry-F.Daniel et el.
3. Selected Experiments in Physical Chemistry- Latham.
4. Experimental Physical Chemistry- Janes and Parichard.
5. Experimental Physical Chemistry- Shoemaker.
6. Experimental Physical Chemistry- Yadav, Goel Publishing House

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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