# Maa Shakumbhari University, Saharanpur

## Syllabus of the Subject:

## Chemistry

### For Four Year Undergraduate Program (FYUP)

**(As per guidelines of Common Minimum Syllabus by U.P. Government according to National Education Policy-2020 amended with GO-2090/70-3-2024-09(01) Dated: 02-09-2024)**

# Syllabus B.Sc. (Chemistry)

## B.Sc. (Honours) - Chemistry as per NEP2020

| Year | Semester | Course Code | Core/Elective/Value Added | Paper Title | Theory/ Practical/ Project | Credits | Internal Marks | External Marks (MinMarks) | Total Marks | Minimum Marks (INT+EXT) | Teaching Hours | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Theory | Tutorial |
| Year-4 as per NEP B.Sc. (Honours) | Semester-VII | 0720201 | Core Compulsory | Inorganic Chemistry I | Theory | 4 | 25 | 75(25) | 100 | 40 | 3x15=45 | 1x15=15 |
| | | 0720202 | Core Compulsory | Organic Chemistry I | Theory | 4 | 25 | 75(25) | 100 | 40 | 3x15=45 | 1x15=15 |
| | | 0720203 | Core Compulsory | Physical Chemistry I | Theory | 4 | 25 | 75(25) | 100 | 40 | 3x15=45 | 1x15=15 |
| | | 0720204 | Core Compulsory | Computers for Chemists | Theory | 4 | 25 | 75(25) | 100 | 40 | 3x15=45 | 1x15=15 |
| | | 0720280 | Core Compulsory | Lab I Chemistry | Practical | 4 | | 100(40) | 100 | 40 | | |
| | Semester VIII | 0820201 | Core Compulsory | Inorganic Chemistry II | Theory | 4 | 25 | 75(25) | 100 | 40 | 3x15=45 | 1x15=15 |
| | | 0820202 | Core Compulsory | Organic Chemistry II | Theory | 4 | 25 | 75(25) | 100 | 40 | 3x15=45 | 1x15=15 |
| | | 0820203 | Core Compulsory | Physical Chemistry II | Theory | 4 | 25 | 75(25) | 100 | 40 | 3x15=45 | 1x15=15 |
| | | 0820204 | Core Compulsory | Group Theory, Spectroscopy & Solid State | Theory | 4 | 25 | 75(25) | 100 | 40 | 3x15=45 | 1x15=15 |
| | | 0820280 | Core Compulsory | Lab II Chemistry | Practical | 4 | | 100(40) | 100 | 40 | | |

# B.Sc. (Honours with Research) - Chemistry as per NEP2020

| Year | Semester | Course Code | Core/Elective/Value Added | Paper Title | Theory/ Practical/ Project | Credits | Internal Marks | External Marks (MinMarks) | Total Marks | Minimum Marks (INT+EXT) | Teaching Hours | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Theory | Tutorial |
| **Year-4 as per NEP** B.Sc. (Honours with Research) | **Semester-VII** | **0720201** | Core Compulsory | Inorganic Chemistry I | Theory | 4 | 25 | 75(25) | 100 | 40 | 3x15=45 | 1x15=15 |
| | | **0720202** | Core Compulsory | Organic Chemistry I | Theory | 4 | 25 | 75(25) | 100 | 40 | 3x15=45 | 1x15=15 |
| | | **0720203** | Core Compulsory | Physical Chemistry I | Theory | 4 | 25 | 75(25) | 100 | 40 | 3x15=45 | 1x15=15 |
| | | **0720280** | Core Compulsory | Lab I Chemistry | Practical | 4 | | 100(40) | 100 | 40 | | |
| | | | **Research Project (Minor)** | | | 4 | | | | | | |
| | **Semester VIII** | **0820201** | Core Compulsory | Inorganic Chemistry II | Theory | 4 | 25 | 75(25) | 100 | 40 | 3x15=45 | 1x15=15 |
| | | **0820202** | Core Compulsory | Organic Chemistry II | Theory | 4 | 25 | 75(25) | 100 | 40 | 3x15=45 | 1x15=15 |
| | | **0820203** | Core Compulsory | Physical Chemistry II | Theory | 4 | 25 | 75(25) | 100 | 40 | 3x15=45 | 1x15=15 |
| | | **0820280** | Core Compulsory | Lab II Chemistry | Practical | 4 | | 100(40) | 100 | 40 | | |
| | | | **Research Project (Major)** | | | 4 | | | | | | |

**NOTE-**

**Only students who secure 75% marks in the first six semesters are eligible for B.Sc. (Honours with Research).**

# B.Sc. (Apprenticeship / Internship embedded UG degree programme) Chemistry as per NEP2020

| Year | Paper Title | Credits |
|---|---|---|
| **Year-4 as per NEP** B.Sc. (Apprenticeship / Internship embedded UG degree programme) | 12 months Apprenticeship / Internship through NATS or from equivalent organization/ Industry/ Institute | 40 |

## Course-1

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|---|---|---|
| **Programme/Class:** B.Sc. | **Year:** UG in Fourth Year | **Semester:** Seventh |
| **Course Code:** **0720201** | **Course Title: Inorganic Chemistry I** | **Theory** |

**Course Objectives:** Acquiring ability for understanding complex molecule formation, their structure, chemical reaction and reaction mechanism.

**Course Outcomes (CO's):**

**CO1.** Ability to learn the stereochemistry and bonding in main group compounds

**CO2.** Determining constants for metal ligand equilibrium in solution

**CO3.** Understanding reaction mechanism of transition metal complexes.

**CO4.** Describing relationship between metal-ligand bonding and geometry of molecules.

| | | |
|---|---|---|
| **Credits: 4** | **Core Compulsory** | **Max Marks (Int. + Ext.): 25+75 Total = 100** **Minimum Marks: 40** |

**Teaching Hours = Lecture-Tutorial-Practical (L-T-P) : 3-1-0 (Four Hours in a week) or 60 Lecture Hours in a Semester**

| Unit | Course Topic | No. of Lectures Hours |
|---|---|---|
| **I** | Stereochemistry and Bonding in Main Group Compounds: VSEPR, Walsh diagrams (tri atomic molecules), dπ-Pπ bonds, Bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules. | **12** |
| **II** | Metal-Ligand Equilibria in Solution: Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and Ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry. | **12** |

| | | |
|---|---|---|
| **III** | Reaction Mechanism of Transition Metal Complexes: Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories.<br>Kinetics of Substitution Reactions- acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism. Anation reactions, reactions without Metal-Ligand bond cleavage.<br>Substitution reactions in square planer complexes, the trans effect, mechanism of the substitution reaction.<br>Redox reactions (electron transfer reactions) -Mechanism of one electron transfer reactions [such as Henry Taube's classical reaction of $(NH_3)_5Co^{3+}$-$Cr^{2+}$, Inner sphere type reactions]. Outer-sphere type reactions (cross reactions) and Marcus-Hush theory (No mathematical treatment). | **24** |
| **IV** | Metal-Ligand Bonding: Adjusted CFT, Limitations of crystal field theory. Octahedral, tetrahedral and square<br>planar complexes. | **12** |

**Teaching Learning Process:** Class discussions/ demonstrations, Power point presentations, using e-content, Class activities/ assignments, etc

**Suggested Readings:**


1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
3. Chemistry of the Elements. N.N. Greenwood and A. Earnshow, Pergamon.
4. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
5. Magnetiochemistry, R.1. Carlin, Springer Verlag.
6. Comprehensive Coordiantion Chemistry eds., G. Wilkinson, R.D. Gillars and J.A. Mc Cleverty,Pergamon.


**Suggested Continuous Evaluation Methods:**

Continuous internal evaluation through internal tests, quizzes and Presentation.

**Suggested equivalent online courses:**

There are online courses on the channels such as Swayam Prabha, Moocs and NPTEL. E-contents from different online libraries, e-PG Pathshaala etc

Further Suggestions:

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## COURSE-2

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|---|---|---|
| **Programme/Class:** B.Sc. | **Year:** UG in Fourth Year | **Semester:** Seventh |
| **Course Code:**<br>**0720202** | **Course Title: Organic Chemistry I** | **Theory** |

**Course Objectives:** Acquiring ability for defining organic molecule formation, bonding nature, structure, reactivity and reaction mechanism.

**Course Outcomes (CO's)**:

**CO1.** Developing skills in the identification of nature of bonding in organic molecules

**CO2.** Determining the connection between molecular geometry and their reactivity.

**CO3.** Ability to apply different approaches in formation of organic molecules.

**CO4.** Describing relationship between molecular structure and isomers and also their transformation.

**CO5.** Understanding the stereochemistry and reaction mechanism.

**CO6.**Understanding aliphatic nucleophilic substitution and aliphatic electrophilic substitution to form specific product.

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|---|---|---|
| **Credits: 4** | **Core Compulsory** | **Max Marks (Int. + Ext.): 25+75 Total = 100**<br>**Minimum Marks: 40** |

**Teaching Hours = Lecture-Tutorial-Practical (L-T-P) : 3-1-0 (Four Hours in a week) or 60 Lecture Hours in a Semester**

| Unit | Course Topic | No. of Lectures Hours |
|---|---|---|
| **I** | Nature of Bonding in Organic Molecules: Delocalized chemical bonding, Conjugation, hyperconjugation, bonding in fullerenes, tautomerism. Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule, energy level of n-molecular orbitals, annulenes, antiaromaticity, w-aromaticity, homo-aromaticity, PMO approach.<br>Bonds weaker than covalent- addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, catenanes and rotaxanes. Stereochemistry and Bonding in Main Group | **10** |

| | | |
|---|---|---|
| | Compounds: VSEPR, Walsh diagrams (tri atomic molecules), dπ-Pπ bonds, Bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules. | |
| II | Stereochemistry: Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding. Elements of symmetry, chirality, molecules with more than one chiral centre, threo and erythro isomers, methods of resolution, optical purity. Enantiotopic and diastereotopic atoms, groups and faces. Stereospecific and stereoselective synthesis. Asymmetric synthesis. Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape. Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus. | 15 |
| III | Reaction Mechanism: Structure and Reactivity-Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Hard and soft acids and bases. Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes.<br>Effect of structure on reactivity-Resonance and field effects, steric effect, quantitative treatment. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft equation. | 15 |
| IV | Aliphatic Nucleophilic Substitution: The SN2, SN1, mixed SN1 & SN2 and SET mechanisms. The neighbouring group mechanism, neighbouring group participation by π and σ bonds, anchimeric assistance. Classical and nonclassical carbocations, Phenonium ions, nonbornyl system, Common carbocation rearrangements. Application of NMR spectroscopy in the detection of carbocations.<br>The SNi mechanism, Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium. Phase transfer catalysis and ultrasound, ambident nucleophile, regioselectivity. Metal-Ligand Bonding: Adjusted CFT, Limitations of crystal field theory. Octahedral, tetrahedral and square planar complexes. | 15 |
| V | Aliphatic Electrophilic Substitution:<br>Bimolecular mechanisms- SE2 and SE1. The SE1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity. | 5 |
| **Teaching Learning Process:** Class discussions/ demonstrations, Power point presentations, using e-content, Class activities/ assignments, etc | | |
| **Suggested Readings:**<br>1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley. | | |

2. Advanced Organic Chemistry, F.A. Carey and R.J. Sunderg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Comell University Press.
5. Organic Chemistry, R.T. Morrison and R.N. Boyd, Prentice-Hall.
6. Modern Organic Reactions, H.O. House, Benjamin.
7. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professionsl.
8. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.
9. Pericyclic Reactions, S.M. Mukherji, Macmillan, India
10. Stereochemistry of Organic Compounds, D.Nasipuri, New Age International.
11. Stereochemisty of Organic Compounds, P.S. Kalsi, New Age International.Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.

**Suggested Continuous Evaluation Methods:**

Continuous internal evaluation through internal tests, quizzes and Presentation.

**Suggested equivalent online courses:**

There are online courses on the channels such as Swayam Prabha, Moocs and NPTEL. E-contents from different online libraries, e-PG Pathshaala etc

Further Suggestions:

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## COURSE-3

| Programme/Class: B.Sc. | Year: UG in Fourth Year | Semester: Seventh |
|---|---|---|
| **Course Code: 0720203** | **Course Title: Quantum Chemistry & Thermodynamics** | **Theory** |

**Course Objectives:** To grow the students with knowledge of advanced quantum chemistry and thermodynamics.

**Course Outcomes (CO's):**

**CO1.** Ability to solve the quantum mechanics e.g. angular momentum etc. of molecules.

**CO2.** Determining the electronic structure, bond order and charge density of molecular orbitals.

**CO3.** Calculating the thermodynamic parameters of substances

| Credits: 4 | Core Compulsory | Max Marks (Int. + Ext.): 25+75 Total = 100 Minimum Marks: 40 |
|---|---|---|

**Teaching Hours = Lecture-Tutorial-Practical (L-T-P) : 3-1-0 (Four Hours in a week) or 60 Lecture Hours in a Semester**

| Unit | Course Topic | No. of Lectures Hours |
|---|---|---|
| I | Introduction to Exact Quantum Mechanical Results: The Schrodinger equation and the postulates of quantum mechanics. Discussion of solutions of the Schrodinger equation to some model systems viz., particle in a box, the harmonic oscillator, the rigid rotor, the hydrogen atom.<br>Approximate Methods: The variation theorem, linear variation principle. Perturbation theory (first order and nondegenerate). Applications of variation method and perturbation theory to the Helium atom.<br>Angular Momentum: Ordinary angular momentum, generalized angular momentum, eigen functions for angular momentum, eigen values of angular momentum, operator using ladder operators, addition of angular momenta, spin, anti symmetry and Pauli's exclusion principle. | 15 |

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|---|---|---|
| II | Electronic Structure of Atoms: Electronic configuration, Russell-Saunders terms and coupling schemes, Slater-Condon parameters, term separation energies of the pn configuration, term separation energies for the dn configurations, magnetic effects: spin-orbit coupling and Zeeman splitting, introduction to the methods of self -consistent field, the virial theorem.<br>Molecular Orbital Theory: Huckel theory of conjugated systems, bond order and charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene etc. Introduction to extended Huckel theory. | 15 |
| III | Classical Thermodynamics: Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies. Partial molar properties; partial molar free energy, partial molar volume and partial molar heat content and their significances. Determinations of these quantities. Concept of fugacity and determination of fugacity. | 8 |
| IV | Statistical Thermodynamics: Concept of distribution, thermodynamic probability and most probable distribution. Ensemble averaging, postulates of ensemble averaging. Canonical, grand canonical and microcanonical ensembles, corresponding distribution laws (using Lagrange's method of undetermined multipliers).<br>Partition functions - translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition functions. Applications of partition functions.<br>Heat capacity behaviour of solids - chemical equilibria and equilibrium constant in terms of partition functions, Fermi-Dirac statistics, distribution law and applications to metal.<br>Bose-Einstein statistics - distribution law and application to helium. | 14 |
| V | Non equilibrium Thermodynamics: Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, entropy balance equations for different irreversible processes (e.g., heat flow, chemical reaction etc.) transformations of the generalized fluxes and forces, nonequilibrium stationary states, phenomenological equations, microscopic reversibility. | 8 |
| **Teaching Learning Process:** Class discussions/ demonstrations, Power point presentations, using e-content, Class activities/ assignments, etc | | |

**Suggested Readings:**


1. Physical Chemistry, P.W. Atkins, ELBS.
2. Introduction to Quantum Chemistyry, A.K. Chandra, Tata Mc Graw Hill.
3. Quantum Chemistry, Ira N. Levine, Prentice Hall.

4. Coulson's Valence, R.Mc Ween y, ELBS.
5. Chemical Kinetics. K.J. Laidler, McGraw-Hill.
6. Kinetics and Mechanism of Chemical Transformation J.Rajaraman and J. Kuriacose, Mc Millan.
7. Micelles, Theoretical and Applied Aspects, V. MOraoi, Plenum.
8. Modern Electrochemistry Vol. 1 and Vol II J.O.M. Bockris and A.K.N. Reddy, Planum.
9. Introduction to Polymer Science, V.R. Gowarikar, N.V. Vishwanathan and J. Sridhar, Wiley Eastern.
10. Introduction to Quantum Chemistry-R.K. Prasad, New Age PublicationAdvanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.

**Suggested Continuous Evaluation Methods:**

Continuous internal evaluation through internal tests, quizzes and Presentation.

**Suggested equivalent online courses:**

There are online courses on the channels such as Swayam Prabha, Moocs and NPTEL. E-contents from different online libraries, e-PG Pathshaala etc

Further Suggestions:

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## COURSE-4

| Programme/Class: B.Sc. | Year: UG in Fourth Year | Semester: Seventh |
|---|---|---|
| **Course Code: 0720204** | **Course Title: Computer for Chemists** | **Theory** |

**Course Objectives:** Acquiring ability to develop the skills in computer application, language and programming in FORTRAN/C/BASIC/ C with the knowledge about programs available for chemists.

**Course Outcomes (CO's):**

**CO1.** Ability to formulate programs for calculating problems in chemistry.
**CO2.** Ability to use MS office for documentation, calculations and graphics presentation.
**CO3.** Ability to apply software to sort out general puzzles in chemistry.
**CO4.** Ability to present the scripts in power point.
**CO5.** Internet searching to solve academic problems and to know about recent studies and advancement in chemistry.

| | Core Compulsory | Max Marks (Int. + Ext.): 25+75 Total = 100 Minimum Marks: 40 |
|---|---|---|
| **Teaching Hours = Lecture-Tutorial-Practical (L-T-P) : 3-1-0 (Four Hours in a week) or 60 Hours in a Semester** | | |
| **Unit** | **Course Topic** | **No. of Lectures Hours** |
| I | Introduction to Computers and Computing: Basic structure and functioning of computers with a PC as an illustrative example. Memory, I/O devices. Secondary storage. Computer languages. Operating systems with DOS as an example. Introduction to UNIX and Windows. Data Processing, principles of programming. Algorithms and flow-charts. | 15 |
| II | Computer Programming in FORTRAN/C/BASIC: The language feature are listed here with reference ton FORTRAN. The instructor may choose another language such as BASIC or C and the feature may be replaced appropriately. Elements of the computer language. Constants and variables. Operations and symbols. Expression. Arithmetic assignment statement input and output. Format statement. Termination statements. Branching statements such as IF or GO TO statement.<br>LOGICAL variables, Double Precision variables. Subscripted variables and DIMENSIONS. DO statements. FUNCTION and SUBROUTINE. COMMON and DATA statements.<br>Decision control structure, case4 control structure, functions, introduction ton arrays, programmes based on above. | 15 |
| III | Programming in Chemistry: Development of small computer course involving simple formula in chemistry such as Vander Waal's equation, pH titration, kinetics, radioactive decay. Evaluation of lattice energy and ionic radii from experimental data. Linear simultaneous equations to solve secular equation with in the Huckel theory. Elementary structural features such as bond lengths, bond angels, dihedral angels etc. of molecule extracted from a database such as Cambridge database. | 15 |
| IV | Use of Computer Programmes: Execution of linear regression, X-V plot, Numerical integration and differentiation as well as differential equation solution programmes. Monte –Carlo and Molecular dynamics. | 15 |

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|---|---|---|
| | Introduction to MS Office (MS Word, MS Excel, MS PowerPoint). Lab sessions based on MS Office package, Introduction to Internet Explorer. | |

**Teaching Learning Process:** Class discussions/ demonstrations, Power point presentations, using e-content, Class activities/ assignments, etc

**Suggested Readings:**

1. Computers and Common Sense, R, Hunt and J, Shelly, Prentice Hall.
2. Computational Chemistry, AC, Norris.
3. Microcomputer Quantum Mechanics, J.P., Killngbeck. Adam Hilger.
4. Computer Programming in FORTRAN IV, V. Rajaraman, Prentice Hall.
5. An Introduction to Digital Computer Design, V. Rajaraman and T. Radhakrishnan,

**Suggested Continuous Evaluation Methods:**

Continuous internal evaluation through internal tests, quizzes and Presentation.

**Suggested equivalent online courses:**

There are online courses on the channels such as Swayam Prabha, Moocs and NPTEL. E-contents from different online libraries, e-PG Pathshaala etc

Further Suggestions:

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## COURSE-5

| | | |
|---|---|---|
| **Programme/Class:** B.Sc. | **Year:** UG in Fourth Year | **Semester:** Seventh |
| **Course Code:** **0720280** | **Course Title: Lab I Chemistry Practical** | **Practical** |

**Course Objectives:** Understanding analysis and separation of inorganic and organic mixtures and chemical preparation of organic and inorganic molecules. Also, to provide advance insight about preparation of solutions standardization, pH meter, solubility, viscosity etc.

**Course Outcomes (CO's):**

**CO1.** Qualitative analysis of inorganic mixtures and insoluble.
**CO2.** Chemical separation techniques of cations and anions.
**CO3.** Qualitative analysis of two component organic mixture.
**CO4.** The basic knowledge like preparation of solutions standardization of secondary solution, dilution and handling of pH meter related to the practical syllabus.
**CO5.** The basic knowledge of some experimental determinations and chemical synthesis to focus their aim for future prospects of Ph.D programme.

| Credits: 4 | Practical | Max Marks (Int. + Ext.): 25+75 Total = 100 Minimum Marks: 40 |
|---|---|---|
| Teaching Hours = Lecture-Tutorial-Practical (L-T-P) : 0-0-8 (Eight Hours in a week) or 120 Hours in a Semester | | |
| **Unit** | **Course Topic** | **No. of Lectures Hours** |
| I | Physical Chemistry Practical (minimum 5 practical)<br>• To find out the strength of the given HCl solution by titrating it against N/10 NaOH using pH meter.<br>• To find out the strength of the given CH3COOH solution by titrating it against N/10 NaOH using pH meter.<br>• To find out the strength of HCl and CH3COOH in a mixture of both by titrating it against N/10 NaOH using pH meter.<br>• To determine the solubility of a given salt at room temperature and also draw its solubility curve.<br>• To find out the heat of solution of oxalic acid by solubility method.<br>• To standardize the given KMnO4 solution by titrating it against standard Ferrous Ammonium Sulphate solution.<br>• To determine the critical solution temperature of phenol water system.<br>• To determine the viscosity of given sample of oil at different temperature using Red Wood Viscometer. | 30 |
| II | INORGANIC PRACTICAL<br>• Macro Qualitative analysis of the mixture of three components (6 radicals).<br>• Inorganic preparations (Minimum 3 preparations)<br>i. To prepare Hexa-Ammine (II) Chloride.<br>ii. To prepare potassium Dioxalato Cuprate (II) Dihydrate.<br>iii. To prepare Potassium Trioxalato Chromate (III).<br>iv. To prepare Tetrammine Cupric Sulphate. | 30 |

| | | |
|---|---|---|
| | v. To prepare Sodium Ferric Oxalate.<br>vi. To prepare crystals of Potassium Tris Oxalate Aluminate (III). | |
| **III** | Organic Chemistry Practical<br>• To identify the given organic compound and prepare its derivatives.<br>• To analyse the given organic mixture (water separation).<br>• Single step preparations (Minimum 3 preparations)<br>i. Hydrolysis<br>ii. Bromination<br>iii. Nitration<br>iv. Oxime formation Reduction<br>v. Hoffmann Bromide reaction<br>vi. Benzoin condensation reaction etc. | **30** |
| **IV** | Computer<br>• Computer Programming in FORTRAN/C/BASIC/ C Language (Any one Language)<br>• Application of MS Office (MS Word, MS Excel, MS PowerPoint).<br>• Introduction to Internet Explorer. | **30** |

**Teaching Learning Process:** Class discussions/ demonstrations, Power point presentations, using e-content, Class activities/ assignments, etc

**Suggested Readings:**


1. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly. Prentice Hall
2. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham, ELBS.
3. Experiments and Techniques in Organic Chemistry, D.P. Pasto, C. Johnson and M. Miller, Prentice Hall.
4. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Health.
5. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
6. Handbook of Organic Analysis-qualitative and Quantitative. H. Clark, Adward Arnold.
7. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
8. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
9. Findley's Practical Physical chemistry, B.P. Levitt, Longman.
10. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw


**Suggested Continuous Evaluation Methods:**

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| Continuous internal evaluation through internal tests, quizzes and Presentation. |
| **Suggested equivalent online courses:**<br>There are online courses on the channels such as Swayam Prabha, Moocs and NPTEL. E-contents from different online libraries, e-PG Pathshaala etc |
| Further Suggestions:<br>..... |

| **COURSE-1** | | |
|---|---|---|
| **Programme/Class:** B.Sc. | **Year:** UG in Fourth Year | **Semester:** Eight |
| **Course Code:**<br>**0820201** | **Course Title: Inorganic Chemistry II** | **Theory** |
| **Course Objectives:** To develop the knowledge about electronic spectra and magnetic properties of transition metal complexes, metal pi complexes, metal clusters, nuclear and Radiochemistry chemistry.<br>**Course Outcomes (CO's):**<br>**CO1.** Ability to understand electronic spectra and magnetic properties of transition metal complexes.<br>**CO2.** Understanding the structure of coordination complex compounds.<br>**CO3.** Ability to find out bonding patterns of metal π-Complexes using vibrational spectroscopy. | | |
| **Credits: 4** | **Core Compulsory** | **Max Marks (Int. + Ext.): 25+75 Total = 100**<br>**Minimum Marks: 40** |
| **Teaching Hours = Lecture-Tutorial-Practical (L-T-P) : 3-1-0 (Four Hours in a week) or 60 Lecture Hours in a Semester** | | |

| Unit | Course Topic | No. of Lectures Hours |
|---|---|---|
| I | Electronic Spectra and Magnetic Properties of Transition Metal Complexes: Spectroscopic ground states, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d1-d9 states), calculations of Dq, B and β parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover | 16 |
| II | Metal π-Complexes: Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding. Structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as Ligand | 16 |
| III | Metal Clusters: Higher boranes, carboranes, metalloboranes and metallocarboranes. Metal carbonyl and halide clusters, compounds with metal-metal multiple bonds. | 8 |
| IV | Nuclear and Radiochemistry: Nuclear structure and nuclear stability, Nuclear models, Radioactivity and nuclear reactions (including nuclear fission and fusion reactions), Chemical effects of nuclear transformations Fission & Fusion, Fission products & fission yields, Hot atom chemistry, nuclear fission and fusion reactors, The interaction of nuclear reactions with matter, Radiation hazards and therapeutics, Detectors and their principles, The direction of radioactivity, The counting errors and their corrections, tracer techniques and their applications, isotope dilution and radioactivation methods of analysis, fission product analysis (e.g. the technique of isolating two or three different fission products of U and Th and determining the yield) | 20 |

**Teaching Learning Process:** Class discussions/ demonstrations, Power point presentations, using e-content, Class activities/ assignments, etc

**Suggested Readings:**


1. Advanced Inorganic Chemistry, FA Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
3. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
4. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
5. Magnetochemistry, R.L. Carlin, Springer Verlag.
6. Comprehensive Coordination Chemistry eds., G. Wilkinson, RD. Gillars and J.A. Mc Cleverty, Pergamon.


**Suggested Continuous Evaluation Methods:**

Continuous internal evaluation through internal tests, quizzes and Presentation.

**Suggested equivalent online courses:**

There are online courses on the channels such as Swayam Prabha, Moocs and NPTEL. E-contents from different online libraries, e-PG Pathshaala etc

Further Suggestions:

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## COURSE-2

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| **Programme/Class:** B.Sc. | **Year:** UG in Fourth Year | **Semester:** Eight |
| **Course Code:** 0820202 | **Course Title: Organic Chemistry II** | **Theory** |

**Course Objectives:** To develop the knowledge about aromatic electrophilic substitution, aromatic nucleophilic substitution, free radical reactions, addition to carbon carbon multiple bonds, addition to carbon hetero multiple bonds, elimination reactions and pericyclic reactions.

**Course Outcomes (CO's):**

**CO1.** Ability to understand organic reaction mechanism.

**CO2.** Understanding the various types of aliphatic nucleophilic substitution reactions and will give them a better understanding of the processes involved.

**CO3** Describing mechanisms for various organic reactions and how to use their understanding of organic mechanisms to predict the outcome of reactions.

**CO4** Understanding molecular orbital symmetry and possibility of thermal and photochemical pericyclic reactions.

**CO5.** Ability to know organic addition reaction on multiple bonds and their product with stereo isomeric chemistry.

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| **Credits:** 4 | **Core Compulsory** | **Max Marks (Int. + Ext.): 25+75 Total = 100** **Minimum Marks: 40** |

**Teaching Hours = Lecture-Tutorial-Practical (L-T-P) : 3-1-0 (Four Hours in a week) or 60 Lecture Hours in a Semester**

| Unit | Course Topic | No. of Lectures Hours |
|---|---|---|
| I | Aromatic Electrophilic Substitution: The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeir reaction, Gattermann-Koch reaction. | 6 |
| II | Aromatic Nucleophilic Substitution: The SNAr, SN 1, benzyne and SRN 1 mechanisms. Reactivity - effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements. | 5 |
| III | Free Radical Reactions: Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity. Allylic halogenations (NBS), oxidation of aldehydes to carboxylic acids, autooxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction. | 8 |
| IV | Addition to Carbon-Carbon Multiple Bonds: Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation. | 6 |
| V | Addition to Carbon-Hetero Multiple Bonds: Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction. Mechanism of condensation reactions involving enolates – Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions.Hydrolysis of esters and amides, ammonolysis of esters. | 12 |
| VI | Elimination Reactions: The E2, E1 and E1 CB mechanisms and their spectrum. Orientation of the double bond. Reactivity - effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination. | 5 |
| VII | Pericyclic Reactions: Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3- butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward--Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions - conrotatory and disrotatory motions, 4n, 4n+2 | 18 |

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|---|---|---|
| | and allyl systems. Cycloaddditions - antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions.<br>Sigmatropic rearrangements - suprafacial and antarafacial shifts of H, Sigmatropic shifts involving carbon moieties, 3,3- and 5,5- Sigmatropic rearrangements. Claisen, Cope, Sommelet Hauser Rearrangement, Ene reaction. | |

**Teaching Learning Process:** Class discussions/ demonstrations, Power point presentations, using e-content, Class activities/ assignments, etc

**Suggested Readings:**


1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C. K. Ingold. Cornell University Press.
5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.
6. Modern Organic Reactions, H. O. House, Benjamin.
7. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional.
8. Pericyclic Reactions, S. M. Mukherji, Macmillan, Irdia.
9. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.
10. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.
11. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.


**Suggested Continuous Evaluation Methods:**

Continuous internal evaluation through internal tests, quizzes and Presentation.

**Suggested equivalent online courses:**

There are online courses on the channels such as Swayam Prabha, Moocs and NPTEL. E-contents from different online libraries, e-PG Pathshaala etc

Further Suggestions:

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## COURSE- 3

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| **Programme/Class:** B.Sc. | **Year:** UG in Fourth Year | **Semester:** Eight |

| Course Code: 0820203 | Course Title: Physical Chemistry II | Theory |
|---|---|---|
| **Course Objectives:** To grow the students with deep knowledge regarding chemical dynamics, surface chemistry and electro chemistry.<br>**Course Outcomes (CO's):**<br>**CO1.** Ability to understand Chemical dynamics in detail.<br>**CO2.** Understanding surface chemistry in broad spectrum.<br>**CO3.** Ability to grow deep knowledge about electro chemistry. | | |
| **Credits: 4** | **Core Compulsory** | **Max Marks (Int. + Ext.): 25+75 Total = 100**<br>**Minimum Marks: 40** |
| **Teaching Hours = Lecture-Tutorial-Practical (L-T-P) : 3-1-0 (Four Hours in a week) or 60 Lecture Hours in a Semester** | | |

| Unit | Course Topic | No. of Lectures Hours |
|---|---|---|
| I | Chemical Dynamics: Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and the activated complex theory; ionic reactions, kinetic salt effects, steady state kinetics, kinetic and thermodynamic control of reactions, treatment of unimolecular reactions.<br>Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical (hydrogen-bromine and hydrogen-chlorine reactions) and oscillatory reactions (Belousov - Zhabotinsky reaction), homogeneous catalysis, kinetics of enzyme, reactions, general features of fast reactions, study of fast reactions by flow method: relaxation method, flash photolysis and the nuclear magnetic resonance method.<br>Dynamics of molecular motions, probing the transition state, dynamics of unimolecular reactions (Lindemann Hinshelwood and Rice-Ramsperger - Kassel-Marcus [RRKM] theories of unimolecular reactions). | 20 |

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| **II** | Surface Chemistry: Adsorption -Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET equation), Elementary treatment of BET equation, catalytic activity at surfaces.<br>Micelles-Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization, solubilization, micro emulsion, reverse micelles. Macromolecules- Polymer definition, types of polymers, kinetics of radical polymerization, mechanism of polymerization. Molecular mass, number and mass average molecular mass, molecular mass determination (Elementary treatment of Osmometry, Viscometry, Sedimentation and Light scattering methods), chain configuration of macromolecules, calculation of average dimensions of various chain structures. | **20** |
| **III** | Electrochemistry: Electrochemistry of solutions. Debye-Huckel - Onsager treatment and its extension, ion solvent interactions. Debye-Huckel-Jerum mode. Thermodynamics of electrified interface equations. Derivation of electro-capillarity, Lippmann equations (surface excess), methods of determination. Structure of electrified interfaces. Guoy -Chapman, Stern. Over potentials, exchange current density, derivation of Butler -Volmer equation, Tafel plot.<br>Quantum aspects of charge transfer at electrodes-solution interfaces, quantization of charge transfer, tunneling. Semiconductor interfaces - theory of double layer at 'Semiconductor, electrolyte solution interfaces, structure of double layer interfaces.<br>Electrocatalysis - influence of various parameters. Hydrogen electrode, Bioelectrochemistry, Polarography theory, Ilkovic equation, half wave potential and its significance.<br>Introduction to corrosion, homogenous theory, forms of corrosion, corrosion monitoring and prevention methods. | **20** |
| **Teaching Learning Process:** Class discussions/ demonstrations, Power point presentations, using e-content, Class activities/ assignments, etc | | |

**Suggested Readings:**


1. Physical Chemistry, P.W Atkins, ELBS.
2. Introduction to Quantum Chemistry, AK. Chandra, Tata McGraw Hill.
3. Quantum Chemistry, Ira N. Levine. PrentCe Hall.
4. Coulson's Valence, R. McWeeny, ELBS.
5. Chemical Kinetics, K. J. Laidler, Mcgraw-Hill.
6. Kinetics and Mechanism of Chemical Transformations, J. Rajaraman and J. Kuriacose, McMillan.

7. Micelles, Theoretical and Applied Aspects, V. Moroi, Plenun
8. Modern Electrochemistry Vol. I and Vol. II, J.O.M. Bockris and AK.N. Reddy, Plenum.
9. Introduction to Polymer Science, V.R. Gowarikar, N.V. Vishwanathan and J. Sridhar, Wiley Eastern.

**Suggested Continuous Evaluation Methods:**

Continuous internal evaluation through internal tests, quizzes and Presentation.

**Suggested equivalent online courses:**

There are online courses on the channels such as Swayam Prabha, Moocs and NPTEL. E-contents from different online libraries, e-PG Pathshaala etc

Further Suggestions:

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## COURSE-4

| Programme/Class: B.Sc. | Year: UG in Fourth Year | Semester: Eight |
|---|---|---|
| **Course Code: 0820204** | **Course Title: Group Theory, Spectroscopy & Diffraction Methods & Solid State** | **Theory** |

**Course Objectives:** To help them to learn the group theory for molecules.

**Course Outcomes (CO's):**

**CO1.** Ability to understand symmetry and symmetry elements.
**CO2.** Understanding electromagnetic energy and their interaction with matter.
**CO3.** Ability to know vibrational and Raman spectroscopy.
**CO4.** Describing electronic spectroscopy.
**CO5.** Understanding the magnetic resonance spectroscopy and Xray diffraction.

| Credits: 4 | Core Compulsory | Max Marks (Int. + Ext.): 25+75 Total = 100 Minimum Marks: 40 |
|---|---|---|

**Teaching Hours = Lecture-Tutorial-Practical (L-T-P) : 3-1-0 (Four Hours in a week) or 60 Lecture Hours in a Semester**

| Unit | Course Topic | No. of Lectures Hours |
|---|---|---|
| I | Symmetry and Group Theory in Chemistry: Symmetry elements and symmetry operation, definitions of group, subgroup, relation between orders of a finite group and its subgroup. Conjugacy relation and classes. Point symmetry group. Schonflies symbols, representations of groups by matrices (representation for the Cn, Cnv, Cnh. Dnh etc. groups to be worked out explicitly). Character of a representation. The great orthogonality theorem (without proof) and its importance. Character tables and their use; spectroscopy. | 10 |
| II | Unifying Principles: Electromagnetic radiation, interaction of electromagnetic radiation with matter absorption, emission, transmission, reflection, refraction, dispersion, polarisation and scattering. Uncertainty relation and natural line width. and natural line broadening, transition probability, results of the time dependent perturbation theory, transition moment, selection rules, intensity of spectral lines, Born-Oppenheimer approximation, rotational, vibrational and electronic energy levels. | 10 |
| III | Vibrational Spectroscopy: Infrared Spectroscopy - Review of linear harmonic oscillator, vibrational energies of diatomic molecules, zero point energy, force constant and bond strengths; anharmonicity, Morse potential energy diagram, vibration-rotation spectroscopy, P,Q,R branches. Breakdown of Oppenheimer approximation; vibrations of poly atomic molecules. Selection rules, normal modes of vibration, group frequencies, overtones, hot bands, factors affecting the band positions and intensities, far IR region, metal-ligand vibrations, normal co-ordinate analysis.<br>Raman Spectroscopy- Classical and quantum theories of Raman effect. Pure rotational, vibrational and Vibrational-rotational Raman spectra, selection rules, mutual exclusion principle. Resonance Raman spectroscopy, coherent anti Stokes Raman spectroscopy (CARS). | 12 |
| IV | Electronic Spectroscopy: Atomic Spectroscopy- Energies of atomic orbitals, vector representation of momenta and vector coupling, spectra of hydrogen atom and alkali metal atoms.<br>Molecular Spectroscopy- Energy levels, molecular orbitals, vibronic transitions, vibrational progressions and geometry of the excited states, Franck-Condon principle, electronic spectra of polyatomic molecules. Emission spectra; radiative and non-radiative decay, internal conversion, spectra of transition metal complexes, charge-transfer spectra.<br>Photoelectron Spectroscopy-Basic principles; photo-electric effect, ionization process, Koopman's theorem. Photoelectron spectra of simple molecules, ESCA, chemical information from ESCA. Auger electron spectroscopy - basic idea. | 8 |

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|---|---|---|
| V | Magnetic Resonance Spectroscopy: Nuclear Magnetic Resonance Spectroscopy<br>Nuclear spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift and its measurements, factors influencing chemical shift, deshielding, spin-spin interactions, factors influencing coupling constant 'J'. Classification (ABX, AMX, ABC, A2B2 etc.), spin decoupling; basic ideas about instrument, NMR studies of nuclei other than proton - 13C.<br>Electron Spin Resonance Spectroscopy-Basic principles, zero field splitting and Kramer's degeneracy, factors affecting the 'g' value. Isotropic and anisotropic hyperfine coupling constants, spin Hamiltonian, spin densities and McConnell relationship, measurement techniques, application. | **10** |
| VI | X-ray Diffraction: Bragg condition, Miller indices, Laue method, Bragg method, Debye-Scherrer method of<br>X-ray structural analysis of crystals, index reflections, identification of unit cells from systematic absences in diffraction pattern. Structure of simple lattices and X-ray intensities, structure factor and its relation to intensity' and electron density, phase problem. Description of the procedure for an X-ray structure analysis, absolute configuration of molecules, Ramchandran diagram. | **10** |

**Teaching Learning Process:** Class discussions/ demonstrations, Power point presentations, using e-content, Class activities/ assignments, etc

**Suggested Readings:**


1. Applied Electron Spectroscopy for Chemical Analysis Ed. H. Windawi and F.L. Ho, Wiley Interscience.
2. NMR, NOR, EPR and M6ssbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood.
3. Physical Methods in Chemistry, R.S. Drago, Saunders College.
4. Chemical Applications of Group Theory, F. A. Cotton.
5. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
6. Basic Principles of Spectroscopy, R. Chang, McGraw Hill.
7. Theory and Applications of UV Spectroscopy, H.H. Jaffe and M. Orchin, ISHOxford.
8. Introduction to Photoelectron Spectroscopy, P. K. Ghosh, John Wiley.
9. Introduction to Magnetic Resonance, A Carrington and A.D. Maclachalari, Harper & Row.
10. Modern Spectroscopy, J.M. Hollas, John Wiley


**Suggested Continuous Evaluation Methods:**

Continuous internal evaluation through internal tests, quizzes and Presentation.

**Suggested equivalent online courses:**

There are online courses on the channels such as Swayam Prabha, Moocs and NPTEL. E-contents from different online libraries, e-PG Pathshaala

etc

Further Suggestions:

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## COURSE- 5

| Programme/Class: B.Sc. | Year: UG in Fourth Year | Semester: Eight |
|---|---|---|
| **Course Code: 0820280** | **Course Title: Lab II Chemistry** | **Practical** |

**Course Objectives:** To help them to learn about different analytical techniques used in inorganic, organic and physical chemistry.

**Course Outcomes (CO's):**

CO1. Ability to understand different techniques and their applicability.

CO2. Understanding quantitative estimation by titrimetric methods.

CO3. Ability to perform separation of organic mixture.

CO4. Ability to prepare useful organic compounds.

| Credits: 4 | Core Compulsory | Max Marks (Int. + Ext.): 25+75 Total = 100 Minimum Marks: 40 |
|---|---|---|

**Teaching Hours = Lecture-Tutorial-Practical (L-T-P) : 0-0-8 (Eight Hours in a week) or 120 Lecture Hours in a Semester**

| Unit | Course Topic | No. of Lectures Hours |
|---|---|---|
| I | Physical Chemistry<br>• To find out the surface tension of the given liquid by drop weight method at room temperature.<br>• To determine the parachor value of given liquid.<br>• To find out the surface tension of $CH_3COOH$, $C_2H_5OH$, n-Hexane at room temperature and hence calculate the atomic parachors of C, H, and O. | 30 |

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|---|---|---|
| | • To compare the cleaning powers of two samples of detergents supplied to you.<br>• To determine the critical micelle concentration of soap.<br>• To find out the strength of HCl solution by titrating it against N/10 NaOH using conductometer.<br>• To find out the strength of given $NH_4OH$ by titrating it against HCl solution using conductometer.<br>• To find the velocity constant of the hydrolysis of methyl acetate catalysed by<br>i. HCl<br>ii. $H_2SO_4$<br>• Determine the relative strengths of two acids i.e. HCl & $H_2SO_4$ by studying the hydrolysis of methyl acetate. | |
| **II** | Inorganic Chemistry<br>• Acidimetry- Alkalimetry titration.<br>• Oxidation –Reduction titration.<br>• Silver Nitrate titration.<br>• Complexometric - EDTA titration.<br>• pH-metry titration.<br>• To estimate Copper and Nickel in the given solution.<br>• To estimate Iron and Nickel in a given solution. | **60** |
| **III** | Organic Chemistry<br>• Analysis of binary organic mixtures<br>i. Separation with $NaHCO_3$<br>ii. Separation with NaOH<br>iii. Separation with HCl<br>• Two step preparations<br>i. To prepare Anthranilic Acid from Phthaic Anhydride.<br>ii. To prepare o- Chlorobenzoic Acid from Phthalamide.<br>iii. To prepare Benzil from Benzaldehyde.<br>iv. To prepare Benzanilide from Benzophenone. | **30** |

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| **Teaching Learning Process:** Class discussions/ demonstrations, Power point presentations, using e-content, Class activities/ assignments, etc |
| **Suggested Readings:**<br>1. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly. Prentice Hall<br>2. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham, ELBS.<br>3. Experiments and Techniques in Organic Chemistry, D.P. Pasto, C. Johnson and M. Miller, Prentice Hall.<br>4. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Health.<br>5. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.<br>6. Handbook of Organic Analysis-qualitative and Quantitative. H. Clark, Adward Arnold.<br>7. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.<br>8. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.<br>9. Findley's Practical Physical chemistry, B.P. Levitt, Longman.<br>10. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill |
| **Suggested Continuous Evaluation Methods:**<br>Continuous internal evaluation through internal tests, quizzes and Presentation. |
| **Suggested equivalent online courses:**<br>There are online courses on the channels such as Swayam Prabha, Moocs and NPTEL. E-contents from different online libraries, e-PG Pathshaala etc |
| Further Suggestions:<br>..... |

**Convener**
**Prof. Mukesh Chand**
**D.A.V. College, Muzaffarnagar**