MANGALORE UNIVRSITY

Name of the Degree Program: BSc (Honors) Chemistry with Analytical Specialization

Discipline Core: Chemistry **Total Credits for the Program: 176**

Starting year of implementation: 2021-22

Program Outcomes:

By the end of the program the students will be able to:

(Refer to literature on outcome based education (OBE) for details on Program Outcomes)

1. **PO. 1:** To create enthusiasm among students for Analytical chemistry and its application in various fields of life.
2. **PO. 2:** To provide students with broad and balanced knowledge and understanding of key concepts in Analytical chemistry
3. **PO. 3:** To develop in students a range of practical skills so that they can understand and assess risks and work safely measures to be followed in the laboratory.
4. **PO. 4:** To develop in students the ability to apply standard methodology to the solution of problems in chemistry
5. **PO. 5:** To provide students with knowledge and skill towards employment or higher education in Analytical chemistry or multi-disciplinary areas involving Analytical chemistry.
6. **PO. 6:** To provide students with the ability to plan and carry out experiments independently and assess the significance of outcomes and to cater to the demands of chemical Industries of well-trained graduates
7. **PO. 7:** To develop in students the ability to adapt and apply methodology to the solution of unfamiliar types of problems.
8. **PO. 8:** To instil critical awareness of advances at the forefront of chemical sciences, to prepare students effectively for professional employment or research degrees in chemical sciences and to develop an independent and responsible work ethics

Assessment:

Weightage for assessments (in percentage)

Type of Course	Formative Assessment / IA	Summative Assessment
Theory	**40**	**60**
Practical	**25**	**25**
Projects	**-**	**-**
Experiential Learning (Internships etc.)	**-**	**-**

Curriculum Structure for the Undergraduate Degree Program
BSc (Honors) Chemistry with Analytical Specialization

Total Credits for the Program: 176 Starting year of implementation: 2021-22
Name of the Degree Program: B. Sc (Honors) Discipline/Subject: Chemistry

Program Articulation Matrix:

This matrix lists only the core courses. Core courses are essential to earn the degree in that discipline/subject. They include courses such as theory, laboratory, project, internships etc. Elective courses may be listed separately

Semester	Title /Name Of the course	Program outcomes that the course addresses (not more than 3 per course)	Pre-requisite course(s)	Pedagogy##	Assessment$
1	**DSC-1: Analytical and Organic Chemistry-I**	• The concepts of chemical analysis, accuracy, precision and statistical data treatment • Understand the preparation of alkanes, alkenes and alkynes, their reactions, etc. • Understand the mechanism of nucleophilic, electrophilic reactions	P.U.C with Chemistry	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	DSC lab-1: Analytical and Organic Practical's-I	• The students will be able to learn how to handle the glassware, prepare and dilute solutions and perform the experiments with prepared reagents • The students will be able to determine the analyte through volumetric and gravimetric analysis and understand the chemistry involved in each method of analysis.	-	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams

		• The students will be able to deduce the conversion factor based on stoichiometry and in turn use this value for calculation			
2	**DSC-2: Inorganic and Physical Chemistry-I**	• The Bohr's theory of atomic structure and how it was developed • Quantum numbers and their necessity in explaining the atomic structure • The concept of unit cell, symmetry elements, Nernst distribution law.	-	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
	DSC Lab -2: Inorganic and Physical Practical's-I	• To prepare standard solutions • Techniques like precipitation, filtration, drying and ignition • Various titrimetric techniques and gravimetric methods		Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
3	**DSC-3: Analytical and Organic Chemistry-II** **DSC Lab-3: Analytical and Organic Practical's-II**		DSC-1 and DSC-2	Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams
4	**DSC-4: Inorganic and Physical Chemistry-II** **DSC Lab-4: Inorganic and Physical Practical's-II**			Assignment Desk work	Internal Exams, Continuous Evaluation, Sem Exams

5.	**DSC-5: Selected topics in Inorganic Chemistry** **DSC Lab-5: Inorganic Chemistry Practical's** **DSC-6: selected topics in Organic Chemistry** **DSC Lab-6: Organic Chemistry Practical's**		DSC-3 and DSC-4	MOOC, Problem solving	Internal tests, Assignments, Quiz
6.	**DSC-7: Selected topics in Physical Chemistry** **DSC Lab-7: Physical Chemistry Practical's.** **DSC-8: Spectroscopy** **DSC Lab-8: Analytical and Industrial Chemistry Practical's**			MOOC, Problem solving	Internal tests, Assignments, Quiz
7.	**DSC-9 :Analytical Techniques=I** **DSC Lab-9: Analytical Chemistry.** **DSC-10:Applied Chemical Analysis.** **DSC Lab-10 :Analytical Chemistry.** **DSC-11: Enviornmental and Nanomaterial Chemistry.**		DSC-5, DSC-6, DSC-7 and DSC-8	MOOC, Problem solving	Internal tests, Assignments, Seminar, Debate, Quiz
8.	**DSC-12: Analytical Techniques-II** **DISIPLINE A13(4)** **DSC-13: Separation and Electroanalytical Techniques.** **DSC-14: Analysis of food and pharmaceuticals**			Project work, Industrial Visit	Internal tests, Assignments, Seminar, Debate, Quiz

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Pedagogy for student engagement is predominantly lectures. However, other pedagogies enhancing better student engagement to be recommended for each course. The list includes active learning/ course projects/ problem or project based learning/ case studies/self study like seminar, term paper or MOOC

$ Every course needs to include assessment for higher order thinking skills (Applying/ Analyzing/ Evaluating/ Creating). However, this column may contain alternate assessment methods that help formative assessment (i.e. assessment for learning).

BSc Chemistry (Honors) with specialization in Analytical Chemistry

Semester 1

Course Title: DSC-1: Analytical and Organic Chemistry-I	
Total Contact Hours: 56	Course Credits: 4
Formative Assessment Marks: 40	Duration of ESA/Exam: 3 hrs
Model Syllabus Authors: Chairman	Summative Assessment Marks: 60

Course Pre-requisite(s): *Mention only course titles from the curriculum that are needed to be taken by the students before registering for this course.*

PUC with Chemistry

Course Outcomes (COs):

At the end of the course the student should be able to:

(Write 3-7 course outcomes. Course outcomes are statements of observable student actions that serve as evidence of knowledge, skills and values acquired in this course)

1. The concepts of chemical analysis, accuracy, precision and statistical data treatment
2. Prepare the solutions after calculating the required quantity of salts in preparing the reagents/solutions and dilution of stock solution.
3. The concept of volumetric and gravimetric analysis and deducing the conversion factor for determination
4. Handling of toxic chemicals, concentrated acids and organic solvents and practice safety procedures.
5. The concepts of Organic reactions and techniques of writing the movement of electrons, bond breaking, bond forming
6. The Concept of aromaticity, resonance, hyper conjugation, etc.
7. Understand the preparation of alkanes, alkenes and alkynes, their reactions, etc.
8. Understand the mechanism of nucleophilic, electrophilic reactions

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12
1	X											
2	X											
3	X											
4	X											
5	X											

6	X											
7	X											
8	X											

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

BA/BSc/BCom/BBA/BCA

BSc Semester 1 – Chemistry (Hons) with specialization in Analytical Chemistry

Title of the Course: DSC-1: Analytical and Organic Chemistry – I

Number of Theory Credits	Number of lecture hours/ semester	Number of practical Credits	Number of practical hours/ semesters
4	56	2	56

Content of Theory Course 1	56Hrs
Unit – 1	14
Language of analytical chemistry: Definitions of analysis, determination, measurement, techniques and methods. Classification of analytical techniques. Choice of an analytical method - accuracy, precision, sensitivity, selectivity, method validation. Figures of merit of analytical methods and limit of detection (LOD), Limit of quantification (LOQ), linear dynamic range (working range). Errors and treatment of analytical data: Limitations of analytical methods – Errors: Determinate and indeterminate errors, absolute error, relative error, minimization of errors. Statistical treatment of finite samples -mean, median, range, standard deviation and variance. External standard calibration - regression equation (least squares method), correlation coefficient (R^2). Numerical problems Basic laboratory practices, calibration of glassware (pipette, burette and volumetric flask), Sampling (solids and liquids), weighing, drying, dissolving, Acid treatment, Rules of work in analytical laboratory, General rule for performing quantitative determinations (volumetric and gravimetric), Safety in Chemical laboratory, Rules of fire prevention and accidents, First aid. Precautions to be taken while handling toxic chemicals, concentrated/fuming acids and organic solvents.	
Unit - 2	14
Titrimetric analysis: Basic principle of titrimetric analysis. Classification, Preparation and dilution of reagents/solutions. Normality, Molarity and Mole fraction. Use of $N_1V_1 = N_2V_2$ formula, Preparation of ppm level solutions from source materials (salts), conversion factors. Acid-base titrimetry: Titration curves for strong acid vs strong base, weak acid vs strong base and weak base vs strong acid titrations. Titration curves, Quantitative applications – selecting and standardizing a titrant, inorganic analysis - alkalinity, acidity. Complexometric titrimetry: Indicators for EDTA titrations - theory of metal ion indicators, titration methods employing EDTA - direct, back, displacement and indirect determinations, Application-determination of hardness of water. Redox titrimetry: Balancing redox equations, calculation of the equilibrium constant of redox	

reactions, titration curves, Theory of redox indicators, calculation of standard potentials using Nernst equation. Applications. Precipitation titrimetry: Titration curves, titrants and standards, indicators for precipitation titrations involving silver nitrate- Volhard's and Mohr's methods and their differences. Gravimetric Analysis: Requisites of precipitation, mechanism of precipitation, Factors influencing precipitation, Co-precipitation, post-precipitation, Advantages of organic reagents over inorganic reagents, reagents used in gravimetry (8-hydroxy quinoline (oxine) and dimethyl glyoxime (DMG). Numerical problems on all the above aspects.	
Unit - 3	14
Classification and nomenclature of organic compounds, Hybridization, Shapes of organic molecules, Influence of hybridization on bond properties. **Nature of bonding in Organic molecules** Formation of Covalent bond, Types of chemical bonding, localized and delocalized, conjugation and cross conjugation, concept of resonance, electronic displacements: Inductive effect, Electromeric effect, Resonance and Hyper conjugation, cross conjugation explanation with examples. Concept of resonance, aromaticity, Huckel rule, anti-aromaticity explanation with examples. Strengths of Organic acid and bases: Comparative study with emphasis on factors effecting pK values. Relative strength of aliphatic and aromatic carboxylic acids-Acetic acid and chloroacetic acid, acetic acid and propionic acid, acetic acid and Benzoic acid. Steric effect- Relative stability of trans and cis-2-butene. **Mechanisms of Organic Reactions** Notations used to represent electron movements and directions of reactions- curly arrows, formal charges. Types of bonds breaking- homolytic and heterolytic. Types of reagents-Electrophiles, nucleophiles, nucleophilicity and basicity. Types of organic reactions- substitution, addition, elimination, rearrangement and pericyclic reactions, explanation with examples. Chemistry of Aliphatic hydrocarbons, Carbon-Carbon Sigma bonds Chemistry of alkanes: Formation of alkanes, Wurtz reaction, Wurtz-Fittig reaction, Free radical substitution, Halogenation- relative reactivity and selectivity **Carbon-carbon pi bonds** Formation of alkenes and alkynes by elimination reaction. Mechanism of E1, E2, E1cb reaction. Saytzeff and Hofmann eliminations. Addition of HBr to propene, Free radical addition of HBr to propene. Addition of halogens to alkenes-carbocation and halonium ion mechanism. Stereospecificity of halogen addition. Ozonolysis mechanism - ozonolysis of propene. Addition of hydrogen halides to alkenes, mechanism, regioselectivity and relative rates of addition. Hydrogenation, hydration, hydroxylation and epoxidation of alkenes, explanation with examples, 1,2 and 1,4- addition reactions in conjugated dienes. Diels-Alder reaction, Allylic and benzylic bromination and mechanism in propene, 1-butene, 1-toluene and ethylbenzene.	
Unit - 4	14
Nucleophilic substitution at saturated carbon. Mechanism of S_N1 and S_N2 reactions with suitable examples. Energy profile diagrams, Stereochemistry and factors effecting S_N1 and S_N2 reactions. Aromatic Electrophilic substitution reactions, Mechanisms, σ and π complexes, Halogenation, Nitration, Sulphonation, Friedel Crafts alkylation and acylation with their mechanism. Activating and deactivating groups. Orientation influence, Ortho-para ratio. Aromatic nucleophilic substitution reaction: S_NAr and Benzyne mechanism with suitable examples	

Text Books

1. 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.(2007).
2. Fundamentals 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, 6th edition, Wiley-India (2007).
4. Practical Volumetric Analysis, Peter A C McPherson, Royal Society of Chemistry, Cambridge, UK (2015).
5. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
6. Finar, I. L. *Organic Chemistry (Volume I),* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)

7. McMurry, J. E. *Fundamentals of Organic Chemistry,* 7th Ed. Cengage Learning India Edition, 2013
8. Organic Reaction mechanism by V. K. AhIuwalia and K. Parashar (Narosa Publishers).
9. Organic Chemistry by S. M. Mukherji, S. P. Singh and R. K. Kapoor. (Narosa Publishers)
10. A Guide book to mechanism in Organic Chemistry by Peter sykes. Pearson.

References

Pedagogy

Formative Assessment	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test	40
Sem End Exam	60
Total	100

Content of Practical Course 1: List of Experiments to be conducted

PART-A Analytical Chemistry

1. Calibration of glassware, pipette, burette and volumetric flask.
2. Determination of sodium carbonate and sodium bicarbonate in a mixture.
3. Determination of alkali present in soaps/detergents
4. Determination of iron(II) using potassium dichromate
5. Determination of oxalic acid using potassium permanganate solution
6. Standardization of EDTA solution and determination of hardness of water
7. Standardization of silver nitrate and determination of chloride in a water sample (demonstration)
8. Determination of alkali content in antacids

PART-B Organic Chemistry

1. Selection of suitable solvents for Purification/Crystallization of organic compounds.
2. Preparation of acetanilide from aniline using Zn/acetic acid (Green method).
3. Synthesis of p-nitro acetanilide from acetanilide using nitrating mixture.
4. Bromination of acetanilide (i) Conventional method and/or (ii) with ceric ammonium nitrate and potassium bromide (Green method).
5. Hydrolysis of methyl m-nitrobenzoate to m-nitrobenzoic acid (Conventional method)
6. Synthesis of diazoaminobenzene from aniline (conventional method).
7. Preparation of dibenzalacetone (Green method).
8. Diels Alder reaction between furan and maleic acid (Green method).

BSc Semester 1 – Chemistry (Hons) with specialization in Analytical Chemistry

Title of the Course: OE-1: CHEMISTRY IN DAILY LIFE

Number of Theory Credits	Number of lecture hours/ semester	Number of practical Credits	Number of practical hours/ semesters
3	42	-	42

Content of Theory Course 1	42 Hrs
Unit – 1	14
Dairy Products: Composition of milk and milk products. Analysis of fat content, minerals in milk and butter. Estimation of added water in milk. Beverages: Analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy, determination of methyl alcohol in alcoholic beverages. **Food additives, adulterants, and contaminants**- Food preservatives like benzoates, propionates, sorbates, disulphites. Artificial sweeteners: Aspartame, saccharin, dulcin, sucralose, and sodium cyclamate. Flavors: Vanillin, alkyl esters (fruit flavors), and monosodium glutamate. **Artificial food colorants:** Coal tar dyes and non-permitted colors and metallic salts. Analysis of pesticide residues in food.	
Unit - 2	14
Vitamins: Classification and Nomenclature. Sources, deficiency diseases, and structures of Vitamin A1, Vitamin B1, Vitamin C, Vitamin D, Vitamin E & Vitamin K1. **Oils and fats**: Composition of edible oils, detection of purity, rancidity of fats and oil. Tests for adulterants like argemone oil and mineral oils. Halphen test. **Soaps & Detergents**: Definition, classification, manufacturing of soaps and detergents, composition and uses	
Unit - 3	14
Chemical and Renewable Energy Sources: principles and applications of primary & secondary batteries and fuel cells. Basics of solar energy, future energy storer. **Polymers:** Basic concept of polymers, classification and characteristics of polymers. Applications of polymers as plastics in electronic, automobile components, medical fields, and aerospace materials. Problems of plastic waste management. Strategies for the development of environment-friendly polymers.	

Text Books

1. B. K. Sharma: Introduction to Industrial Chemistry, Goel Publishing, Meerut (1998)
2. Medicinal Chemistry- Ashtoush Kar.
3. Analysis of Foods – H.E. Cox: 13.
4. Chemical Analysis of Foods – H.E. Cox and Pearson.
5. Foods: Facts and Principles. N. Shakuntala Many and S. Swamy, 4thed. New Age International (1998)
6. Physical Chemistry – P l Atkins and J. de Paula – 7thEd. 2002, Oxford University Press.

7. Handbook on Fertilizer Technology by Swaminathan and Goswamy, 6th ed. 2001, FAI.
8. Organic Chemistry by I. L. Finar, Vol. 1 & 2. 9. Polymer Science and Technology, J. R. Fired (Prentice Hall).

References

Pedagogy

Formative Assessment	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test	40
Sem End Exam	60
Total	100

BSc Semester 2 – Chemistry (Hons) with specialization in Analytical Chemistry

Title of the Course: DSC – 2: INORGANIC AND PHYSICAL CHEMISTRY - I

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/ semesters
4	56	2	56

Content of Theory Course 2	56Hrs
Unit – 1	14
Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations- Electronic configurations of the elements (Z=1-30), effective nuclear charge, shielding/screening effect, Slater's rules. Variation of effective nuclear charge in Periodic Table.	
Unit - 2	14
s, p, d and f-block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s and p-block elements: (a) Atomic radii (van der Waals) (b) Ionic and crystal radii. (c) Covalent radii (d) Ionization enthalpy, successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (e) Electron gain enthalpy, trends of electron gain enthalpy. (f) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Trends in the chemistry of the compounds of groups 13 to 17 (hydrides, carbides, oxides and halides) are to be discussed.	
Unit - 3	14
<u>Gaseous State</u> Elementary aspects of kinetic theory of gases, Ideal and real gases. Boyle temperature (derivation not required), Molecular velocity, collision frequency, collision diameter, Collision cross section, collision number and mean free path and coefficient of viscosity, calculation of σ and η, variation of viscosity with temperature and pressure. Maxwell's Boltzmann distribution law of molecular velocities (Most probable, average and root mean square velocities). Relation between RMS, average and most probable velocity and average kinetic energies. (Mathematical derivation not required), law of equipartition of	

energy. Behaviour of real gases: Deviation from ideal gas behaviour. Compressibility factor (Z) and its variation with pressure for different gases. Causes of deviation from ideal behaviour, vander Waals equation of stat (No derivation) and application in explaining real gas behaviour. Critical phenomena - Andrews isotherms of CO_2, critical constants and their calculation from van der Waals equation, Continuity of states, Law of corresponding states. Numerical problems. **Liquid State** **Surface Tension**: Definition and its determination using stalagmometer, effect of temperature and solute on surface tension **Viscosity**: Definition, Coefficient of viscosity. Determination of viscosity of a liquid using Oswald viscometer. Effect of temperature, size, weight, shape of molecules and intermolecular forces. **Refraction**: Specific and molar refraction- definition and advantages. Determination of refractive index by Abbes Refractometer. Additive and constitutive properties. **Parachor:** Definition, Atomic and structure parachor, Elucidation of structure of benzene and benzoquinone. Viscosity and molecular structure. Molar refraction and chemical constitution. Numerical Problems.	
Unit - 4	14
Liquid Crystals Explanation, classification with examples- Smetic, nematic, cholesteric, dics shaped and polymeric. Structures of nematic and cholesteric phases-molecular arrangements in nematic and cholesteric liquid crystals. Applications of liquid crystals in LCDs and thermal sensing. **Solids** **Forms of solids:** Unit cell and space lattice, anisotropy of crystals, size and shape of crystals, Laws of Crystallography: Law of constancy of interfacial angles, Law of rational indices, Law of symmetry (Symmetry elements), Crystal systems, Bravais lattice types and identification of lattice planes. Miller indices and its calculation, X–Ray diffraction by crystals: Bragg's law and derivation of Bragg's equation, Single crystal and powder diffraction methods. Defects in crystals, glasses and liquid crystals. Numerical problems. **Distribution Law** Nernst Distribution Law - Statement and its derivation. Distribution constant, factors affecting distribution constant, validity of Distribution Law, Modification of distribution law when molecules undergo a) Association b) Dissociation. Application of Distribution Law in Solvent extraction. Derivation for simple and multiple extraction. Principles of distribution law in Parkes Process of desilverisation of lead. Numerical Problems.	

Text Books

1. Concise Inorganic Chemistry: J D Lee, 4th Edn, Wiley, (2021)
2. Fundamentals Concepts of Inorganic Chemistry, Vol 1 and 2, 2nd Edition, Asim K Das, CBS Publishers and Distributors, (2013)
3. Basic Inorganic Chemistry, F A Cotton, G Wilkinson and P. L. Gaus, 3rd Edition. Wiley. India
4. Inorganic Chemistry, 2nd Edn. Catherine E. Housecroft and A.G. Sharpe, Pearson Prentice Hall (2005)
5. Atkins Physical Chemistry.8th Edition. Peter Atkins & Julio De Paula Oxford University Press.
6. Physical Chemistry by Samuel Glasstone, ELBS (1982).

7. A Text book of Physical Chemistry, A S Negi & S C Anand, New Age International Publishers (2007).
8. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
9. A Text Book of Physical Chemistry P.L.Soni , O.P. Dharmarhaand and U.N.Dash, Sultan Chand and Sons.
10. Advanced Physical Chemistry, Gurdeep Raj, Goel Publishing House (2018)

References

Pedagogy

Formative Assessment	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test	40
Sem End Exam	60
Total	100

Date Course Co-ordinator Subject Committee Chairperson

Content of Practical Course 2: List of Experiments to be conducted

PART-A Inorganic Chemistry

TITRIMETRY

1. Determination of carbonate and hydroxide present in a mixture.
2. Determination of oxalic acid and sodium oxalate in a given mixture using standard $KMnO_4$/NaOH solution
3. Standardization of potassium permanganate solution and determination of nitrite in a water sample
4. Determination of chlorine in bleaching powder using iodometric method.

GRAVIMETRY

1. Determination of Ba^{2+} as $BaSO_4$
2. Determination of Cu^{2+} as CuSCN

3.Determination of Fe^{2+} as Fe_2O_3

4.Determination of Ni^{2+} as $Ni(DMG)_2$ complex.

PART-B Physical Chemistry

1. Safety Practices in the Chemistry Laboratory, Knowledge about common toxic chemicals and safety measures in their handling, cleaning and drying of glassware's
2. Determination of density using specific gravity bottle and viscosity of liquids using Ostwald's viscometer (Ethyl acetate, Toluene, Chloroform, Chlorobenzene or any other non-hazardous liquids)
3. Study of the variation of viscosity of sucrose solution with the concentration of a solute
4. Determination of the density using specific gravity bottle and surface tension of liquids using Stalagmometer (Ethyl acetate, Toluene, Chlorobenzene, any other non-hazardous liquids

5. Study of variation of surface tension of detergent solution with concentration.
6. Determination of specific and molar refraction by Abbes Refractometer. (Ethyl acetate, Methyl acetate, Ethylene Chloride)
7. Determination of the composition of liquid mixture by refractometry. (Toluene & Alcohol, Water & Sucrose)
8. Determination of partition/distribution coefficient - i) Acetic acid in water and cyclohexane. ii) Acetic acid in Water and Butanol. iii) Benzoic acid in water and toluene.

BSc Semester 2 – Chemistry (Hons) with specialization in Analytical Chemistry

Title of the Course: OE – 2: Molecules of Life

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/ semesters
3	42	-	42

Content of Theory Course 2	42 Hrs
Unit – 1	14
Carbohydrates Classification of carbohydrates, reducing and non-reducing sugars, General properties of glucose and fructose, their open chain structures. Epimers, mutarotation and anomers. Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation. **Amino Acids, Peptides and Proteins** Classification of amino acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides.	
Unit - 2	14
Enzymes and correlation with drug action Mechanism of enzyme action, factors affecting enzyme action, Co-enzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity), Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Non competitive inhibition including allosteric inhibition). **Drug action**-receptor theory. Structure–activity relationships of drug molecules, binding role of –OH group, -NH_2 group, double bond and aromatic ring **Lipids** Introduction to lipids, classification. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).	
Unit - 3	14
Nucleic Acids Components of nucleic acids: Adenine, guanine, thymine and cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides **(nomenclature)**,	

Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (**types of RNA**), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation. **Concept of Energy in Biosystems** Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy. Outline of catabolic pathways of Carbohydrate- Glycolysis, Fermentation, Krebs Cycle. Overview of catabolic pathways of Fats and Proteins. Interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates.	

Text Books

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. *Organic Chemistry* (*Volume 2),* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry 7th Ed.,*
5. W. H. Freeman. Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, , 2002.

References

Formative Assessment	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test	40
Sem End Exam	60
Total	100

Sd/-

THIRD SEMESTER BSc CHEMISTRY

DSC-3:Analytical and Organic Chemistry-II

Contact Hours: 56 **Work load: 4 Hours/Week.**

Credit Points :4

Evaluation: Continuous Internal Assesment-40 Marks

Semester End Examination -60 Marks

Course Objectives:

1) Interrelationship among frequency, wavelength and wave number and importance of validation parameters of an instrumental method will be taught
2) Principle, instrumentation and applications of spectrophotometry, nephelometry and turbidometry will be taught
3) Fundamentals of separation methods and principles of paper, thin layer and column chromatography will be taught
4) Principle, types and applications of solvent extraction will be taught
5) Principle and mechanism of ion-exchange, types of resins and domestic and industrial applications of ion-exchange chromatography will be taught
6) The concept of mechanism and its importance will be taught to the student
7) Concept and importance of intermediates in organic chemistry will be taught taking proper examples
8) The various techniques for identification of reaction mechanism will be taught to the student taking proper examples
9) Concept of stereochemistry and its importance will be taught.
10) The various projection formulae and the techniques of designating the molecules into R, S, D, L will be taught taking proper examples
11) The theory and concept of Cis-, Trans- isomerism and its importance and the techniques to differentiate between them will be taught taking examples

Course Specific Outcomes

After the completion of this course, the student would be able to

1) Understand the importance of fundamental law and validation parameters in chemical analysis
2) Know how different analytes in different matrices (water and real samples) can be determined by spectrophotometric, nephelometric and turbidometric methods.

3)Understand the requirement for chemical analysis by paper, thin layer and column chromatography.

4) Apply solvent extraction method for quantitative determination of metal ions in different samples
5) Utilize the ion-exchange chromatography for domestic and industrial applications
6) Explain mechanism for a given reaction.
7) Predict the probable mechanism for an reaction
   Eexplain the importance of reaction intermediates, its role and techniques of generating such intermediates
8) Explain the importance of Stereochemistry in predicting the structure and property of organic molecules.
9) Predict the configuration of an organic molecule and able to designate it.
10) Identify the chiral molecules and predict its actual configuration

Unit-I

Quantitataive analysis-Instrumental methods

Electromagnetic spectrum, absorption of electromagnetic radiation, Definition and units of frequency, wavelength, wave number, Beer's law, Beer-Lambert law derivation, deviations from Beer's law, limitations, construction of calibration graph (Plot of absorbance versus concentration), Evaluation Procedures- standard addition, Internal standard addition, validation parameters-detection limits, sensitivity, dynamic/linearity range, Instrumentation, spectrophotometers, quantitative applications of colorimetry (determination of Fe and Cu) and numerical problems on application of Beer's law.

10 hrs

Nephelometry and Turbidimetry: Introduction, principle, instrumentations of nephelometry and turbidimetry; effects of concentration, particle size and wavelength on scattering; applications of nephelometry and turbidimetry (determination of SO_4^{2-} and PO_4^{3-}) **4 hrs**

Unit-II

Separation methods

Fundamentals of chromatography: General description, definition, terms and parameters used in chromatography, classification of chromatographic methods, criteria for selection of stationary and mobile phase and nature of adsorbents. Principles of paper, thin layer, column chromatography. Column efficiency, factors affecting the column efficiency, van Deemter's equation and its modern version.

3hrs

Paper chromatography: Theory and applications

Thin layer chromatography (TLC): Mechanism, R_f value, efficiency of TLC plates, methodology–selection of stationary and mobile phases, development, spray reagents, identification and detection, qualitative applications. **4 hrs**

Solvent Extraction: Types- batch, continous, efficiency, selectivity, distribution coefficient, Nernst distribution law, derivation, factors affecting the partition, relationship between % extraction and volume fraction, Numerical problems on solvent extraction. Solvent extraction of iron and copper. **4hrs**

Ion-exchange chromatography: resins, types with examples- cation exchange and anion exchange resins, mechanism of cation and anion exchange process and applications of ion-exchange chromatography (softening of hard water, separation of lanthanides, industrial applications). **03Hrs**

Unit-III

Reaction Intermediates: Generation, Stability and Reactions of,

i) Carbocations: Dienone-phenol; and Pinacol-Pinacolone Rearrangement.
ii) Carbanions :Perkin Reaction,Aldolcondensation,Claisen-Schmith condensation.
iii) Free Radicals : Sandmeyer Reaction
iv) Carbenes and Nitrenes: Singlet and Triplet states, their relative stability and reactions
v) Arynes: Formation, detection **8 hrs**

Methods for Identifying Reaction Mechanism:

Product analysis, Isolation and Identification of Intermediates, Stereochemical Evidences,Effect of Catalyst,crossover Experiments,Isotopic studies,Kinetic Studies.

6 hrs

Unit-IV

Stereochemistry of Organic Compounds:

Fischer projection,Newmann and Sawhorse projection formulae and thei interconversions.

Geometrical isomerism : Cis-trans and syn-anti isomerism, E/Z notations with C.I.P rules.

Optical Isomerism :Optical activity, Specific rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral centres, Diasteroisomers, meso structures, Racemic mixtures and Resolution, Relative and absolute configuration, D/L and R/S designations

14 hrs

References :

1) Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York (2005).
2) Analytical Chemistry, G.D. Christian, 6th edition, Wiley-India (2007).

3) Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, PHI Learning Pvt Ltd.NewDelhi(2009).
4) Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D.Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt.Ltd.(2007).
5) Organic Reaction Mechanism by V.K.Ahluwalia and R.K.Parashar (Narosa Publishers)
6) Organic Chemistry by S.M.Mukherji,S.P.Sinh and R.K.Kapoor (Narosa Publishers)
7) Morrison R.N and Boyd R.N,OrganicChemistry,Darling Kindersley(India)Pvt.Ltd.(Pearson Education)
8) Finar I.L,Organic Chemistry(Volume I); Finar I.L (Volume II) Stereochemistry and the Chemistry of Natural Products.,Dorling Kindersley(India)Pvt.Ltd.(Pearson Education)
9) Kalsi P.S.Stereochemistry,conformation and Mechanism,New age International
10) Eliel E.L and wilenS.H,Stereochemistry of Organic Compounds,Wiley,(London)

PRACTICALS

Credit Points: 2 **Teaching Hours:4 hrs**

Evaluation : ContinuousInternal Assessment-25 marks

Semester End Examination :25 marks

Course Objectives

1) To impart skills related to preparation of stock and working solutions and handling of instrumental methods
2) To know the principle of colorimetric analysis and construction of calibration plot
3) To understand the chemistry involved in colorimetric determination of metal ions and anions
4) To determine R_f values of different metal ions present in a mixture
5) To impart knowledge on the importance of functional groups in organic compounds.
6) Techniques to identify the functional groups in an compound by performing physical and chemical tests
7) To record its melting point/boiling point.
8) To prepare suitable derivative for that compound and to characterize it.

Course Specific outcomes

After the completion of this course, the student would be able to

1) Understand the importance of instrumental methods for quantitative applications

2) Apply colorimetric methods for accurate determination of metal ions and anions in water or real samples
3) Understand how functional groups in an compound is responsible for its characteristic property
4) Learn the importance of qualitative tests in identifying functional groups.
5) Learn how to prepare a derivative for particular functional groups and how to purify it'

PART-A (Analytical Chemistry)

1) Colorimetric determination of copper using ammonia solution
2) Colorimetric determination of iron using thiocyanate solution
3) Colorimetric determination of nickel using DMG solution
4) Colorimetric determination of nitrite in a water sample (diazo coupling Reaction/Griess reagent
5) Determination of R_f values of two or three component systems by TLC
6) Separation of different metal ions by paper chromatography/ Solvent extraction of iron using oxine solution **(demonstration)**

PART-B(Organic Chemistry)

Qualitative analysis of bifunctional Organic compounds such as 1)Salycilic acid ,p-Chloro benzoic acid 2) o-Cresol,p-Cresol,Resorcinol,o- Nitrophenol,p-nitophenol 3)o-Nitro aniline,p-Nitroaniline,p-Toluidine, 4)Ethyl Salicylate, Salicylaldehyde, Acetophenone, p-Nitrotoluene,,Benzamide etc.(Atleast 6-8 compounds to be analysed in a semester)

References

1) 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.(2007)
2) Vogels Text Book of Qualitative Chemical Analysis,ELBS

Semester 3 B Sc / B Sc (Honors)

Title of the Course: Open Elective-3: ATOMIC STRUCTURE, BONDING AND CONCEPTS IN ORGANIC CHEMISTRY

Contact Hours: 42 **Workload: 3 hours per week**
Credit Points: 3
Evaluation: Continuous Internal Assessment - 40 marks
Semester End Examination - 60 marks

Course Objectives:

- To develop an understanding of principles of Atomic structure
- To know the importance of quantum numbers, writing of electronic configurations and represention of orbitals
- To develop an understanding of the periodic trends
- To understand the nature of bonding and to predict the shapes of molecules
- To construct MO energy level diagrams and predict the properties of molecules
- To understand the formation of sigma and pi bonds and the bond strength.
- To study the classification of organic reactions
- To learn nomenclature preparation and reactions of alkanes, alkenes, alkynes and stability of alicyclic compounds

COURSE CONTENT

Unit I: Atomic Structure and Periodic Properties
History of an atom. Idea of de Broglie matter waves. Heisenberg uncertainty principle. Schrödinger wave equation, significance of wave functions, Bohr's model of hydrogen atom and its limitations. Quantum numbers and their importance, atomic orbitals and shapes of s, p, d orbitals , Multi-electron atoms, Aufbau and Pauli exclusion principle and Hund's multiplicity rule- Electronic configurations of the elements (atomic no. up to 30), effective nuclear charge and shielding.
(8 hours)

Periodic Properties

Atomic radius, Covalent, ionic and van der Waal radii-explanation with examples. Definition and periodicity of the following properties - ionic radii, ionisation potential, electron affinity and electronegativity, methods of determination of electronegativity. Factors affecting the values of ionisation energy. **(6 hours)**

Unit II: Chemical Bonding
Ionic Solids– Ionic structures (NaCl, CsCl, TiO_2, ZnS), radius ratio rule and coordination number, limitation of radius ratio rule, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajan's rule and their consequences.
(4 hours)
Covalent Bond – Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization with examples and shapes of simple inorganic molecules and ions. Shapes of NH_3, I_3^+, I_3^- , SF_4, ClF_3, IF_5, ICl_2^- and H_2O using valence shell electron pair repulsion (VSEPR) theory, linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals, physical picture of bonding and antibonding wave

functions. Applications of MO theory to explain the stability of homo dinuclear (He_2, N_2, O_2, F_2, C_2) and hetero dinuclear (NO and CO) molecules. Comparison of M.O. and V.B. Models. **(7 hours)**

Metallic bond-free electron, Band theory-electrical properties of metals, semiconductors and insulators.
Weak interactions – Hydrogen bonding and its consequences, van der Waals forces.
(**3 hours)**

Unit III: Bonding and molecular structure and hydrocarbons
Bonding and molecular structure: Introduction to organic chemistry, atomic orbitals,sigma and pi bond formation-molecular orbital [MO] method,sp,$sp^2$and sp^3 hybridization,bond length, bond dissociation energies and bond angles(open chain and cyclic compounds). Electronegativity and polarity of the bonds. Classification and reactions of organic compounds (with examples). **7 Hours**

Alkanes, Alkenes and Alkynes
Definition,Nomenclature,preparations (any two methods)
Reactions: Electrophilic, nucleophilic and free radical addition reactions
Alicyclic compounds:
Nomenclature, preparation and stability of cyclopropane, cyclobutane, cyclopentane and cyclohexane.
7 Hours

Reference Books:

1. Concise Inorganic Chemistry, J. D. Lee, ELBS, 1996.
2. Inorganic Chemistry, A. K. Das
3. Inorganic Chemistry: Principles of Structure and Reactivity, Huheey, J. E., Keiter, E.A., Keiter, R.L. & Medhi, O. K. Pearson Education India, 2006.
4. Inorganic Chemistry, Shriver, D.F. & Atkins, P.W.Oxford University Press.
5. Schaum's Outline Series Theory and Problems of Organic Chemistry.SI (metric) edition Herbert Meislich,Howard Nechamkin and Jacob Sharefkin.
6. Organic chemistry. Robert T.Morrison Robert N. Boyd,6thEdition
7. Organic Chemistry Volume-1, I.L.Finar

COURSE OUTCOME:

On completion of the course the student will learn and be able to understand/explain

- the concept of atomic structure, significance of quantum numbers, filling of electrons of atoms/ions in various orbitals as per rules
- the trends in periodic properties
- the structures of ionic solids, applications of B-H cycle, solubility of compounds and consequences of polarization of ions
- the shapes of molecules/ions based on VSEPR theory
- the construction of MO energy level diagrams and prediction of properties of molecules/ions like bond order, bond energies, bond lengths and magnetic properties.
- the formation of sigma and pi bonds and the bond strength
- the classification of organic reactions
- nomenclature preparation, and reactions of alkanes, alkenes, alkynes and stability of alicyclic compounds.

CHEMISTRY

DSC-4: Inorganic and Physical Chemistry-II

Contact Hours: 56 Work load: 4 Hours/Week.

Credit Points :4

Evaluation: Continuous Internal Assesment-40 Marks

Semester End Examination -60 Marks

Course Objectives:

Students learn about

1. Different types of bonding in molecules/compounds/ions
2. The structures of molecules/compounds/ions based on different models/theories
3. Properties of compounds based on bonding and structure
4. The fundamentals of thermodynamics including the laws, the concept of entropy and free energy functions and their applications.
5. The concepts of surface chemistry, catalysis and their applications.
6. The theoretical and experimental aspects of chemical kinetics including basic theories of reaction rates and methods of determining order.
7. Electrochemistry dealing with electrolytes in solution. Conductance measurements and applications. Concept of ionic mobility and their determination.

Course outcomes: After the completion of this course, the student would be able to

1. Predict the nature of the bond formed between different elements
2. Identify the possible type of arrangements of ions in ionic compounds
3. Write Born - Haber cycle for different ionic compounds
4. Relate different energy parameters like, lattice energy, entropy, enthalpy and solvation energy in the dissolution of ionic solids
5. Explain covalent nature in ionic compounds
6. Write the M.O. energy diagrams for simple molecules
7. Differentiate bonding in metals from their compounds
8. Learn important laws of thermodynamics and their applications to various thermodynamic systems
9. Understand adsorption processes and their mechanisms and the function and purpose of a catalyst

10. Apply adsorption as a versatile method for waste water purification.
11. Understand the concept of rate of a chemical reaction, integrated rate equations, energy of activation and determination of order of a reaction based on experimental data
12. Know different types of electrolytes, usefulness of conductance and ionic mobility measurements
13. Determine the transport numbers

Unit - I

Structure and Bonding -I

The ionic bond :Structures of ionic solids

Radius ratio rules, Calculation of some limiting radius ratio values, Coordination number 3 (planar triangle), Coordination number 4 (tetrahedral and square planar), Coordination number 6 (octahedral), Close packing. **3hrs**

Classification of ionic structures:

Ionic compounds of the type AX (ZnS, NaCl, CsCl)

Ionic compounds of the type AX_2 (Calcium fluoride (fluorite) and Rutile structure

Limitations of radius ratio concept **2 hrs**

Lattice energy and Born-Haber cycle, Born-Lande equation and itsdrawbacks, Kapustinskii equation (No derivation), solvation energy and solubility of ionic solids, polarizing power and polarizability, Fajan's rules with applications.

Numerical problems **5 hrs**

Covalent bond: Valence bond theory, The Lewis theory,The octet rule, Exceptions to the octet rule, Sidgwick- Powell theory. Valence shell electron pair repulsion (VSEPR) theory, Effect of lone pairs, electronegativity, isoelectronic principle, Examples using VSEPR theory: BF_3 and BF_4^-, $NH_3$and NH_4^+, H_2O, PCl_5, ClF_3, SF_4, SF_6, and IF_7.

Limitations of VSEPR. **4 hrs**

Unit - II

Structure and Bonding -II

Concept of resonance, resonance energy, hybridisation, types of hybridization, sp, sp^2, sp^3 dsp^2 dsp^3, d^2sp^3, sp^3d^2 with one example each, and energetics of hybridization. Bent's rule, Limitations of Valence Bond Theory.

3 hrs

Molecular Orbital theory:

LCAO concept: s-s, s-p and p-p combinations of orbitals, bonding, nonbonding and antibonding molecular orbitals, non-bonding combinations of orbitals, Rules for linear combination of atomic orbitals

Examples of molecular orbital treatment for homonuclear diatomic molecules H_2 molecule, H^+_2, He_2 molecule, He^+_2 molecule ion, Li_2 molecule, Be_2 molecule B_2 molecule, C_2 molecule, N_2 molecule, N_2^+, O_2 molecule, O_2^- and O_2^{2-}.
M.O. energy diagrams of heteronuclear diatomic molecules with examples (NO, NO^+ CO and HCl). Calculation of bond order, relationship between bond order, bond energy and bond length, magnetic properties based on MOT. **7 hrs**

Metallic Bonding:

General properties of metals : Conductivity, Lustre, Malleability and ductility. Crystal structures of metals and Bond lengths

Theories of bonding in metals:

Free electron theory,Valence bond theory, Molecular orbital or band theory of solids Prediction of conducting properties of conductors. insulators and semiconductors, extrinsic and intrinsic semiconductors using M.O. theory. **4 hrs**

UNIT III

First Law of Thermodynamics

Thermodynamic Processes, Reversible and Irreversible Processes, Nature of Heat and Work,Internal Energy, First Law of Thermodynamics, Enthalpy of a System,Work done in isothermal and adiabatic expansion of an ideal gas, Numerical problems, Joule -Thomson Expansion, Relation between Joule-Thomson coefficient and other thermodynamic parameters.

Second law of Thermodynamics

Concept of entropy, thermodynamic scale of temperature, Statements of the Second Law of Thermodynamics, molecular and statistical interpretation of entropy, Calculation of entropy change for reversible and irreversible processes, Free Energy Functions: Gibbs and Helmholtz energy, Variation of S, G, A with T, V and P, Numerical problems, Free energy change and spontaneity, Gibbs-Helmholtz equation.

Third Lawof Thermodynamics

Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. **10 Hrs**

Surface Chemistry

Adsorption

Types of adsorption isotherms. Freundlich adsorption isotherm (only equation), its limitations. Langmuir adsorption isotherm (derivation to be done) and BET equation (derivation not included).

Catalysis

Types of Catalysis and theories with examples (intermediate compound theory and adsorption theory), Theory of acid base catalysis, Michaelis-Menten equation. Heterogeneous catalysis: surface reactions, unimolecular, bimolecular surface reactions. Autocatalysis with examples. Applications: Design process to removal of toxic compounds from industrial wastewater and treatment of portable water requirements.

4Hrs

UNIT IV

Chemical Kinetics

Differential and integrated form of rate expressions up to second order reactions, Derivation of expression of rate constant of second order reaction (a=b), Problems on rate constant (a=b), Methods of determination of order of a reaction, temperature dependence of reaction rates; Arrhenius equation, activation energy, Numerical problems on Arrhenius equation in calculating energy of activation and rate constants. Collision theory of reaction rates, Lindemann's mechanism, qualitative treatment of the theory of absolute reaction rates. Experimental determination of kinetics of (i) inversion of cane sugar by polarimetric method (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide. **7 Hrs**

Electrochemistry – I

Arrhenius theory of electrolytic dissociation. Merits and Demerits, Conductance, Specific conductance, equivalent and molar conductivity and their variation with dilution. Molar conductivity at infinite dilution. Numerical problems.

Kohlrausch's law of independent migration of ions and its applications, Debye-Hückel-Onsager equation. Ionic mobilities and their determinations, transference numbers and their relation to ionic mobility's, determination of transference numbers using Hittorf(non attachable electrode) and Moving Boundary methods.

Applications of conductance measurement: (i) degree of dissociation of weak electrolytes (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts (iv) conductometric titrations (acid base titrations only) and (v) Hydrolysis constants of salts. Numerical problems. **7 Hrs**

Reference Books

1. Peter Atkins & Julio De Paula, Physical Chemistry, 9th Ed., Oxford University Press (2010)
2. G W Castellan, Physical Chemistry, 4th Ed., Narosa (2004)
3. R G Mortimer, Physical Chemistry 3rd Ed., Elsevier: Noida, UP (2009)
4. B R Puri, L R Sharma and M S Pathania, Principal of Physical Chemistry, Vishal Publishing Co.
5. B S Bahl, G D Tuli and Arun Bahl, Essentials of Physical chemistry, S Chand & Company Ltd.
6. A S Negi and S C Anand, A textbook of Physical Chemistry, New Age International Publishers.
7. B N Bajpai, Advanced Physical chemistry, S Chand and Company ltd.
8. R L Madan, Chemistry for Degree Students, Semester I, II, III and IV, S Chand and Company Ltd.
9. P L Soni, O P Dharmarha and U N Dash, Textbook of Physical Chemistry, Sultan Chand and Sons.

PRACTICALS

Credit Points: 2 **Teaching Hours:4Hrs**

Evaluation : Continuous Internal Assessment : 25 marks

Semester End Examination : 25 marks

Course objective:

To attain practical knowledge about:

1. Analytical skills in detecting the constituents present in unknown samples by systematically carrying out the qualitative analysis.
2. The methods of determining rates of chemical reactions.
3. Designing electrochemical cells and making measurements related to it.
4. Determination of physical characteristics of electrolytes using conductivity measurements in solution.
5. Adsorption phenomenon, mechanism and basic models to explain adsorption.
6. Simple techniques like conductometry to obtain physicochemical parameters of electrolytes.

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

1.Understand the chemical reactions involved in the detection of cations and anions.
2. Explain basic principles involved in classification of ions into groups in semi-micro qualitative analysis of salt mixture
3. Carryout the separation of cations into groups and understandthe concept of common ion effect.

4. Understand the choice of group reagents used in the analysis.
5. Analyse a simple inorganic salt mixture containing two anions and cations
6. Use instruments like conductivity meter to obtain various physicochemical parameters.
7. Apply the theory about chemical kinetics and determine the velocity constants of various reactions.
8. Learn about the reaction mechanisms.
9. Interpret the behaviour of interfaces, the phenomena of physisorption and chemisorptions and their applications in chemical and industrial processes.
10. Learn to fit experimental data with theoretical models and interpret the data

Part A- Inorganic Chemistry Practicals

Qualitative semi-micro analysis of mixtures containing 2 anions and 2 cations.
Emphasis should be given to the understanding of different reactions.
The following cations and anions are suggested.
Cations: NH_4^+, Pb^{2+}, Bi^{3+}, Cu^{2+}, Al^{3+}, Fe^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Zn^{2+}, Mn^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+}, Na^+, K^+ and Li^+.
Anions: CO_3^{2-}, CH_3COO^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, SO_4^{2-}, $C_2O_4^{2-}$ and PO_4^{3-}
Spot tests and flame tests to be carried out wherever possible.

Part B- Physical Chemistry Practicals

1. Determination of the enthalpy of neutralization of a strong acid with strong base.
2. Verification of Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.
3. The study of kinetics of potassium persulphate and potassium iodide volumetrically.
4. Determination of velocity constant for acid catalyzed hydrolysis of methyl acetate.
5. Determination of velocity constant for the saponification of ethyl acetate ($a = b$) volumetrically.
6. Determination of equivalent conductivity of strong electrolyte and verification of DHO equation.
7. Determination of dissociation constant of weak acid by conductivity method.
8. Conductometric titration of strong acid and strong base.
9. Conductometric titration of weak acid and strong base.
10. Determination of solubility product of sparingly soluble salt conductometrically.

References

1. Vogel's Qualitative analysis, Revised by G. Svehla, Pearson education, 2002
2. J B Yadav, Advanced Physical Chemistry, Krishna Prakashan Media (P) Ltd, Meerut.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
4. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
5. Halpern, A. M. &McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

Semester 4

B Sc / B Sc (Honors)

Title of the Course: **Open Elective: Electrochemistry, Corrosion and Metallurgy**

Number of Theory Credits	Number of lecture hours/semester
3	42

Evaluation Scheme for Theory:

Continuous Internal Assessment (CIA) – 40 Marks
Semester End Examination (SEE) – 60 marks

This course provides a broad introduction to the fundamental principles of Electrochemistry, Corrosion and Metallurgy. The student will gain an understanding of basic and practical applications in various fields of Electrochemistry, Corrosion and Metals and Alloy behaviour and manufacturing processes. This course is a valuable prerequisite for taking more technically challenging courses that will be required for career development.

Course Objectives

This course will deal with

1. Types of conductance, concept of electrolytes, electrolysis, redox reactions and EMF
2. Concept of different types of electrochemical cells, Types of electrodes and electrode potential. Application of electrochemical series.
3. Basic principles and applications of conductometric, potentiometric and pH titrations.
4. Different types of Batteries their principle construction and working - lead-acid storage and lithium ion battery. Study of Fuels cells.
5. Concept of corrosion, types of corrosion and its prevention by different methods. Introduction to electroplating.
6. Introduction to ores and minerals, extraction of metals from their ores, and purification. Eg., Manganese, Titanium and Uranium.
7. Study of alloys, classification, production and uses of alloys.

Expected Course Outcomes

Upon completion of the course students will be able to

1. Understand the concept of conductance in electrolytic solutions, electrolysis and redox reactions involved in electrode reactions.

2. Learn the different types of electrochemical cells, their symbolical representation and application of electrochemical series.
3. Apply conductometric, potentiometric and pH titrations
4. Know the principle, construction and working of batteries
5. Understand different types of corrosion and its prevention by different methods
6. Learn the methods of extraction of metals from their ores and purification

UNIT I

Electrochemistry

Conductance, specific and molar conductance Types of Electrolytes, Conductivity in electrolytic solution, Electrolysis, Kohlrausch's law and its application, Equivalent Conductance of Weak electrolyte at Infinite dilution.

Oxidation -reduction reactions, electrode potential, EMFof an electrochemical cell, cell reaction, Daniel cell, dry Cells - electrolytic and Galvanic cell, Representation of a cell. Standard electrode potential, Nernst equation (No derivation) and its application to chemical cell, Electrochemical series and its importance. Types of Electrodes.

Basic Principles of (i) Conductometric titrations- HCl Vs NaOH, CH_3COOH Vs NaOH
(ii) Potentiometric titrations: Acid-base titration HCl Vs NaOH, Redox titration (FAS Vs $K_2Cr_2O_7$)
Determination of P^H using glass electrode. **12 hrs**

Batteries- Primary and Secondary batteries, Battery components and their role. Working of the following Batteries- Lead acid, Lithium Storage, Batteries, Fuel cells. **2 hrs**

UNIT II

Corrosion: Introduction, definition, Types of Corrosion, Corrosion rate, Factors affecting corrosion rate, Metallic factor-purity, electrode potential of metal, hydrogen over voltage, natureof corrosion product. Environmental Factors-Temperature, pH of the medium, humidity, presence of impurities, electrical conductivity of the medium, velocity of the medium, concentration of the medium.

Prevention of Corrosion: Material selection - Metals and alloys, metal purification, non-metallic, Alteration of environment - Changing media, inhibitors, Design-wall thickness, design rules, Coating-Metallic and other inorganic coatings, organic coating.

Electroplating: Introduction, Electroplating of chromium (hard and decorative). Electro less plating: Introduction, distinction between electroplating and electroless plating processes. Electroless plating of copper. **14 hrs**

UNIT III

Metallurgy

Introduction: Ore, minerals, important ores of some common elements in India, General Principles of pyrometallurgy, roasting, Calcination, Gangue, Smelting, Flux, Gravity separation, Froth flotation process, leaching. Techniques employed for Purification of metal (Distillation process, Bessemerization, Electro-refining, Van Arkel and De Boer's Filament.

6 hrs

Extraction of metals: Extraction of Manganese (Pyrolusite), Titanium (Ilmanite) and Uranium.

4 hrs

Alloys: Introduction, Classification of alloys, commercially important alloys, gold karats,Production of Ferro alloys; Ferrochrome, Ferro Manganese, Uses of alloys. **4 hrs**

Reference Books

1. Barrow. G.M, Physical Chemistry, Tata McGraw-Hill, (2007)
2. An introduction to electrochemistry, Samuel Glasstone, East-West edition New Delhi,(1942)
3. Text book of physical chemistry, Samuel Glasstone, 2nd Edition, Mac Millan India Ltd,(1991)
4. Principles and applications of Electrochemistry, D. R. Crow, 3rd edition, ChapmanhallLondon, (1988)
5. Fundamentals of electrochemical deposition, Milan Paunovic and MordechaySchlesinger, Wiley Interscience Publications, New York, (1998)
6. Engineering Chemistry, V R Kulkarni and K Ramakrishna Reddy, New Age International,(2015)
7. Electrochemistry and Corrosion Science, Nestor Perez, Springer (india) Pvt. Ltd., (2004)
8. Principles and Prevention of Corrosion, D. A. Jones, Macmillan Publ. Co., (1996)
9. Essential of Materials Science and Engineering, Donald R. Askeland, Thomson Learning,5th Edition, (2006)
10. Introduction to Engineering Materials, B. K. Agarwal, Tata McGraw Hill, 1st Edition
11. Material Science and Engineering, V. Raghavan, PHI Learning, 5th Edition
12. Engineering Materials and Metallurgy, R. K. Rajput, S. Chand - 1st Edition, (2011)

OPEN ELECTIVES

I SEM Non-Science Students

Environmental Chemistry

Unit I

Environmental Chemistry

Vertical temperature and vertical structure of atmosphere, Heat/ radiation budget of the earth: Energy balance of earth, Bio Geo Chemical Cycles in environment: Oxygen, Carbon, Nitrogen, Phosphorous, Sulphur Cycle, Bio distribution of elements

Ozone layer

Ozone layer- Earth's protective umbrella: Formation & depletion, Ozone hole over Antarctica, harmful effects of Chlorofluoro Carbons (CFC),

Acid rain: Introduction, Theories of acid rain, adverse effects of acid rain, control of acid rain

21 Hours

Unit II

Environmental Pollution

Air pollution dealing with Particles, ions and radicals. Important photochemical reactions in atmosphere, Major sources of Air pollution, Aerosols and their effects, Effects of particulate matter, indoor and occupational pollutants, Air Quality standards

Vehicular pollution

Automobile emissions, Fuels: Diesel vs CNG, biofuels, prevention and control of vehicular pollution, gobal efforts in reducing vehicular pollution

Smog: Definition, mechanism of smog formation, examples of London Smog, Los Angeles Smog

21 Hours

References

1. Environmental Chemistry, Dr H Kaur, Pragathi Prakashan, 2016
2. Environmental Chemistry by Colin Baird and Michael Cann | 2012
3. A Textbook Of Environmental Chemistry 2020 by V. Subramanian

II SEM Non-Science Students

Green Chemistry and clean energy sources

Unit I

Principles and goals of Green Chemistry, Green chemicals, Green reagents, Green catalysts, Green solvents.

Emerging Green technologies, Microwave chemistry, Sono chemistry, Photo chemistry and Electro chemistry

Use of pesticides synthesized by Green chemistry route

21 Hours

Unit II

Growing energy demands, Resources of energy, Conventional sources of energy with example of hydroelectric power/ thermal power plants, nonconventional sources of energy: solar, wind, geothermal energy, ocean energy and tidal power

Fossil fuel based energy: coal, methanol, petroleum, natural gas, biomass energy, biogas

Hydrogen as an alternate source of energy. Energy consumption and conservation

Environmental impact assessment and environmental laws in India

21 Hours

References:

1.Green Chemistry for Beginners, , Anju Srivastava**,** Rakesh K Sharma, Tayler and Francis 2022.

2.Green Chemistry, Fundamentals and Applications, *Suresh C. Ameta, Rakshit Ameta,* Tayler and Francis 2022.2021

III SEM Non-Science Students

Effects of Radioactivity

Unit I

Introduction, Radiation, Natural and manmade sources of radioactive pollution, effects of radioactive pollution, biological effects of radiation, radiation effects on plants

Precautions to be taken in the event of nuclear war, preventive measures and control of radiation from nuclear power plants, atom bomb disaster in Hiroshima, three mile island disaster, Chernobyl : world's worst nuclear disaster

21 Hours

Unit II

Disposal of hazardous radioactive waste

Radioactive waste, environmental problems and management of nuclear waste, disposal methods of radioactive waste, recent methods to dispose critically dangerous radioactive waste

Classification of hazardous waste, management of hazardous waste, treatment and disposal of hazardous chemicals

21 Hours

References:

4. Environmental Chemistry, Dr H Kaur, Pragathi Prakashan, 2016
5. Environmental Chemistry by Colin Baird and Michael Cann | 2012
6. A Textbook Of Environmental Chemistry 2020 by V. Subramanian

IV SEM Non-Science Students

Water

Unit I

Introduction: Water quality parameters, standards and laws, Hard and Soft water, softening of water, demineralisation of waste water, purification of water for municipal purposes, chlorination and dechlorination, fluoridation and deflouridation, potability of water

Control of water pollution-minimisation, functions of central and state pollution control boards, recycling of waste water

21 Hours

Unit II

Analysis of water pollutants, objectives of water analysis, chemical substances affecting water quality: colour, odour, turbidity, conductivity, pH, acidity, alkalinity, etc, chemicals substances in water affecting health.

Definitions of following terms: Dissolved oxygen, COD(Chemical Oxygen Demand), BOD(Biological Oxygen Demand), and Total organic carbon content.

21 Hours

References:

1.Monitoring Water Quality Pollution Assessment, Analysis, and Remediation, Satinder Ahuja, Elsevier 2013.

2.Environmental Chemistry, Dr H Kaur, Pragathi Prakashan, 2016

Mangalore University

Scheme of Practical Examinations for B.Sc Chemistry Practicals

(As per the New Education Policy)

III Semester Chemistry Practical III

Duration: 4 hrs **Max.marks:25**

PART A

Q.1 Any one of the following experiments may be set for the actual experimental work. The distribution of experiments is to be done such that more than four students do not get the same experiment. **10Marks**

1.Colorimetric determination of Copper using ammonia solution.

2.Colorimetric determination of Iron using Thiocyanate solution.

3.Colorimetric determination of Nickel using DMG solution.

4.Colorimetric determination of Titanium using hydrogen peroxide.

5.Colorimetric determination of Phosphate as Ammonium phosphomolybdate.

6.Colorimetric determination of Nitrite in a water sample (diazo coupling reaction/Griers reagent).

7.Determination of Rf values of two or three component systems by TLC.

VALUATION SCHEME

The practical class records certified by the teacher in charge and head of the chemistry department should be produced at the time of examination.

EXPERIMENT

I Colorimetric Determinations:

i) Graph (good plot) with four points - 4 marks

Other plots -1 mark

ii) Error in concentration:

± 0.2mM	6 Marks
±0.3mM	5 Marks
± 0.4mM	2 Marks
Any other value	1 Mark

II Chromatography:

i) Error in Rf volue

	Error upto ± 5%	8Marks
	± 6% to10%	6Marks
	± 11 % to 15%	4Marks
	Any other value	2Marks
ii	Calculation	2Marks

PART B

Organic Analysis 15 marks

I Any one of the following organic compounds may be given for an analysis

1)Salycilic acid, p-Nitro benzoic acid, Antranilicacid, p-Chloro benzoic acid 2) o-Cresol,p-Cresol, Resorcinol, o- Nitrophenol, p-nitophenol 3)o-Nitro aniline, p-Nitroaniline, p-Toluidine, p-Chloroaniline, p-Bromoaniline, 4)Ethyl Salicylate, Salicylaldehyde, Acetophenone, p-Dichlorobenzene, p-Nitro toluene, Benzamide.

II) Compounds should be distributed among students such that, more than three students do not get same compound.

Valuation Scheme

Preliminary tests	1 mark
Physical Constant	1 mark
Detection of elements(Nitrogen & Halogen)	4 marks
Determination of Solubility	3 marks
Reactions of functional group (any two)	4 marks
Name and Structure	2 marks

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Allotment of Marks for Formative assessment:

Maximum marks: 25

i)Laboratory Record and Attendance 10Marks

ii)Internal Practical Examination 15Marks.

Internal Practical Examination should be conducted as per the university examination scheme and maximum marks is to be reduced from 25 to 15.

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Scheme of Practical Examinations and Valuation Procedures for B.Sc. Chemistry Practical as per the New Education Policy

IV Semester BSc Chemistry Practical – IV

Duration: 4Hrs **Max. Marks: 25**

Part –A Inorganic chemistry Practical

Exercise set for inorganic qualitative analysis (12 marks)

1. Inorganic systematic qualitative analysis of the mixture of two simple salts containing two anions and two cations using semi micro technique.

i)A simple powdered mixture of inorganic salts containing two anions and two cations is to be prepared on the spot by examiners from simple salts having the following anions and cations.

Anions: CO_3^{-2}, CH_3COO^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, SO_4^{2-} $C_2O_4^{-2}$ and PO_4^-,

Cations: NH_4^+,Pb^{2+}, Bi^{3+}, Cu^{2+}, Al^{3+},Fe^{+3} Mn^{2+}, Zn^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+}, Na^+, K^+ and Li^{+1}

Note:

1.Mixture requiring elimination of phosphate and borate radicals must be avoided (avoid cations such as Ba^{2+}, Ca^{2+}, Sr^{2+},Mg^{2+} when borate or phosphate radicals are given).

2. Mixures of salts which on double decomposition form precipitates insoluble in dilute HCl (like $BaSO_4$, $SrSO_4$, $PbSO_4$) should not be given.

3. Combination like NO_3^- and Br^-, NO_3^- and I^- ,Cl^- and Br^-, Cl^- and I^-, Cl^- and NO_3^-, Br^- and I^- must be avoided.

4. The cations should belong to different groups. For example a combination of Ca^{2+}, and Sr^{2+}, Ba^{2+} and Ca^{2+}, Ba^{2+} and Sr^{2+}, Mg^{2+} and Na^+, Na^+ and K^+, Mg^{2+} and Na^+, Na^+ and K^+, Mg^{2+} and K^+, Al^{3+} and Mn^{2+}, Mn^{2+} and Zn^{2+}, Bi^{3+} and Cd^{2+} must be avoided.

5. AR and GR grade chemicals are used for preparing mixtures.

6. Different mixtures should be prepared and distributed to the candidates (by lots) so that not more than three candidates in a batch get the same mixture.

7. In case of cations, recording of tests are to be done until two cations are detected and confirmed.

Inorganic qualitative analysis.

Four radicals reported correctly	12marks
Three radicals reported correctly	09 marks
Two radicals reported correctly	06 marks
One radical reported correctly	03marks

Note:

1. For detecting only the group to which the cations belong, one mark for each correct group should be given.

2. If more than four radicals are reported, reduce three marks for each extra radical reported.

3. In case of anions, confirmatory test is expected.

4. In case of cations confirmatory test is expected only in case of NH_4^+.

5. Flame test may be considered as one of the preliminary test only and not as a conclusive test for cation.

6. In case of anions, positive tests should be recorded in detail while the essential negative tests may be recorded in brief.

Part B- Physical Chemistry Practical (13 marks)

Any one of the following experiments may be given.

- Determination of the enthalpy of neutralization of a strong acid with a strong base.

7. Verification of Freundlich isotherm for adsorption of acetic acid adsorbed onactivated charcoal.
8. The study of kinetics of potassium persulphate and potassium iodidevolumetrically.
9. Determination of velocity constant for acid catalyzed hydrolysis of methyl acetate.
10. Determination of velocity constant for the saponification of ethyl acetate ($a = b$)volumetrically.
11. Determination of equivalent conductivity of sodium chloride and verification ofDHO equation.
12. Determination of dissociation constant of weak acid by conductivity method.
13. Conductometric titration of strong acid and strong base.
14. Conductometric titration of weak acid and strong base.

10. Determination of solubility product of sparingly soluble salt conductometrically

Valuation Scheme

1. Determination of the enthalpy of neutralization of a strong acid with strong base. 13 Marks

i) Error in enthalpy value

Error upto ±10%	10 Marks
±11% to 15%	08 Marks
±16% to 20%	06 Marks
±21% to 25%	04 Marks
Any Other value	02 Marks
Calculation	03 Marks

2. Verification of Freundlich isotherm for adsorption of acetic acid on activated charcoal

a) Tabulation and calculation 03 Marks

b) Graph (good plot) 06 Marks
Deduct marks proportionally for variation

c) Calculation of k and n values
Calculation 04 marks

Experiments 3 to 5 (Velocity constant determination Experiments)

i) Error in velocity constant value

Error upto ±10%	10 Marks
±11% to 15%	08 Marks
±16% to 20%	06 Marks
±21% to 25%	04 Marks
Any Other value	02 Marks

ii) Calculation 03 Marks

6.. Determination of equivalent conductivity of strong electrolyte(sodium chloride) and verification ofDHO equation

a) Graph (good plot) 04Marks
Other plots 02Marks

b) Error in values

± 0.2 ml	06Marks
± 0.3 ml	05Marks
± 0.4 ml	04Marks
± 0.5 ml	03Marks
Other values	02Marks

c) Calculation of equivalent conductance 03Marks

7. Determination of dissociation constant of weak acid by conductivity method

a) Graph (good plot) 04 Marks
Other plots 02 Marks
b) Error in values

± 0.2 ml	06 Marks
± 0.3 ml	05 Marks
± 0.4 ml	04 Marks
± 0.5 ml	03 Marks
Any Other value	02 Marks

c) Calculation dissociation constant 03 Marks

8. Conductometric titration of a strong acid with a strong base

a) Graph (good plot) 05 Marks
Other plots 02 Marks
b) Error in values

± 0.2 ml	06 Marks
± 0.3 ml	05 Marks
± 0.4 ml	04 Marks
± 0.5 ml	03 Marks
Any Other value	02 Marks

c) Calculation 02 Marks

9. Conductometric titration of weak acid and strong base.

a) +Graph (good plot) 05 Marks
Other plots 02 Marks
b) Error in values

± 0.2 ml	06 Marks
± 0.3 ml	05 Marks
± 0.4 ml	04 Marks
± 0.5 ml	03 Marks
Any Other value	02 Marks
Calculation	02 Marks

10. Determination of solubility product of sparingly soluble salt conductometrically

i) Error in solubility product value

Error upto ±8%	10 Marks
±9% to 13 %	08 Marks
±14% to 16%	06 Marks
±16% to 20%	04 Marks

Any Other value 02 Marks

ii) Calculation 03 Marks

Allotment of Marks or Formative Assessment:
Maximum Marks: 25

i)Laboratory Record and Attendance 10Marks
ii)Internal Practical Examination 15Marks.

Internal Practical Examination should be conducted as per the university examination scheme and maximum marks is to be reduced from 25 to 15.

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V SEMESTER BSc CHEMISTRY

PAPER - V : INORGANIC AND PHYSICAL CHEMISTRY
BSCCHCN501

Contact hours: 56 **Work Load: 4Hours/week** **Credit points:4**

Evaluation:Continuous Internal Assesment: 40Marks

Semester End Examination: 60Marks

Course Objectives:

i) To introduce the students to various theories of chemical bonding

ii) To make the students learn nuclear reactions and their applications.

iii)To introduce the students to quantum mechanical concepts, Schrodinger wave equation and its solutions.

iv) To make the students learn the structure and properties of main group elements which have large number of applications in daily life.

Course Specific outcomes:

After the completion of this course, students will

i) Understand the types of bonding in compounds and the theories to explain them

ii) Understand nuclear reactions, the importance of nuclear phenomenon, radiation chemistry & it's applications.

iii) Know the application of Quantum mechanics to particle in a box and hydrogen atom.

iv) Know chemistry of main group elements and acid base concepts.

v) Know chemical dynamics and kinetics of chemical reactions.

UNIT - I

Chemical Bonding: **8h**

VSEPR model, shapes of molecules-ClF_3, ICl_4^-, TeF_5^-, I_3^-, $TeCl_6^{2-}$, XeF_6, IF_7, Bent rules and energetics of hybridization; electronegativity and partial ionic character; Bonds- Multicenter, Synergic and Agostic bonding. Molecular orbital theory: LCAO and MO diagrams of heteronuclear diatomic (CO, HF, ICl) molecules.

M-M bond and metal atom clusters, halide clusters, bonding in $[Re_2Cl_8]^{2-}$.

Nuclear Chemistry: **6h**

The atomic nucleus-elementary particles, quarks, classification of nuclides based on Z and N values, nuclear stability, nuclear potential, binding energy. Nuclear Models: Liquid drop model, Fermi gas model. Radioactivity, radioactive decay kinetics, Parent-daughter decay-growth relationship-secular and transient equilibria. Applications of radioactive isotopes. (Numerical problems to be worked out wherever necessary).

UNIT – II

Chemistry of main group elements: 8**h**

Structure and bonding in boranes, carboranes, Styx Number, Wades rules, borazines, phosphazenes, S, N- compounds. Silicates- Classification, structures, isomorphous replacement, pyroxenes, layered and vitreous silicates, zeolites and molecular sieves.

HSAB concept: 6**h**

Basis of HSAB concept, acid-base strength, hardness and softness, symbiosis, applications of HSAB concept; Acid- base concept in non-aqueous media, reactions in BrF_3, N_2O_4, anhydrous H_2SO_4, CH_3COOH.

UNIT – III

Quantum Mechanics: **10h**

Concepts of Operators: Laplacian, Hamiltonian, Linear and Hermitian operators. Algebra of operators, commutator operator. Eigenfunctions and eigenvalues. Solutions of Schrödinger wave equation for a particle in a three-dimensional box, particle in a ring. Quantum mechanical degeneracy, tunneling (no derivation).

Formulation of Schrodinger equation to hydrogen atom in spherical polar co-ordinates (no derivation). Quantum numbers and their characteristics. Coupling of Angular momenta. Russell-Saunders and JJ-coupling, Term symbols. Zeeman effect.

Chemical Dynamics -I **4h**

Review of theories of reaction rate- Collision theory and Transition state theory, Comparison of collision theory with transition state theory, Arrhenius equation-characteristics, Significance of energy of activation, Temperature coefficient and its evaluation. Problems to be worked out wherever necessary. Introduction to fast reaction techniques.

UNIT – IV

Chemical Dynamics – II **6h**

Concept of Steady state kinetics, Chain reactions - chain length and chain inhibition, comparison of photochemical and thermal reactions, Mechanisms of thermal and photochemical reactions between hydrogen-bromine and hydrogen-chlorine. Comparative study of thermal and photochemical hydrogen-halogen reactions. Pyrolysis of acetaldehyde, Decomposition of ethane.

Radiation Chemistry: **4h**

Introduction. Radiation sources and units. Radiation dosimetry, dosimeter. Radiolysis of water (using gamma rays), radiolysis of gases and liquids. Application of radioisotopes in the study of organic reaction mechanism. Industrial applications.

Surface Chemistry: **4h**

Types of adsorption isotherms, Effect of temperature on adsorption. Gibbs adsorption isotherm and its significance, surface tension and surface energy. Derivation of BET equation. Determination of surface area using BET equation.

Recommended Books/References:

1. Basic Inorganic Chemistry- F. A. Cotton, G. Wilkinson and P. L. Gaus; John Wiley and sons. Inc, 6thedition (1999).
2. Advanced Inorganic Chemistry, 6th edition; F. A. Cotton and G. Wilkinson.
3. Inorganic Chemistry IV edition; J. E. Huheey, E. A. Keiter and R. L. Keiter, Addison; Wesley (1993).
4. Inorganic Chemistry, II edition, D. F. Shriver, P. W. Atkins and C. H. Langford, ELBS;

Oxford University Press, 1994.
5. Chemistry of elements; N. N. Greenwood and A. E. Earnshaw, Butterworth Heinemann (1997).
6. Concise Inorganic Chemistry, 5th edition; J. D. Lee (1996).
7. Essentials of nuclear chemistry, 4th edition; H. J. Arniker, NAIL publishers (1995); Chapters 1, 3 and 4.
8. Nuclear and Radioactive chemistry; Friedlander, Kennedy and Miller; Chapters 8 and 9.
9. Inorganic Chemistry, 3rd Edition; Gary. L. Miessler and Donald . A. Tarr (2007).
10. Physical Chemistry, P. W. Atkins, Julio de Paula, ELBS, 7th edition, (2002).
11. Physical Chemistry: A Molecular Approach, McQuarie and Simon, Viva, New Delhi, (2001).
12. Introduction to Quantum Chemistry, A. K. Chandra, Tata McGraw Hill, (1988).
13. Quantum Chemistry, Ira. N. Levine, Prentice Hall, New Jersey, (1991).
14. Quantum Chemistry, R. K. Prasad, New Age International, 2nd edition, (2000).
15. Quantum Chemistry through problems and solutions, R. K. Prasad, New Age International (1997).
16. Chemical Kinetics- K. J. Laidler, McGraw Hill. Inc. New York (1988).
17. Principles of Chemical Kinetics - House J. E. Wm C Brown Publisher, Boston, (1997).
18. Kinetics and Mechanism - A. A. Frost and R. G. Pearson, John-Wiley, New York, (1961).
19. Chemical Kinetic Methods - C. Kalidas, New Age International Publisher, New Delhi (1995)
20. S.H. Maran and C. F. Pruton, 4th Edn., Oxford, & IBH publishing Co. Pvt. Ltd. New Delhi (1965).
21. Physical Chemistry- P. Atkins and J. D. Paula, 9th Edn., Oxford University Press (2010).
22. Biochemistry, - Geoffrey Zubay, 2nd Edn.,Macmillan Publishing Co. New York (1981).
23. Kinetics and Mechanism of Chemical Transformations- J. Rajaraman and J. Kuriakose, Mc Millan.

PRACTICAL V
INORGANIC & PHYSICAL CHEMISTRY PRACTICAL
BSCCHPN501

Work Load: 4Hours/week **Credit points:2**
Evaluation:Continuous Internal Assesment:25Marks
Semester End Examination: 25Marks

Course Objectives:
Students are made to learn
i) the practical aspects of preparation of complexes
ii) analysis of anions and cations. i
ii) instrumental methods of analysis

Course Specific outcomes:
i) Students will have practical experience in systematic semimicro qualiitative analysis of inorganic mixtures containing less familiar elements.

ii) Students acquire the knowledge in the preparation of inorganic complexes.

iii) Theoretical knowledge of students is strengthened with laboratory experiments using instruments like colorimeter, conductivity meter and potentiometer.

INORGANIC CHEMISTRY EXPERIMENTS

I Semi micro qualitative analysis of mixtures containing **two anions, two common cations and one less familiar elements**: W, Mo, Ce, Zr, V and Li. (Any five combinations).

II Preparation 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 pentamminechlorocobalt(III)chloride.

PHYSICAL CHEMISTRY EXPERIMENTS

I Colorimetric Experiments

1. Verification of Beer's Law for Cu^{2+} ion/ Fe^{2+} ion.
2. Estimation of Fe^{2+} ion concentration using EDTA through colorimetric method.

II Conductometric Experiments

1. Precipitation titration: conductometric titration of lithium sulphate versus $BaCl_2$.
2. Conductometric titration of weak acid versus weak base.

III Potentiometric Experiments

1. Determination of single electrode potential of M^{2+}/M and estimate the given unknown concentration (Zn^{2+}/Zn, Cu^{2+}/Cu)
2. Titration of weak acid against a strong base using quinhydrone electrode and calculation of pKa and Ka of the weak acid.

Recommended Books/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).
5. Findlays practical physical chemistry revised by P. B. Levitt, Longman's London (1966).
6. Experiments in Physical Chemistry by Shoemaker and Garland, McGraw Hill International Edn. (1966)
7. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publications Meerut (1988)
8. Senior Practical Physical Chemistry by B. C. Kosla, Simla Printers New Delhi (1987)
9. Experimental Physical Chemistry by Daniel et al., McGraw Hill, New York (1962).
10. Practical Physical Chemistry by A.M James and P. E. Pritchard, Longman's Group Ltd (1968)
11. Experimental Physical Chemistry by Wilson, Newcombe & others, Pergamon Press, New York (1962)
12. Experimental Physical Chemistry by R. C. Behra and B Behra, Tata McGraw, New Delhi (1983)
13. Experimental Physical Chemistry by V. D. Atavale and Parul Mathur, New Age International, New York (2
14. Physical Chemistry Laboratory Principles and Experiments by H. W. Salberg J. I. Morrow, S. R. Cohen an Green Macmillan publishing Co .new York.
15. Practical's in physical chemistry A. Modern Approach by P.S Sindhu, Mac. Millan Publishers Delhi (200 (1986).
16. Physical Chemistry of Surfaces- A. W. Adamson, Interscience Publisher Inc., New York (1967).
17. Surface Chemistry: Theory and Applications, J. J. Bikerman, Academic Press. New York (1972).

PAPER - VI: ORGANIC CHEMISTRY AND SPECTROSCOPY
BSCCHCN502
UNIT – I

Contact hours:56 Work Load:4Hours/week Credit points:4
Evaluation:
Continuous Internal Assesment:40Marks
Semester End Examination: 60Marks

Course Objectives:

i)To acquire detailed knowledge of the nature of bonding and reaction mechanism in organic molecules.

ii)To study carbohydrates, their Conformations and Configurations.

ii) To acquire the knowledge of structure and properties of heterocyclic compounds.

iv)To gain knowledge of molecular-vibrational, rotational, Raman and UV spectroscopic techniques.

Course Specific outcomes:
After the completion of the course students will be able to:

i) Differentiate aliphatic and aromatic compounds, understand the concept of resonance and write simple reaction mechanisms.
ii) Identify some of the heterocyclic compounds, their structure and physiological properties.
iii) have the basic knowledge of molecular spectroscopic methods like rotational, vibrational, Raman, NMR and UV Spectroscopy.

UNIT – I

Nature of Bonding in Organic Molecules: 4h

Delocalized chemical bonding, resonance, cross conjugation. Aromaticity. Huckel's rule of aromaticity. Aromatic systems with number of electrons other than six (azulene, tropone, tropolone and annulenes). Antiaromaticity. Aromaticity in benzenoids. Homo-aromaticity. Hyperconjugation. Tautomerism.

Reaction mechanism: 5h

Effect of structure on reactivity: - Resonance and field effects; steric effects.

Nucleophilic substitution reaction at a saturated carbon: S_N1, S_N2, and SET mechanisms. Effect of substrate structure, attacking nucleophile, leaving group.
Nucleophilic substitution in Aromatic compounds. S_NAr-Aryl mechanism.

Carbohydrates: 5h

Configuration, conformation of monosaccharides and classification. Interconversions of glucose and fructose, chain lengthening of aldoses (Kiliani-Fischer method), Chain shortening (Ruff degradation) Conversion of glucose and mannose-epimerisation, Mechanism of osazone formation-Amadori rearrangement, Formation of glycosides, ethers (methyl), esters (acetates). Configuration of glucose and fructose-deduction, Determination of ring size of monosaccharides (methylation and periodic acid method), Elucidation of cyclic structure of D(+) glucose, Mechanism of muta rotation.

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UNIT – II

Heterocyclic Compounds: **7h**

Nomenclature of heterocyclic compounds. Structure, reactivity, synthesis and reactions of Pyrrole, Furan, Thiophene, pyrazole, oxazole, thiazole, pyrimidine, purine and indole.

Vitamins: **7h**

Biological importance and synthesis of Vitamins A, Vitamin B1 (thiamine), Vitamin B6 (pyridoxine), folic acid, pantothenic acid, riboflavin, Vitamin C, Vitamin E (α-tocopherol), Vitamin H (biotin), Vitamins K1 and K2.

UNIT – III

Molecular Spectroscopy – I

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation(No mathematical derivation. Physical meaning only). **3h**

Rotation spectroscopy:

Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution. **4h**

Vibrational spectroscopy:

Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies. Fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. **4h**

Raman spectroscopy:

Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference. **3h**

UNIT – IV

Nuclear Magnetic Resonance (NMR) spectroscopy: **8h**

Introduction, origin of spectra, instrumentation of PMR spectrometer, solvents used, scales, number of signals for simple organic molecule, area of signals. Chemical shift and factors affecting chemical shift. Nuclear shielding and deshielding, Spin-spin splitting, coupling constants. Interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromo ethane and ethyl acetate.

UV Spectroscopy: **6h**

Types of electronic transitions, λmax, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λ max for the following systems: α,β-unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.

Recommended Books/References:

1. Advanced Organic Chemistry - Reactions, Mechanism and Structure, Jerry March, John Wiley (2008).
2. Advanced Organic Chemistry, F A Carey and R J Sundberg Plenum, (1990).
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman, (2000).
4. Structure and mechanism of Organic Chemistry, C K Ingold, Cornell University Press (1999).
5. Organic Chemistry, R T Morrison and R N Boyd, Prentice-Hall, (1998).
6. Modern Organic Reactions, H O House, Benjamin, (1972).
7. Principles of Organic Synthesis, R O C Norman and J M Coxon, Blackie Academic

and Professional, (1996).
8. Stereochemistry of Organic Compounds, D Nasipuri, New-Age International, (1999).
9. Stereochemistry of Carbon Compounds, E L Eliel, S H Wilen and L N Mander, John Wiley, (1994).
10. Stereochemistry, Potapov, MIR, Moscow, 1984.
11. Organic Chemistry, Volumes I and II, I L Finar, Longman, (1999).
12. Laideler K. J. and Meiser J. M. Physical Chemistry Third Edition (International)1999
13. Levine I. N., Physical Chemistry, Fourth Edition), McGraw-Hill (International), 1995.
14. McQuarrie D. A. and Simon J. D. Physical Chemistry- A Molecular Approach, University Science Books, 1998.
15. P.W. Atkins: Physical Chemistry.
16. G.W. Castellan: Physical Chemistry.
17. Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).
18. Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.
19. Kemp, W. Organic Spectroscopy, Palgrave
20. Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7).
21. Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle.

PRACTICAL VI
ORGANIC CHEMISTRY PRACTICAL
BSCCHPN502

Work Load: 4Hours/week **Credit points:2**
Evaluation:
Continuous Internal Assessment: 25Marks
Semester End Examination: 25Marks

Course Objectives:
i)To make students learn synthesis of simple organic compounds and analysis of organic compounds with bifunctional groups.

Course Specific outcomes:
i) Students will know how to systematically identify organic compounds containing two functional groups by qualitative method.

ii) Students will be able to do simple single stage organic synthesis.

I- Preparation (one stage)

1. Cannizarro reaction: Benzaldehyde.
2. Pechmann reaction: Resorcinol and ethylacetoacetate.
3. Oxidation of Cyclohexanol.
4. Preparation of S-Benzylisothiuronium chloride.
5. Synthesis of p-Iodonitrobenzene
6. Synthesis of N-Phenyl-2,4-dinitroaniline.
7. Synthesis of 2,4,6-Tribromoaniline.

II- Qualitative analysis of bifunctional organic compounds

Systematic analysis and identification of organic compounds:

1. p-nitrobenzoic acid	2. p-nitrophenol	3. salicylic acid,
4. anthranilic acid,	5. o-chloroaniline,	6. p-nitroaniline,
7. p-nitrobenzaldehyde		

Recommended Books/References:

1. Laboratory manual of Organic Chemistry- B. B. Dey, M V Sitaraman and T R Govindachari, Allied Publishers, NewDelhi, (1996).
2. Practical Organic Chemistry - Mann and Saunders, (1980).
3. Textbook of Practical Organic Chemistry- A. I. Vogel, (1996).
4. Textbook 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.

VI SEMESTER BSc CHEMISTRY
PAPER VII: INORGANIC AND PHYSICAL CHEMISTRY
BSCCHCN601

Contact hours:56 **Work Load:4Hours/week** **Credit points:4**

Evaluation:Continuous Internal Assesment:40Marks
Semester End Examination: 60Marks

Course Objectives:

i) To make the students aware of the kinetics, stability, electronic spectra and types of bonding in complex compounds.
ii) To make the students understand the theories of binary mixtures and thermal methods of analysis of compounds.
iii) To make the students learn the potentiometric methods of quantitative analysis.

Course Specific outcomes:

After the completion of course, the students will

i) know the Kinetics of complex formation and also the electronic spectra of complexes which will help them in selecting the methods of synthesis and identification of complex compounds.
ii) understand the theories of bonding in complex compounds.
iii) understand the principle of steam distillation and separation of components of binary mixtures.
iv) get introduced to thermal methods of analysis.
v) understand the concept of galvanic cells and potentiometric methods of quantitative analysis.

UNIT – I

Metal-Ligand equilibria in solution: 10h

Step-wise and overall formation constant and their relationship, 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 effect, macrocyclic effect and their thermodynamic origin.

Electronic spectra of coordination compounds: 4h

Spectroscopic terms for ground states, selection rules, term symbols for d^n ions, Racah parameters, Orgel diagrams, spectra of 3d metal-aqua complexes of trivalent V, Cr, calculation of Dq, B and β parameters, CT spectra.

UNIT – II

Metal- ligand bonding: 12h

Stereoisomerism- coordination numbers 4 and 6. Crystal field theory, salient features, spectrochemical series, splitting of d-orbitals in tetragonal, square planar, trigonal bipyramidal and square-pyramidal geometry, applications of CFT- colours of transition metal complexes, magnetic properties of octahedral complex, distortion of octahedral complex, CFSE and their uses, factors affecting CFSE, limitations of CFT, experimental evidence for metal-ligand covalent bonding in complexes, nephelauxetic effect,

Magnetic properties of coordination compounds: 2h

Classification of magnetic materials, magnetic susceptibility, and its determination by Gouy method.

UNIT – III

Binary Mixtures 4h

Ideal liquid mixtures - Raoult's law, Vapour pressure vs composition (mole-fraction) curves. Azeotropes - HCl-H_2O and Ethanol-Water system; Fractional distillation, partially miscible liquids - phenol-water, triethylamine-water and nicotine-water systems. Lower and upper critical temperature; Effect of impurity on critical temperature. Immiscible liquids – steam distillation.

Phase Equilibrium 5h

Phase rule-Statement (mathematical expression) and meaning of the terms. Explanation for the terms phase, component and degrees of freedom with suitable examples for each. Derivation of phase rule from thermodynamic consideration. Explanation of phase equilibria of one component system (water and sulphur system) using phase diagram. Two component system - classification with examples, simple eutectic system (lead-silver system) - phase diagram and explanation, desilverisation of lead (Pattinson's Process). Compound formation with incongruent melting point (NaCl + water system) - phase diagram and explanation.

Thermo-analytical methods 5h

TGA - Principle, instrumentation, types of thermo balances; Deflection and null type; Factors affecting TGA curves – rate of heating and furnace atmosphere; Determination of composition of a compound with example of $CaC_2O_4.H_2O$. Applications – evaluation of suitable standard, testing of sample purity, study of organic compound, drying and ignition temperature, determination of curie point. DTG – Advantages over TGA; Significance of DTG curves. DTA - Principle, Factors affecting DTA curves – rate of heating and furnace atmosphere with example of $CaC_2O_4.H_2O$; Simultaneous TGA and DTA curves; interpretation of DTA curve.

UNIT – IV

Dilute Solutions and Colligative Properties: 6h

Ideal and non-ideal solutions - thermodynamic properties (ΔG, ΔH and ΔS) of ideal solutions, Activity and Activity coefficients, colligative properties – Definition and an elementary account of the four colligative properties. Raoult's Law of relative lowering of vapour pressure. Osmosis - Laws of osmotic pressure.

Elevation in boiling point and depression in freezing point. Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental determination of molecular weight by Walker-Lumsden method and Beckmann's method. Numerical Problems to be solved wherever necessary.

Electrochemistry: 8h

Galvanic cells. Reference electrodes, Calomel, Quinhydrone, Ag-AgCl and glass electrode (Construction, Electrode reaction, Nernst equation), E.M.F. of cells and its

measurements by potentiometric method, calculation of electrode potential, computation of cell EMF, relation between ΔG^0 and K for cell reaction, calculations.

Concentration cells: Electrolyte concentration cells with/without transport, liquid junction potential, calculations. Applications of concentration cells: Determination of a) valency of ions, b) solubility product

Application of E.M.F. measurements: a) Potentiometric titrations (acid- base and redox), b) Determination of p^H using hydrogen electrode, Quinhydrone electrode and Glass electrode by potentiometric methods.

Recommended Books/References:

1. Basic Inorganic Chemistry- F. A. Cotton, G. Wilkinson and P. L. Gaus; John Wiley and sons. Inc, 6th edition (1999).
2. Chemistry of elements- N. N. Greenwood and A. E. Earnshaw, Butterworth Heinemann (1997).
3. Inorganic Chemistry IV edition; J. E. Huheey, E. A. Keiter and R. L. Keiter, Addison; Wesley (1993).
4. Inorganic Chemistry, II edition, D. F. Shriver, P. W. Atkins and C. H. Langford, ELBS; Oxford University Press, 1994.
5. Inorganic Electronic spectroscopy, A. B. P. Lever, Elsevier. (1968).
6. Magnetochemistry, R.L. Carlin, Springer Verlag.
7. Electronic Absorption Spectroscopy and related Techniques, D. N. Sathyanarayana, University Press (2001).
8. Inorganic Chemistry A Unified Approach by W. W. Porterfield, Elsevier 2005 2nd edition.
9. Textbook of inorganic chemistry by G. S. Sodhi, Viva books Pvt. Ltd (2011).
10. Molecular thermodynamics, Donald A. Mc Quarrie, John D. Simon University Science Books California, (1999).
11. Thermodynamics for Chemists, by S. Glasstone, East-West Press, New Delhi, (1960).
12. Thermodynamics, by Rajaraman and Kuriacose, East-West Press, (1986).
13. Statistical Thermodynamics, M. C. Gupta (Wiley Eastern Ltd.) 1993.
14. Elementary Statistical Thermodynamics, N. D. Smith, Plenum Press, NY, (1982).
15. Elements of Classical and Statistical Thermodynamics, L. K. Nash, Addison-Wiley (1979).
16. Thermodynamics, Statistical Thermodynamics and Kinetics by Thomas Engel & Philip Reid, Pearson Education inc. (2007)
17. Modern Electrochemistry Vol-1 and 2 J. O. M Bockris and A. K. N. Raddy, Plenum New York (1978)
18. An introduction to electrochemistry- Samuel Glastone East-West edition New Delhi (1942)
19. Text book of physical chemistry Samuel Glastone , 2nd edition, Mac Millan India Ltd (1991)
20. Electrochemistry, Principles and applications, Edmund, C. Potter, Cleaver-Hume press London (1961).
21. Principles and applications of Electrochemistry- D. R. Crow 3rd edition Chapmanhall London (1988).

PRACTICAL – VII

PHYSICAL & INORGANIC CHEMISTRY PRACTICAL

BSCCHPN601

Work Load: 4Hours/week **Credit points:2**

Evaluation: Continuous Internal Assesment: 25Marks

Semester End Examination: 25Marks

Course Objectives:

i) To introduce the students to gravimetric and volumetric methods analysis.
ii) To make students learn about physical properties of liquids.
iii) To make students learn some electrochemical methods of analysis.

Course Specific outcomes:

i) Students learn the application of gravimetry and volumetry in chemical analysis.
ii) Learn some of the instrumental and physical methods used in quantitative analysis.

PHYSICAL CHEMISTRY PRACTICAL

Chemical kinetics:

1. Study the hydrolysis of methyl acetate in presence of two different concentrations of HCl and report the relative strength.
2. Study the hydrolysis of methyl acetate in the presence of HCl at different temperatures and report the energy of activation.
3. Study of variation of viscosity of a liquid with temperature, determine the constant A and B.
4. Determination of pH of acetic acid -sodium acetate buffer by pHmetry.

Conductometric titration

1. Acid mixture versus NaOH.
2. Weak acid (CH_3COOH) with salt ($CuSO_4$) versus NaOH.
3. Strong acid (HCl) with salt (NH_4Cl) versus NaOH.

Potentiometric titration

1. $K_2Cr_2O_7$ versus FAS.
2. Weak acid versus NaOH

INORGANIC CHEMISTRY PRACTICAL

I-Gravimetric analysis

1.Gravimetric determination of Fe in iron ore as Fe_2O_3.

2.Gravimetric determination of Ni in Cu and Ni mixture.

3. Gravimetric estimation of Cu in Cu and Zn mixture.

II-Volumetric analysis

1.Volumetric estimation of Ca and Mg in Dolomite solution.

1. Volumetric estimation of Zn in Cu and Zn mixture.
2. Volumetric estimation of Ni in Ni and Zn mixture.

Recommended Books/References:

1. 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).
2. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Von Nostrand Reinhold Co., London (1972).
3. Findlays practical physical chemisty revised by P. B. Levitt, Longman's London (1966).
4. Experiments in Physical Chemistry by Shoemaker and Garland, McGraw Hill International Edn. (1966).
5. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publications Meerut (1988).
6. Senior Practical Physical Chemistry by B. C. Kosla, Simla Printers New Delhi (1987).
7. Experimental Physical Chemistry by Daniel et al., McGraw Hill, New York (1962).
8. Practical Physical Chemistry by A.M James and P. E. Pritchard, Longman's Group Ltd (1968)
9. Experimental Physical Chemistry by Wilson, Newcombe & others, Pergamon Press, New York (1962).
10. Experimental Physical Chemistry by R. C. Behra and B Behra, Tata McGraw, New Delhi (1983).
11. Experimental Physical Chemistry by V. D. Atavale and Parul Mathur, New Age International, New York (2001).
12. Physical Chemistry Laboratory Principles and Experiments by H. W. Salberg J. I. Morrow,S. R. Cohen and M. E. Green Macmillan publishing Co .new York.
13. Practical's in physical chemistry A. Modern Approach by P.S Sindhu, Mac. Millan Publishers Delhi (2006).

PAPER VIII: ORGANIC CHEMISTRY AND SPECTROSCOPY
BSCCHCN602

Contact hours:56 Work Load:4Hours/week Credit points:4
Evaluation:Continuous Internal Assesment:40Marks
Semester End Examination: 60Marks

Course Objectives:

i)To understand the mechanism of electrophilic and nucleophilic substitution reactions and addition reactions with suitable examples.
ii) To learn the basics of symmetry and group theory.
iii) To learn PES and flame photometry.

Course Specific outcomes:

After the completion of the course, the students will
i) know the mechanism of selected electrophilic and nucleophilic substitution reactions
ii) understand the mechanism of addition reactions in organic compounds.
iii) get exposure to symmetry and group theory.
iv) get introduction to photo electron spectroscopy and flame photometry.

UNIT – I

Aromatic Substitution Reactions: 4h

Electrophilic Substitution Reactions: Sulfonylation reactions; Diazonium coupling, Vilsmeier-Haack reaction, Gatterman reaction.

Nucleophilic substitution reactions: 3h

Goldberg reaction, Bucherer reaction, Schiemann reaction.

Rearrangements: 3h

Wagner-Meerwein, Curtius, Lossen and Schmidt rearrangements. Benzil-benzilic acid rearrangement, Baeyer-Villiger oxidation.

Amino acids and Peptides: 4h

Synthesis and reactions of amino acids. Classification and nomenclature of peptides. Edman methods of sequencing. Cleavage of peptide bond by chemical and enzymatic methods. Protection of amino group and carboxyl group as alkyl and aryl esters. Coupling of protected amino acids.

UNIT - II

Addition Reactions: 14h

Addition to carbon-carbon multiple bonds: mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles, and free radicals. Regio, stereo- and chemoselectivities. Orientation and reactivity. Addition of halogens to alkenes-carbocation and halonium ion mechanisms. Stereo specificity of halogen addition. Addition to cyclopropane ring. Hydrogenation of double and triple bonds. Michael reaction.

Ozonolysis- Mechanism of ozonolysis of propene. Addition of hydrogen halides to alkenes- mechanism, regioselectivity and relative rates of addition. hydration, hydroxylation and epoxidation of alkenes-Explanation with examples. Electrophilic addition to conjugated dienes-effect of temperature. Free radical addition to 1,3-butadiene.

Addition to carbon-heteroatom multiple bonds: Addition of Grignard reagents and organolithium

reagents to carbonyl compounds and unsaturated carbonyl compounds. Wittig, Mannich and Stobbe reactions.

UNIT – III

Symmetry and Group Theory in Chemistry: 6h

Definition of groups, subgroups, simple theorems in group theory. Symmetry elements and symmetry operations, point groups, Schöenflies notations, representations of groups by matrices, reducible and irreducible representations, character tables, Great Orthogonality Theorem (without proof) and its applications.

Photochemistry 8h

Interaction of radiation with matter, difference between thermal and photochemical processes. primary and secondary processes of a photochemical reaction, Laws of photochemistry: Grothuss - Draper law, Stark - Einstein law, (only statement) Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing). Quantum yield- definition, reasons for low and high quantum yield. Explanation for low and high quantum yield reactions taking combination of H_2 and Br_2 and combination of H_2 and Cl_2 as examples. Photosensitized reactions-energy transfer processes definition of photosensitization.(e.g.: Photosynthesis in plants, dissociation of H_2, Isomerization of 2-butene and butadiene).

UNIT – IV

Photoelectron Spectroscopy 3h

Principle, valence and core binding energies, shifts in energies due to chemical forces, photoelectron spectra of simple molecules.

Electron Paramagnetic Resonance Spectroscopy 8h

Electron Paramagnetic Resonance (EPR) Spectroscopy: Basic principles, selection rules, intensity, width, position of spectral line, multiplet structure of EPR spectra, hyperfine interaction, spin-orbit coupling, zero field splitting and Kramer's degeneracy, rules for interpreting spectra, factors affecting the magnitude of values. Instrumentation. Applications to the study of free radicals, coordination compounds.

Flame photometry 3h

General principles, Instrumentation, Interference and applications

Recommended Books/References:

1. Advanced Organic Chemistry - Reactions, Mechanism and Structure, Jerry March, John Wiley (2008).
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum (1990).
3. A Guide Book to Mechanism of Organic Chemistry, Peter Sykes, Longman (2000).
4. Structure and Mechanism of Organic Chemistry, C. K. Ingold, Cornell University Press.
5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall (1998).
6. Modern Organic Reactions, H. O. House, Benjamin (1972).
7. Principles of Organic Synthesis, ROC Norman and J. M. Coxon, Blackie Academic and Professional(1996).
8. Stereochemistry of Organic Compounds, D. Nasipuri, New-Age International (1999).
9. Stereochemistry of Carbon Compounds, E. L. Eliel, S. H. Wilen and L. N. Mander, John Wiley (1994).
10. Organic Chemistry, Volumes I and II, I L Finar, Longman. (1999).

11. Medicinal Chemistry, A Kar, Wiley (2000).
12. Peptides Chemistry: A practical text book, M. Bodansky, Springer-Verlag NY, 1988.
13. Solid-phase peptide synthesis: A practical approach-E. Artherton & R.C. Sheppard, I R L, Oxford Univ. Press, 1989.
14. Peptides: Chemistry and Biology, N Selwad and H.-D. Jakubke, Wiley-VCH, 2002.
15. Chemical Applications of Group Theory, F. A. Cotton, Wiley Eastern (1976).
16. Molecular Symmetry, D. S. Schonland, Van Nostrand (1965).
17. Introduction to Molecular Spectroscopy, C. N. Banwell, TMH Edition (1994).
18. Introduction to Molecular Spectroscopy, G. M. Barrow, McGraw Hill (Int. Students Edition) (1988).
19. Molecular Spectroscopy, J. D. Graybeal, McGraw Hill (Int. Students Edition) (1990).
20. Spectroscopy, Vols. 1-3, B. P. Straughan and W. Walker, Chapman Hall (1976).
21. Physical Methods in Chemistry - R .S. Drago, Saunder college.
22. Structural Methods in Inorganic Chemistry - E. A. Ebsworth, D. W. H. Ranbin and S.Cradock, ELBS.
23. Spectra of Inorganic and Coordination Compounds - K. Nakamoto.
24. 10.Infrared Spectroscopy - C.N.R. Rao.
25. Introduction to Spectroscopy - D.L.Pavia, G.M.Lampman and G.S.Kriz, Thomson Learning, Singapore (2001)
26. Spectroscopic Identification of organic compounds - R. M. Silverstein and F. X. Webster, 6th Edition, Wiley and Sons, India Ltd. (2006).
27. Interpretation of Mass Spectroscopy-McLafferty.

PRACTICAL – VIII

ORGANIC CHEMISTRY PRACTICAL

BSCCHPN602

Work Load:4Hours/week **Credit points:2**
Evaluation:Continuous Internal Assesment:25Marks
Semester End Examination: 25Marks

Course Objectives:

i) To learn two and three stage synthesis of selected organic compounds.

ii) To learn the volumetric analysis of selected organic compounds.

Course Specific outcomes:

After the practical course, the students will know

i) two and three stage synthesis of selected organic compounds .

ii) how to analyse amino acids, phthalic acid, glucose and phenol volumetrically.

iii) to determine the saponification and iodine value of oils

Preparation (Two and three stages)

1. 2,4-Dinitrophenylhydrazine from chloronitrobenzene.
2. Anthranilic acid from phthalic acid.
3. Benzanilide from benzophenone.
4. Benzilic acid from benzoin.
5. Synthesis of Acridone.

Quantitative analysis

1.Titrimetric estimation of amino acids.
2.Saponification value of oil.
3.Estimation of glucose by Feighling's method.
4.Estimation of phenols.
5.Iodine value of oil (chloramine-T method).

Recommended Books/References:

1. Laboratory manual of Organic Chemistry- B. B. Dey, M V Sitaraman and T R Govindachari, Allied Publishers, NewDelhi, (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. Comprehensive practical organic chemistry : Preparation and quantitative Analysis, V. K. Ahluwalia, R. Aggarwal, Universities Press (India), 2000.
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New central book agency, Calcutta, 2000.
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8. Practical organic chemistry (Quantitative analysis), B. B. Dey, M. V. Sitaraman and T. R. Govindachari, Allied Publishers, New Delhi, 1992.