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**ST. JOSEPH’S COLLEGE (AUTONOMOUS)**

**Syllabus for**

**B.Sc. / B.Sc. (Honors) Chemistry**

**III & IV Semester**

**2021-24**

**Department of Chemistry**

**School of Chemical Sciences**

**St. Joseph’s College (Autonomous)**

**Bangalore - 560 027**

**Structure of the chemistry course for I- IV semesters of BSc (honors) degree**

The B.Sc. (honors) degree course is a four-year program divided into eight semesters. Each semester will consist of 14 weeks of instruction for theory and 11 weeks of instruction for practicals. In Chemistry there will be 7 discipline core papers, 1 discipline specific elective papers and 7 practical papers from I to VI semesters. Internal Assessment (CIA) of each is given 40% weightage and End Semester Examination (SE) each is given 60% the weightage in every theory paper. CIA is based on written tests, seminars, assignments, quiz etc. End semester theory examination is for 2 h duration (60 marks) and practical examination is for 3 h duration (25 marks).

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Semester** | **Code number** | **Title of the paper** | **No. of hours of instruction** | **No. of hours of teaching per week** | **Continuous internal assessment (CIA)** | **End semester marks** | **Total marks** |
| **I** | CH121CH1P1 | Chemistry IPractical I | 5644 | **4****4** | **40****25** | **60****25** | **100****50** |
| **II** | CH221CH2P1 | Chemistry IIPractical II | 5644 | **4****4** | **40****25** | **60****25** | **100****50** |
| **III** | CH321CH3P1 | Chemistry IIIPractical III | 5644 | **4****4** | **40****25** | **60****25** | **100****50** |
| **IV** | CH421CH4P1 | Chemistry IVPractical IV | 5644 | **4****4** | **40****25** | **60****25** | **100****50** |

**Summary of credits for I-IV semesters**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Semester** | **Code number** | **Title of the paper** | **No. of hours of teaching per week** | **Credit** |
| I | CH121CH1P1 | Chemistry IPractical I | 44 | 42 |
| II | CH221CH2P1 | Chemistry IIPractical II | 44 | 42 |
| III | CH321CH3P1 | Chemistry IIIPractical III | 44 | 42 |
| IV | CH421CH4P1 | Chemistry IVPractical IV | 44 | 42 |

**Assessment:** Weightage for assessments (in percentage)

|  |  |  |
| --- | --- | --- |
| **Type of Course** | **Formative Assessment / IA**  | **Summative Assessment** |
| Theory | 40 | 60 |
| Practical | 25 | 25 |

**B.Sc. / B.Sc. (Honors) Chemistry Semester III**

|  |
| --- |
| **Course Title: DSC-3: Chemistry-III** |
| Total Contact Hours: 56 | Course Credits: 4 |
| Formative Assessment marks: 40 | Summative Assessment Marks: 60 |
| Duration of ESA/Exam: 2 h |  |

**DSC-3: Chemistry-III**

|  |  |
| --- | --- |
| Semester | III |
| Paper code | CH 321 |
| Paper title | Chemistry-III |
| Number of teaching hours per week | 4 |
| Total number of teaching hours per semester | 56 |
| Number of credits | 4 |

 **Note: 1. Text underlined and in italics correspond to self-study.**

 **2. Text within parenthesis and italics correspond to recall/review.**

1. **CHEMICAL BONDING 18+2 h**

Ionic bonding: lattice energy, Born-Lande equation, Born-Haber cycle. Relation between lattice energy and melting point of an ionic solid.

Covalent bonding: octet rule and its limitations, Lewis structures of molecules and ions (when provided with sequence of atoms). Formal charge calculation for different atoms in molecules/ions. *Partial covalent character of ionic bonds: Fajan’s rules. Partial ionic character of covalent bonds. Calculation of % ionic character.*

VSEPR theory: Application to ABn and ABnLm type molecules/ions (A= s or p block element;

n $\leq $7)

Valence bond treatment of hydrogen molecule: qualitative discussion of wave functions, concept of resonance. Molecular structure: bond length, bond angle, dihedral angle and molecular geometry. Overlapping of atomic orbitals, sigma and pi bonds. Hybridisation: sp, sp2, sp3, sp3d, sp3d2 with examples (inorganic molecules ABn and ABnLm type with and without π-bonds).

Molecular orbital (MO) treatment of hydrogen molecule: linear combination atomic orbitals, bonding and antibonding orbitals, energy level diagram. MO energy level diagram of homonuclear diatomic molecules/ions (Z ≤ 9): bond order and magnetic behaviour of these molecules and ions, correlation of bond order with bond length and bond strength. MO energy level diagram of heteronuclear diatomic molecules – HF and CO.

Metallic bonding: band theory (qualitative), classification of solids into conductors, insulators and semiconductors based on band theory, electrical conductance of Li and Be.

1. **ACIDS, BASES AND SOLVENTS 7+1 h**

Theories of acids and bases: Lowry-Bronsted concept, conjugate acid-base pairs, amphiprotic substances, relative strengths of acid-base pairs, solvent system concept of acids and bases and examples. Lewis concept- types of molecules or species that can act as Lewis acids and Lewis bases, Pearson’s hard and soft acid-base concept. Characteristics of hard and soft acids and bases, HSAB principle. Applications of HSAB principle-stability of complexes, prediction of coordination in complexes of ambidentate ligands, predicting feasibility of a reaction, prediction of hardness and softness. Solvent properties-liquid range, dielectric constant, solvent polarity, classification of solvents. Protic solvents-autoionisation of protic solvents (H2O, liq. NH3). Aprotic solvents-classification with examples. Molten salts-classification with examples for each, and uses. Levelling effect of solvents- explanation, levelling solvents and differentiating solvents. Liquid NH3- autoionisation, acid-base reactions, solvation, solvolysis (comparison with H2O in each case). Solutions of alkali metals in liquid ammonia. Advantages and disadvantages of liq. NH3 solvent. *Liquid SO2 as solvent- autoionisation and acid base reactions. Anhydrous HF-autoionisation, acid-base reactions*. Superacids and superbases: examples and Hammett acidity function (equation not required). Applications of superacids and superbases.

1. **THERMODYNAMICS 13+1 h**

*Terminology in thermodynamics- phase, system and surroundings. Types of systems-open, closed and isolated systems; homogeneous and heterogeneous systems, macroscopic properties. State of a system, state variables, extensive and intensive properties, thermodynamic equilibrium*. Thermodynamic processes-isothermal, adiabatic, isochoric, isobaric and cyclic. Reversible, irreversible and spontaneous processes. Concept of heat and work- sign convention, state functions and path functions, exact and inexact differentials.

Zeroth law- applications, thermodynamic temperature scale.

First law of thermodynamics-statement and mathematical form. Expression for work done in isothermal, adiabatic, isobaric, isochoric and cyclic processes. Work done in i) irreversible expansion and compression of an ideal gas, ii) reversible isothermal expansion and compression of an ideal gas (both isothermal and adiabatic conditions). Kirchoff’s law (derivation). Limitations of first law, scope of second law, statements of second law of thermodynamics. Spontaneous and non-spontaneous processes, spontaneity and equilibrium. Driving force for spontaneous processes. Concept of entropy. Entropy changes in adiabatic and isothermal reversible expansions of an ideal gas. Change in entropy of an ideal gas as a function of P, V and T. Entropy changes of an ideal gas for isothermal, isochoric and isobaric processes. Entropy changes in phase transformations. Entropy changes in the system and surroundings for reversible expansion and irreversible processes; Carnot cycle- derivation of efficiency based on entropy concept. Entropy as a criterion for spontaneity. Physical significance of entropy and relation between entropy and probability.

Free energy–Gibb’s free energy & Helmholtz free energy (work function), relation between w and ∆A and ∆G, standard free energy change of a reaction. Free energy criteria of spontaneity, variation of G with T and P. Gibbs-Helmholtz equation–derivation; van’t Hoff’s reaction isotherm. Relation between free energy & equilibrium constant of a reaction.

Third law: Standard entropies, determination of absolute entropies of substances, residual entropy.

**4. CHEMICAL KINETICS 6h** *(Review of chemical kinetics: definitions of rate of a reaction, order, molecularity, rate constant, rate equation or law, half-life).*

Derivation of rate expressions for a second order reaction when a=b and a≠b. Methods of calculation of order of a reaction: i) integral and graphical method ii) half-life period method. Effect of temperature on reaction rates, temperature coefficient. Arrhenius theory, concept of energy barrier. Bimolecular collision theory (final equation given, no derivation). Limitations of bimolecular collision theory. Transition state theory– qualitative approach. Steady state approximation, Lindemann theory- kinetics of unimolecular reactions.

1. **CATALYSIS 3 h**

Catalysis: general characteristics of catalytic reactions, catalytic poisons, catalytic promoters, positive and negative catalysts, auto catalysis, working of a catalyst. Types of catalysis–homogeneous and heterogeneous catalysis with examples, kinetics and mechanism of acid catalysed reactions, derivation of rate expression for general and specific acid catalysed reactions only. Theories of catalysis- intermediate complex theory, adsorption theory.

1. **PHOTOCHEMISTRY 5 h**

Introduction to photochemistry, photophysical and photochemical processes. Difference between thermal and photochemical reactions. Laws of photochemistry. Consequences of absorption of light radiation- luminescence, fluorescence, phosphorescence; singlet and triplet states; explanation for fluorescence, phosphorescence with the help of Jablonski diagram, chemiluminescence. Energy absorbed /mol (Einstein), calculation of Einstein; Beer-Lambert’s law- derivation of A= εcx. Application to colorimetry. Quantum efficiency Φ; study of the following photochemical reactions: i) between H2 and Cl2 ii) between H2 and Br2

 iii) photochemical decomposition of HI in gaseous phase and iv) dimerization of anthracene [expression for rate constant for case (i) to (iv)]. Photosensitization, bioluminescence.

**REFERENCES**

1. Principles of Physical Chemistry; B. R. Puri; L. R. Sharma and M. B. Pathania (47th edition); Vishal Chand Publishing Co.; (2016).
2. Principles of Inorganic Chemistry; B. R. Puri; L. R. Sharma and K. C. Kalia; (33rd edition) Vallabh Publications; (2016).
3. Text Book of Physical Chemistry; Samuel Glasstone; Macmillan India Ltd.
4. Physical Chemistry for the Chemical and Biological Sciences; Raymond Chang; (Indian Edition 2015); University Science Books.
5. Atkins Physical Chemistry; Peter Atkins and Julio de Paula; (Seventh Edition).; Oxford

University Press; (2002).

1. Basic inorganic chemistry, F. A. Cotton, G. Wilkinson, Paul L. Gaus. 3rd ed., John Wiley India Pub (2009).
2. Inorganic chemistry, James H. Huheey, Ellen A. Keiter, Richard L. Keiter, 4th ed. Pearson education (2005).
3. Inorganic Chemistry, 7th edition, M. Weller, J. Rourke, T. Overton, F. Armstrong, Oxford Univ. Press. (1999).

**Pedagogy:** ICT tools, Chalk & Talk, Models & Charts.

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| --- |
| **Formative Assessment (Internal assessment) Theory** |
| **Assessment Occasion/ type** | **Weightage in Marks** |
| Continuous evaluation and class test | 20 |
| Seminars/Class work | 10 |
| Assignments/Discussions | 10 |
| **Total** | 40 |

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| --- | --- | --- |
| **Course Outcomes** | **Cognitive Level** | **At the end of the course, the student should be able to** |
| CO1 | Knowledge | Recall definitions, laws, relationships in second and third law of thermodynamics, acids, bases and solvents, chemical bonding in molecules, ionic compounds, metals. |
| CO2 | Understand | Understand explain concepts, relationships, theories, and models in acids, bases and solvents, molecular structure, chemical bonding, second and third law of thermodynamics. |
| CO3 | Apply | Apply the bonding theories in predicting structure, bonding and magnetic properties of molecules, calculate efficiency of heat engines. |
| CO4 | Analyze | Analyze compare and contrast theories and generalisations of second and third law of thermodynamics, acids, bases and solvents, molecular structures, bonding. |
| CO5 | Evaluate | Evaluate assess the applicability of theories of thermodynamics and kinetics, solvents, acids and bases, structure and bonding for a given system |

|  |  |  |  |
| --- | --- | --- | --- |
| Name of the chapters | Total teaching hours | Marks excluding bonus questions | Marks including bonus questions |
| Chemical bonding | 20 | 21 | 28 |
| Acid, bases and solvents | 8 | 9 | 12 |
| Thermodynamics | 14 | 14 | 19 |
| Chemical Kinetics | 6 | 7 | 9 |
| Catalysis | 3 | 3 | 5 |
| Photochemistry | 5 | 6 | 7 |
| Total marks excluding bonus questions | 60 |
| Total marks including bonus questions | 80 |

Blue print of question paper

Paper code: CH 321 Paper title: Chemistry- III

**PRACTICALS - SEMESTER III**

|  |  |
| --- | --- |
| Semester | III |
| Paper code | CH3P1 |
| Paper title | Practical-III |
| Number of teaching hours per week | 4 |
| Total number of teaching hours per semester | 44 |
| Number of credits | 2 |

**Course Outcomes**

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

* Identify the acid and basic radicals in a given salt and salt mixture.
* Explain ionic product, solubility product and relate these to the separation of cations in a given mixture and develop laboratory skill to classify the ions into the respective groups.
* Analyze and distinguish the ions in a given mixture qualitatively.

**PART-A (Inorganic Chemistry)**

**LIST OF EXPERIMENTS**

1. Inorganic Semi – micro qualitative analysis.
2. Inorganic Semi – micro qualitative analysis.
3. Inorganic Semi – micro qualitative analysis.
4. Inorganic Semi – micro qualitative analysis.
5. Inorganic Semi – micro qualitative analysis.
6. Inorganic Semi – micro qualitative analysis.

**PART -B (Physical Chemistry)**

**Course outcomes**

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

* Understand the kinetics of chemical reactions.
* Determine the rate constant and order of chemical reactions from kinetic studies.
* Explain the application of photocatalysis in dye degradation and also deduce the rate of a reaction by dye degradation.
* Apply the concept of Beer -Lambert’s law for the estimation of ions using colorimetry.

**LIST OF EXPERIMENTS**

1. To determine the rate constant and order of the reaction of the hydrolysis of an ester catalyzed by an acid.
2. To study the kinetics of saponification of ester and to determine its rate constant at room temperature.
3. To determine the order of reaction in iodine for the acid catalyzed iodination of acetone by colorimetric method.
4. Colorimetric estimation of Fe
5. Colorimetric estimation of Cu
6. Photocatalytic degradation of an organic dye using anatase (TiO2) photocatalyst
7. To determine the order of photocatalytic degradation of an organic dye

**Note:**

1. In the first 20 minutes the teacher should discuss in detail the theory, principle, procedure and calculations.

2. Instructions to be given for operating instruments, weighing chemicals and precautions while handling chemicals.

**Recommended Books/References**

1. Practical physical chemistry: J. B. Yadav.
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).
4. Athawale V. D. and Mathur P. Experimental Physical Chemistry, New Age International (2001).

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| **Formative Assessment (Internal assessment) Practicals** |
| **Assessment Occasion/ type** | **Weightage in Marks** |
| Continuous evaluation  | 20 |
| Viva voce | 05 |
| **Total** | 25 |

**B.Sc. / B.Sc. (Honors) Chemistry Semester IV**

|  |
| --- |
| **Course Title: DSC-4: Chemistry – IV** |
| Total Contact Hours: 56 | Course Credits: 4 |
| Formative Assessment marks: 40 | Summative Assessment Marks: 60 |
| Duration of ESA/Exam: 2 h |  |

**DSC-4: Chemistry – IV**

|  |  |
| --- | --- |
| Semester | IV |
| Paper code | CH 421 |
| Paper title | Chemistry-IV |
| Number of teaching hours per week | 4 |
| Total number of teaching hours per semester | 56 |
| Number of credits | 4 |

 **Note: 1. Text underlined and in italics correspond to self-study.**

 **2. Text within parenthesis and italics correspond to recall/review.**

1. **SPECTROSCOPY- THEORETICAL CONCEPTS 12+2 h**

Electromagnetic radiation- characteristics, frequency, wavelength and wave number and mathematical expressions connecting them. Types of Spectra: i) atomic and molecular ii) absorption and emission iii) continuous, band and line iv) rotational, vibrational (vibrational-rotational), electronic (UV & visible). Regions of electromagnetic spectrum. Processes and spectral techniques associated with different regions. Born Oppenheimer approximation.

Rotational spectra of diatomic molecules: Rigid rotor model. Expression for rotational energy in terms of joule and cm-1. Expression for rotational constant; selection rules, gross and quantum selection rules. Energy level diagram for a rigid rotor and rotational spectrum. Factors influencing rotational spacings.

Vibrational spectra of diatomic molecules: Frequency of oscillation of a simple harmonic oscillator. Hooke’s law. Mathematical equation for fundamental vibrational frequency and fundamental wave number, significance of force constant, effect of reduced mass on vibrational frequency. Potential energy curve for a diatomic molecule behaving as a simple harmonic oscillator. Selection rules, energy level diagram. Expression for frequency of vibrational transition and zero-point energy. Fundamental vibrations, total degrees of freedom (translational, rotational and vibrational) for linear and non-linear molecules. Calculation of number of fundamental vibrational frequencies for linear and non-linear molecules (e.g., H2O, CO2). Schematic representation of fundamental vibrations for H2O, CO2 and discussion of their IR activity. Anharmonicity of vibrations of diatomic molecules, complexity of spectrum, origin of P, Q and R branches (qualitative treatment only).

Raman spectra: Polarizability of a molecules, elastic and inelastic collisions, Rayleigh and Raman scattering. Raman shift, Stokes and anti-Stokes lines. Selection rules (rotational Raman and vibrational Raman), intensity of Stokes and anti-Stokes lines, quantum theory of Raman effect, energy level diagram, rule of mutual exclusion. Differences between different types of spectra.

*Problem solving.*

1. **SPECTROSCOPY - APPLICATIONS 14 h**

Electronic spectroscopy:Types of electronic transitions in organic molecules, meaning of λmax, Є and A, observed transitions in a typical UV-vis spectrum of simple organic molecules, effect of conjugation on λmax. Analytical uses of UV-vis spectroscopy.

Infrared (IR) spectroscopy:Modes of bending and stretching vibrations, functional group and fingerprint region, typical infra-red absorption frequencies of functional groups. Interpreting IR spectra, IR spectra of hydrocarbons and some functional groups containing heteroatoms; alcohols, ethers, difference in the IR spectra of 10, 20 and 30 amines, comparison of IR spectra of carboxylic acids, acid chlorides, esters and amide.

NMR spectroscopy:nuclear spin, origin of the signal, chemical shift, shielding and deshielding of protons, equivalent and non-equivalent protons. Integration of signal areas, signal splitting, spin-spin coupling, coupling constant. Interpretation of 1H NMR spectra. Proton NMR and rate processes. Chemical exchange causing spin decoupling eg. ethanol.

Combined spectral problems using UV, IR and NMR techniques.

1. **ALKANES AND CYCLOALKANES 9 +1 h**

Alkanes: Classification of types of hydrogen atoms. Physical properties of alkanes and cycloalkanes**.** Nomenclature of monocyclic cycloalkanes, cycloalkenes.

Sigma bonds and bond rotation, meaning of conformations, Newman projections, Sawhorse formula. Conformational analysis of ethane and butane. 1H NMR spectra of bromoethane at room temperature and at low temperature.

Relative stabilities and ring strain of cyclopropane, cyclobutane and cyclopentane. Chair and boat conformations of cyclohexane and substituted cyclohexanes: axial and equatorial hydrogens. Conformational analysis of methyl cyclohexane. 1H NMR spectra of cyclohexane and undecadeuteriocyclohexane at ordinary temperature and low temperature.

 *Nomenclature of alkanes, 1,3- diaxial interactions of t-butyl group, end chapter problems*

1. **STEREOCHEMISTRY 11 + 1 h**

Constitutional isomers and stereoisomerism: constitutional isomers, enantiomers and diastereomers and chiral molecules. Chirality and stereochemistry. Molecules having one chirality centre, test for chirality- plane of symmetry; R, S system of naming enantiomers. Properties of enantiomers: optical activity and its origin, specific rotation. Polarimeter experiment. Molecules with more than one chirality centre, meso compounds, Fischer projection formulae. Separation of enantiomers: resolution, amines as resolving agents. Chiral molecules that do not possess chirality centre: diphenyls, allenes.

Diastereomerism: E, Z isomerism in alkenes, cis-trans isomerism in 1,2-dimethylcyclopropane

*End chapter problems.*

1. **ALCOHOLS, ETHERS AND EPOXIDES 6 h**

*(Recall, review: Nomenclature of alcohols, ethers and epoxides).*

Alcohols as acids; conversion of alcohols into alkyl halides.

Synthesis of ethers by intermolecular dehydration of alcohols and Williamson ether synthesis, mechanism; cleavage of ethers (mechanism excluded).

Synthesis of epoxides (mechanism excluded); reactions of epoxides: acid and base catalysed ring opening of unsymmetrical epoxides, mechanism, regioselectivity – examples.

**REFERENCES:**

1. Principles of physical Chemistry, B. R. Puri, L. R. Sharma, M. S. Pathania, (48th edition), Vishal publishing Co, (2019).
2. Fundamentals of molecular spectroscopy, C. N. Banwell, E. M. McCash, (4th edition), tata McGraw-Hill, (2008)
3. Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, James R. Vyvyan (5rd edition), Thomson Press, (2015).
4. Organic Spectroscopy, William Kemp, (3rd edition), Red Globe Press London, (2019).
5. Organic Chemistry, T. W. G. Solomons, C.B. Fryhle, Scott A. Snyder (12th Edition), Wiley India, (2016).
6. Organic Chemistry, R.T. Morrison and R.N. Boyd, (7th Edition), Prentice Hall, (2010).

**Pedagogy:** ICT tools, Chalk & Talk, Models & Charts.

|  |
| --- |
| **Formative Assessment (Internal assessment) Theory** |
| **Assessment Occasion/ type** | **Weightage in Marks** |
| Continuous evaluation and class test | 20 |
| Seminars/Class work | 10 |
| Assignments/Discussions | 10 |
| **Total** | 40 |

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| --- | --- | --- | --- |
|  | **Course Outcomes** | **Cognitive Level** | **At the end of the course, the student should be able to** |
|  | CO1  | Remember  | Recall various concepts of electromagnetic radiation, types of isomers; nomenclature of alkanes, cycloalkenes, alcohols, ethers and epoxides, stereochemistry. |
|  |  |  |
|  | CO2  | Understand | Explain concepts, relationships, processes and models in spectroscopy, conformational analysis of alkanes and cycloalkanes, regioselectivity of ring opening in epoxides. |
|  | CO3  | Apply  | Predict molecular properties from spectral data, apply the concepts of spectroscopy to solve the spectral problems, apply the selection rules in identification of chirality and configuration. |
|  |  |  |
|  | CO4  | Analyse | Compare and contrast various spectroscopic methods for their applications. Analyse the given spectral data and arrive at a probable structure. Analyse the given molecule for plane of symmetry, chirality and optical activity. |
|  |  |  |
|  | CO5  | Evaluate  | Assess the given conditions for ring opening of epoxides and evaluate regioselectivity. Based on the given spectral data evaluate the functional group/s present in the molecules.  |
|  |  |  |
|  | CO6  | Create  | Design a suitable synthetic route for organic molecules and suggest a spectral method to assess the transformation.  |

Blue print of question paper

Paper code: CH 421 Paper title: Chemistry- III

|  |  |  |  |
| --- | --- | --- | --- |
| Name of the chapters | Total teaching hours | Marks excluding bonus | Marks including bonus |
| Spectroscopy- theoretical concepts | 14 | 15 | 20 |
| Spectroscopy applications | 14 | 15 | 20 |
| Alkanes and cycloalkanes | 10 | 11 | 14 |
| Stereochemistry | 12 | 13 | 17 |
| Alcohols, ethers & epoxides | 6 | 6 | 9 |
| Total marks excluding bonus questions | 60 |
| Total marks including bonus questions | 80 |

**PRACTICALS (SEMESTER IV)**

|  |  |
| --- | --- |
| Semester | IV |
| Paper Code | CH4P1 |
| Paper title | Practical-IV |
| Number of teaching hours per week | 4 |
| Total number of teaching hours per semester | 44 |
| Number of credits | 2 |

**Course outcomes**

**At the end of this course, student should be able to**

* Assess waste water quality parameters like BOD and COD in determining the extent of pollution.
* Apply the concept of spectroscopy to solve spectral problems.
* To develop analytical skills of determination through titrimetry.
* Identify different amino acids based on retention factor difference by thin layer chromatography
* Apply the concept of analytical techniques like colorimetry for accurate chemical analysis.

 **PART- A Analytical Chemistry**

**LIST OF EXPERIMENTS**

1. Determination of dissolved oxygen (DO) in water sample.
2. Determination of chemical oxygen demand (COD) of water.
3. Estimation of inorganic phosphate by Fiske-subbarow method.
4. Thin layer chromatography of amino acids.
5. Structural analysis of compounds using NMR and IR spectra.
6. Structural analysis of compounds using NMR and IR spectra.

**PART- B Organic Chemistry**

## **Course outcomes:**

**At the end of this course, student should be able to**

1. Synthesize small organic molecules using green and conventional methods.
2. Distinguish between green and conventional methods of organic synthesis.
3. Characterize the synthesized organic compounds by UV-Vis/IR spectroscopy and thin layer chromatography techniques
4. Estimate the amount of phenol in a given sample by bromination and perform acid- base and iodometric titrations.

**List of Experiments**

1. Determination of percentage purity of phenol.
2. Estimation of amine salt.
3. Mechanochemical synthesis of Schiff base via solvent free method.
4. Characterization of Schiff base by UV and IR spectroscopy.
5. Green synthesis of aspirin by heterogeneous catalysis.
6. Preparation of anthraquinone from anthracene.
7. Characterization of anthraquinone by UV and IR spectroscopy.

**NOTE**

1. In the first 20 minutes the teacher should discuss in detail the theory, principle, procedure and calculations.
2. Instructions to be given for operating instruments, weighing chemicals and precautions while handling chemicals.

**Recommended Books/References**

* + - 1. Mendham, J., A. I. Vogel’s Quantitative Chemical Analysis Sixth Edition, Pearson, 2009.
			2. Practical Volumetric Analysis, Peter A C McPherson, Royal Society of Chemistry, Cambridge, UK (2015).
			3. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry,4th edition, Pearson Education (2009).
			4. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).

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| **Formative Assessment (Internal assessment) Practicals** |
| **Assessment Occasion/ type** | **Weightage in Marks** |
| Continuous evaluation  | 20 |
| Viva voce | 05 |
| **Total** | 25 |

**QUESTION PAPER PATTERN**

**St. Joseph’s College (Autonomous)**

**III and IV Semester B.Sc. Examination**

**(2022-23 & onwards)**

**Paper-III-CHEMISTRY**

**Time: 2 hours Max. Marks: 60**

**Instructions**

1. Question paper has three Parts. Answer all the Parts.

2. Write chemical equations and diagrams wherever necessary.

**PART– A**

Answer any **SEVEN** of the following NINE questions. Each question carries **TWO** marks.

 **(7 x 2 =14)**

**PART– B**

Answer any **SIX** of the following EIGHT questions. Each question carries **SIX** marks.

**(6 x 6 = 36)**

**PART– C**

Answer any **TWO** of the following THREE questions. Each question carries **FIVE** marks.

**(2 x 5= 10)**