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_N^2, S_N^1, mixed S_N^2 and S_N^1 and SET mechanisms. The neighboring group mechanism, neighboring group participation by π and σ bonds.Common carbocation rearrangements.The S_N^imechanism.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-$S_E^2$and S_E^1, 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: 21CHE1C4L
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: 21CHE1S1LT
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 – 583 105

Department of Studies in Mathematics

SYLLABUS

Master of Science
(I-IV Semester)

With effect from
2021-22