जननायक चन्द्रशेखर विश्वविद्यालय,बलिया

JANANAYAK CHANDRASHEKHAR UNIVERSITY, BALLIA

(A state University Established under the Uttar Pradesh University Act 1973)

Curriculum in Accordance with National Education Policy-2020

Programme Name	B.Sc. Honors (Four Years Programme)
Subject	Chemistry

Department of Chemistry

Jananayak Chandrashekhar University, Ballia

Saheed Smark, SurhaTaal, Basantpur, Ballia -277301, Uttar Pradesh, India

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For Four Years Undergraduate Programme in accordance with National Education Policy – 2020 and Common Minimum Syllabus Semester wise Title of the Papers

Year	Sem	Course Code	Paper Title	Theory/ Practical	Credits	Total Credits	Max Marks
1st	I	B020101T	Fundamentals of Chemistry	Theory	4	6	75
		B020102P	Quantitative Analysis	Practical	2		25
	II	B020201T	Bioorganic and Medicinal Chemistry	Theory	4	6	75
		B020202P	Biochemical Analysis	Practical	2		25
2nd	III	B020301T	Chemical Dynamics & Coordination Chemistry	Theory	4	6	75
		B020302P	Physical Analysis	Practical	2		25
	IV	B020401T	Quantum Mechanics and Analytical Techniques	Theory	4	6	75
		B020402P	Instrumental Analysis	Practical	2		25
3rd	V	B020501T	Organic Synthesis-A	Theory	4	14	75
		B020502T	Rearrangements and Chemistry of Group Elements	Theory	4		75
		B020503P	Qualitative Analysis	Practical	2		50
		B020504R	Minor Research Project - I	Minor Project	4		
	VI	B020601T	Organic Synthesis-B	Theory	4	14	75
		B020602T	Chemical Energetics and Radiochemistry	Theory	4		75
		B020603P	Analytical Methods	Practical	2		50
		B020604R	Minor Research Project - II	Minor Project	4		100
4th	VII	B020701T	Inorganic Chemistry	Theory	4	24	75
		B020702T	Organic Chemistry	Theory	4		75
		B020703T	Physical Chemistry	Theory	4		75
		B020704T	Section-A Computer for Chemist (Compulsory for all Students)	Theory	2		45
			Section-B Mathematics for Chemist (For students without Mathematics in B.Sc.)	Theory	2		30
			Section-C Biology for Chemist (For students without Biology in B.Sc.)	Theory	2		30
		B020705P	Practical	Practical	4		100
			Research Project –I	Project Work	4		
	VIII	B020801T	Inorganic Chemistry	Theory	4	24	75
		B020802T	Organic Chemistry	Theory	4		75
		B020803T	Physical Chemistry	Theory	4		75
		B020804T	Spectroscopy and Diffraction	Theory	4		75
		B020805P	Practical	Practical	4		100
		B020806R	Research Project – II	Project Work	4		100

Note:

*The student shall prepare a Minor Research Project (MRP) in the 5th and 6th Semester (3rd Year) of Graduation. The MRP shall be submitted and evaluated in the 6th Semester.

*The student shall prepare a Research Project in the 7th and 8th Semesters (4th Year) of Graduation. The MRP shall be submitted and evaluated in the 8th Semester.

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Course Code	B020101T	
Course Title	Fundamentals of Chemistry	
Credit	4	Maximum Marks : 25 + 50

- **Course Objective:**
- To understand fundamental to chemistry and chemical bond.
- Periodic trends, arising from the arrangement of the periodic table, periodic properties.
- To understand atomic structure of the elements within their respective group families or periods, and because of the periodic nature of the elements.
- Reaction intermediates &mechanism gives the fundamental knowledge of carrying out an organic reaction in a step-by-step manner.
- To understand the various organic reactions and reagents used in them as
- Tools applied in the art of organic synthesis.
- To understand the basics of computer & net surfing.
- To understand the basics mathematical concept of chemistry.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

. to gain an understanding of

- Molecular geometries, physical and chemical properties of the molecules.
- Current bonding models for simple inorganic and organic molecules in order to predict structures and important bonding parameters.
- The chapter Recapitulation of basics of organic chemistry gives the most primary and almost important knowledge and concepts of organic Chemistry.
- This course gives a broader theoretical picture in multiple stages in an overall chemical reaction. It describes reactive intermediates, transition states and states of all the bonds broken and formed .It enables to understand the reactants, catalyst, stereochemistry and major and minor products of any organic reaction.
- It describes the types of reactions and the Kinetic and thermodynamic aspects one should know for carrying out any reaction and the ways how the reaction mechanism can be determined.
- The chapters Stereochemistry gives the clear picture of two-dimensional and three-dimensional structure of the molecules, and their role in reaction mechanism.

Syllabus

Unit	Course Content
I	**Recapitulation of basics of Organic Chemistry:** Bond length, bond angle, Bond energy, Hybridization, inclusion compounds, Clatherates, Charge transfer complexes, Polarizing power and polarizability, Electronic Displacements: Inductive effect, electrometric effect, mesomeric effect and their applications, hyper-conjugation, resonance & resonance energy. **Molecular polarity and Weak Chemical Forces :** Formal charge, Van der Waals forces, ion-dipole forces, dipole- dipole interactions, induced dipole interaction, dipole moment and molecular Structure (Diatomic and polyatomic molecules), Percentage ionic character from dipole moment, vander Waals interactions, (induced dipole-induced dipole interactions, dipole-dipole interactions, dipole-induced dipole interaction), Hydrogen bonding, Fajan's rules and its applications.
II	**Simple Bonding theories of Molecules** Atomic orbitals, Aufbau principle, multiple bonding (σ and π bond approach) and bond lengths, the valence bond theory (VBT), Concept of hybridization, hybrid orbitals and molecular geometry, Bent's rule, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_5, SF_6, SF_4, ClF_3, I_3^-, and H_3O^+. Molecular orbital theory (MOT). Molecular orbital diagrams bond orders of homonuclear and heteronuclear diatomic molecules and ions (N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions) **Periodic properties of Atoms (with reference to s & p-block):** Brief discussion, factors affecting and variation trends of following properties in groups and periods. Effective nuclear charge, shielding or screening effect, Slater rules, Atomic and ionic radii, Electronegativity, Pauling's/ Allred Rochow's scales, Ionization enthalpy, Electron gain enthalpy.
III	**Mechanism of Organic Reactions:** Curved arrow notation, drawing electron movements with allows, half-headed and double-headed arrows, homolytic and heterolytic bond fission, Types of reagents – electrophiles and nucleophiles, Types of organic reactions, Energy considerations. Reactive intermediates–Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples). **Stereochemistry**-Concept of isomerism, Types of isomerism; Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, disasteromers, threo and erythro diastereomers, meso compounds, resolution of enantionmer, inversion, retention and recemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. Conformational isomerism–conformational analysis of ethane and n-butane; conformations of cyclohexane.

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IV	**Basic Computer system (in brief)-** Hardware and Software; Input devices, Storage devices, Output devices, Central Processing Unit (Control Unit and Arithmetic Logic Unit); Number system (Binary, Octal and Hexadecimal Operating System); Computer Codes (BCD and ASCII); Numeric/String constants and variables. Introduction on Operating Systems (DOS, WINDOWS, and Linux); Introduction of Software languages: Low level and High Level languages (Machine language, Assembly language; QBASIC, FORTRAN), Software Products (Office, chem. sketch, scilab, matlab, hyper chem, etc.), Internet application. **Mathematical Concepts for Chemistry** Logarithmic relations, curve sketching, linear graphs and calculation of slopes, differentiation of functions like Kx, e^x, X^n, sin x, log x; maxima and minima, partial differentiation and reciprocity relations, Integration of some useful/relevant functions; permutations and combinations, Factorials, Probability.

References:

- Lee, J.D. Concise Inorganic Chemistry, Pearson Education2010
- Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structureand Reactivity, Pearson Education 2006.
- Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford,1970
- Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.,* Oxford University Press,1994.
- Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications1962.
- Singh J.,Yadav L.D.S., Advanced Organic Chemistry, Pragati Edition
- Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (PearsonEducation).
- Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education,2012.
- Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press,2008.
- Clayden,J., Greeves, N. &Warren, S.*Organic Chemistry,* 2nd edition, Oxford UniversityPress, 2012.
- Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons,Inc.
- Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education,2003
- Francis**, P. G.** Mathematics for Chemists, Springer,1984

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggested online links:

http://heecontent.upsdc.gov.in/Home.aspxhttps://nptel.ac.in/courses/104/106/104106096/http://heecontent.upsdc.gov.in/Home.aspxhttps://nptel.ac.in/courses/104/106/104106096/

https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htmhttps://nptel.ac.in/courses/104/103/104103071/#

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Semester	**Semester-I, Paper-2 (Practical)**	
Course Code	B020102P	
Course Title	Quantitative Analysis	
Credit	2	Maximum Marks : 25

Course Objective:

- Quality of water & analysis.
- Estimation of metal ions in samples
- Estimation of alkali and acid contents in samples by laboratory titration methods.
- Estimation of alkali and alkaline metal ions of commercial vinegar and antacid.

Course outcomes: Upon completion of this course the students will have the knowledge and skills to:

- Understand the laboratory methods.
- Potability tests of water samples& estimation by laboratory methods.
- Estimation of alkali and alkaline metal ions of commercial vinegar and antacid.
- Estimation of alkali and acid contents in samples of commercial products.
- Estimation of inorganic salts and hydrated water in samples

Syllabus

Unit	Course Content
I	**Water Quality analysis** 1. Estimation of hardness of water by EDTA. 2. Determination of chemical oxygen demand (COD). 3. Determination of Biological oxygen demand (BOD).
II	**Estimation of Metals ions** 1. Estimation of ferrous and ferric by dichromate method. 2. Estimation of copper using thiosulphate.
III	**Estimation of acids and alkali contents** 1. Determination of acetic acid in commercial vinegar using NaOH. 2. Determination of alkali content – antacid tablet using HCl. 3. Estimation of oxalic acid by titrating it with $KMnO_4$.
IV	**Estimation of inorganic salts and hydrated water** 1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture. 2. Estimation of calcium content in chalk as calcium oxalate by permanganometry. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.

References:

1. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
2. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters3-
3. Harris, D.C. *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
4. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
5. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggestive digital platforms web links

6. https://www.labster.com/chemistry-virtual-labs/
7. https://www.vlab.co.in/broad-area-chemical-sciences
   http://chemcollective.org/vlabs

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Semester	Semester-II Paper-1(Theory)	
Course Code	B020102T	
Course Title	Bioorganic and Materials Chemistry	
Credit	4	Maximum Marks : 25+75

Course Objective:

- This course aims to introduce the students with basic experimental understanding of carbohydrates, amino acids, proteins,nucleic acids and medicinal chemistry.
- To gain the knowledge of designing, mechanism and action of drugs.
- Knowledge of polymers.
- Basic knowledge of synthesis and colour constituent of dyes.
- Upon completion of this course students may get job opportunities in food, beverage and pharmaceutical industries.

Learning Outcomes:

- After successful completion of the syllabus, learners will be able to gain an understanding of biomolecules are important for the functioning of living organisms.
- Trigger important biochemical reactions in living organisms.
- Determination of structure by X-ray and powder methods.
- Mechanism of SAR, General introduction of analgesics agents, antipyretic agents, anti-inflammatory agents, antibiotics, antibacterial and antifungal agents.
- Understanding how the biomolecules play the important physiological function that regulates the proper growth and development of a human body.
- Synthesis of dyes.

Syllabus

Unit	Course Content
I	**Chemistry of Carbohydrates:** Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Mechanism of mutarotation Determination of configuration of Glucose (Fischer's proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Interconversions of sugars (ascending and descending of sugar series, conversion of aldoses to ketoses), stepping–up (Kiliani- Fischer method) and stepping–down (Ruff's & Wohl's methods) of aldoses; end-group- interchange of aldoses Linkage between monosaccharides, structure of disaccharides(sucrose, maltose, lactose.) **Chemistry of Proteins:** Classification of amino acids, Zwitter ion structure and Isoelectric point. Overview of primary, secondary, tertiary and quaternary structure of proteins. Protein denaturation/ renaturation.
II	**Chemistry of Nucleic Acids:** Constituents of Nucleic acids: Adenine, guanine, thymine and Cytosine (**Structure only**), Nucleosides and nucleotides **(nomenclature)**, Synthesis of nucleic acids, Structure of polynucleotides;StructureofDNA(Watson-Crickmodel)and RNA & types of RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation **Introductory Medicinal Chemistry:** Drug discovery, design and development; Basic Retrosyntheticapproach.Drugaction-receptortheory.Structure–activityrelationshipsofdrug molecules, binding role of –OH group, -NH_2group, double bond and aromatic ring. Mechanism of action of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide); antiviralagents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), HIV-AIDS related drugs (AZT-

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	Zidovudine)
III	**Solid State** Definition of space lattice, unit cell. Laws of crystallography – (i) Law of constancy of interfacialangles,(ii)Lawofrationalityofindicesandiii)Symmetryelementsincrystalsand law of symmetry .X-ray diffraction by crystals. Derivation of Bragg equation. Determination of crystal structure of NaCl, KCl and CsCl (powder method). **Introduction to Polymer** Monomers, Oligomers, Polymers and their characteristics, Classification of polymers: Natural synthetic, linear, cross linked and network; plastics, elastomers, fibers, Homopolymers and Co-polymers, Bonding in polymers: Primary and secondary bond forces in polymers; cohesive energy, and decomposition of polymers. Determination of Molecular mass of polymers: Number Average molecular mass (Mn) and Weight average molecular mass (Mw) of polymers and determination by (i) Viscosity (ii) Light scattering method (iii) Gel permeation chromatography.
IV	**Silicones and Phosphazenes**–Silicones and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes. **Kinetics and Mechanism of Polymerization**: Polymerization techniques, Mechanism and kinetics of copolymerization, Addition or chain- growth polymerization, Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler- Natta polymerization and vinyl polymers, Condensation or step growth-polymerization, Polyesters, polyamides, phenol formaldehyde resins, and polyurethanes. **Synthetic Dyes:** Colour and constitution (electronic Concept), Classification of dyes, Chemistry and synthesis of Methyl orange, Congo red, Malachite green, crystal violet, phenolphthalein, fluoresceine, alizarin and Indigo.

Suggested Readings:

Davis, B. G., Fairbanks, A. J., *Carbohydrate Chemistry*, Oxford Chemistry Primer, Oxford University Press.

1. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
2. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.,* W. H.Freeman.
3. Berg, J. M., Tymoczko, J. L. &Stryer, L. *Biochemistry 7th Ed.,* W. H. Freeman.
4. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Patrick, G. L. Introduction to Medicinal Chemistry, Oxford University Press, UK, 2013.
6. Singh, H. & Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, NewDelhi, 2012.
7. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13(2006).
8. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
9. Castellan, G. W. Physical Chemistry 4th Ed. Narosa(2004).
10. R.B. Seymour & C.E. Carraher: *Polymer Chemistry: An Introduction,* Marcel Dekker, Inc. New York, 1981.
11. G.Odian: *Principles of Polymerization*, 4th Ed.Wiley, 2004.
12. F.W. Billmeyer: *Textbookof Polymer Science*, 2nd Ed. Wiley Inter science,1971.
13. P. Ghosh: Polymer Science & Technology, Tata McGraw-Hill Education,1991

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Suggested online links:

http://heecontent.upsdc.gov.in/Home.aspxhttps://nptel.ac.in/courses/104/105/104105124/https://nptel.ac.in/courses/103/106/105106204/

https://nptel.ac.in/courses/104/105/104105034/

https://nptel.ac.in/courses/104/103/104103121/https://nptel.ac.in/courses/104/102/104102016/https://nptel.ac.in/courses/104/106/104106106/https://nptel.ac.in/courses/104/105/104105120/

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Semester	**Semester-II Paper 2 (Practical)**	
Course Code	B020202P	
Course Title	Biochemical Analysis	
Credit	2	Maximum Marks : 25

Course Objective:

- Qualitative and quantitative analysis of Carbohydrates:
- Qualitative and quantitative analysis of Proteins, amino acids and Fats
- Determination and identification of Nucleic Acids
- Synthesis of Simple drug molecules.

Learning Outcomes:

- After successful completion of this course Learner are able to know:-
- Basic qualitative and quantitative experimental knowledge of biomolecules such as Synthesis of carbohydrates, proteins, amino acids, nucleic acids.
- Synthesis of simple drug molecules.
- Analysis by paper & thin later chromatography techniques.
- Synthesis of Drug.
- Upon successful completion of this course students may get job opportunities in food, beverage and pharmaceutical industries.

Syllabus

Unit	Course Content
I	**Qualitative and quantitative analysis of Carbohydrates:** 1. Separation of a mixture of two sugars by ascending paper chromatography 2. Differentiate between a reducing/ non reducing sugar 3. Synthesis of Osazones.
II	**Qualitative and quantitative analysis of Proteins, amino acids and Fats** 1. Isolation of protein. 2. Determination of protein by the Biuret reaction. 3. TLC separation of a mixture containing 2/3 amino acids 4. Paper chromatographic separation of a mixture containing 2/3 amino acids 5. Action of salivary amylase on starch 6. To determine the concentration of glycine solution by formylation method. 7. To determine the saponification value of an oil/fat. 8. To determine the iodine value of an oil/fat
III	**Determination and identification of Nucleic Acids** 1. Determination of nucleic acids 2. Extraction of DNA from onion/cauli flower
IV	**Synthesis of Simple drug molecules** 1. To synthesize aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC. 2. Synthesis of barbituric acid 3. Synthesis of propranolol

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References:

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012).
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education.
3. *Vogel's Qualitative Inorganic Analysis*, Revised by G.Svehla.
4. Vogel, A.I. *A Textbook of Quantitative Analysis*, ELBS.1986
5. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. *Vogel's Textbook of Practical Organic Chemistry*, ELBS.
6. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* UniversitiesPres
7. Cooper, T.G. Tool of Biochemistry. Wiley-Blackwell (1977).
8. Wilson, K. & Walker, J. Practical Biochemistry. Cambridge University Press (2009).
9. Varley, H., Gowenlock, A.H & Bell, M.: Practical Clinical Biochemistry, Heinemann,

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggestive digital platforms web links

1. https://www.labster.com/chemistry-virtual-labs/
2. https://www.vlab.co.in/broad-area-chemical-sciences

http://chemcollective.org/vlabs

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Semester	Semester III, Paper-1 (Theory)	
Course Code	B02020301T	
Course Title	Chemical Dynamics & Coordination Chemistry	
Credit	4	Maximum Marks : 25+50

Course Objective:

- Probing and grasping understanding regarding various phenomenon viz.
- Chemical kinetics
- chemical equilibria phase equilibria
- Kinetic theory of gases.
- Understanding of coordination chemistry and coordination compounds.

Learning Outcomes: After successful completion of the syllabus, learners will be able to describe the :-

- Characteristic of the three states of matter.
- Describe the different physical properties of each state of matter.
- Kinetic theory of gases, laws of crystallography, liquid state and liquid crystals, conductometric, potentiometric, optical methods, polarimetry and spectrophotometer technique to study Chemical kinetics and chemical equilibrium.
- After the completion of the course, Students will be able to understand metal-ligand bonding in transition metal complexes.
- IUPAC nomenclature of coordination complexes.
- Know the isomerism in coordination compounds/complexes.
- Thermodynamic and kinetic aspects of metal complexes.

Syllabus

Unit	Course Content
I	**Chemical Kinetics:** Rate of a reaction and its measurement, factor affecting rate of reactions, rate law and rate constant, temperature coefficient, molecularity and order of reaction (zero order, first order, second order, pseudo-order), half-life and average/mean life. Determination of the order of reaction – differential method, method of integration, half-life method and isolation method. Arrhenius equation, concept of activation energy. Theories of reaction rate: Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Mathematical treatment of transition state theory and thermodynamic aspects (no derivation), comparison of transition state theory with collision theory. **Chemical Equilibrium:** Reversible and irreversible reaction, Equilibrium constants and interrelationship, free energy, Law of mass action and its thermodynamic derivation and its applications. Le Chatelier's principle and its application. Van't Hoff reaction isotherm and isochore, Clapeyron-Clausius equation and its applications.
II	**Phase Equilibrium**: Statement and meaning of the terms-phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system– water, CO_2 and Sulphur systems. Phase equilibria of two component systems, simple eutectic – Bi-Cd, Pb-Ag systems. **Kinetic theories of gases:** Gaseous State**:** Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waals equation of state. Critical phenomena: PV isotherms of real gases, continuity of states, the isotherms of Van der Waals equation, relationship between critical constants and Van der Waals constants, the law of corresponding states, reduced equation of state. Molecular Velocities, collision number, mean free path and collision diameter.
III	**Liquid State** **Liquid State:** Intermolecular forces, structure of liquids (a quantitative description). Structural differences between solids, liquids and gases. Liquid crystals: difference between liquid crystal, solid and liquid. Classification, structure of nematic, smectic and cholesteric phases. **Liquids in solid (Gels):** Classification, preparation, properties and general application. **Coordination Chemistry** Werner's theory of coordination complexes, classification of ligands, ambidentate ligands, chelates, coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereoisomerism, geometrical and optical isomerism in square planar and octahedral complexes

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IV	**Theories of Coordination Chemistry** **I** -Metal- ligand bonding in transition metal complexes, limitations of valance bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planner complexes, John teller effect, factors affecting the crystal-field parameters. **II** -Thermodynamic and kinetic aspects of metal complexes: A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, stability constants of complexes and their determination, substitution reactions of square planar complexes **Inorganic Spectroscopy and Magnetism** **I** – Electronic spectra of transition metal complexes, types of electronic transitions, selection rules for d-d transition, spectroscopic ground states, spectrochemical series, Orgel - energy diagram for d^1 and d^9 states, discuss the electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion. II – Magnetic properties of metal complexes, types of magnetic behavior, spin only formula, L-S coupling, correlation of μ_s and μ_{eff}.

Suggested Readings:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13(2006).
2. Ball, D. W. Physical Chemistry Thomson Press, India(2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa(2004).
4. Cotton, F.A, Wilkinson, G and Gaus, P. L ,Basic Inorganic Chemistry,3rd Edition ,Wiley1995
5. Lee, J.D, Concise Inorganic Chemistry 4th EditionELBS,1977
6. Douglas, B, McDaniel ,D and Alexander, J ,Concepts of Models of Inorganic Chemistry, John Wiley &Sons; 3rd edition ,1994
7. Shriver, D.E Atkins, P.W and Langford, C .H , Inorganic Chemistry ,Oxford University Press,1994.
8. Porterfield ,W.W, Inorganic Chemistry ,Addison Wesley1984.
9. Sharpe, A .G, Inorganic Chemistry, ELBS,3RD edition,1993
10. Miessler, G.L, Tarr, D.A, Inorganic Chemistry, 2nd edition , PrenticeHall,2001

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggestive digital platforms web links-

Suggestive digital platforms web links:

- https://swayam.gov.in/
- https://www.coursera.org/learn/physical-chemistry
- https://www.mooc-list.com/tags/physical-chemistry
- https://www.openlearning.com/courses/introduction-to-physical-chemistry/
- https://www.my-mooc.com/en/categorie/chemistry
- https://onlinecourses.swayam2.ac.in/nce19_sc15/preview
- https://swayam.gov.in/
- **https://www.coursera.org/browse/physical-science-and-engineering/chemistry**

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Semester	Semester-III Paper 2- Practical	
Course Code	B020302P	
Course Title	Physical Analysis	
Credit	2	Maximum Marks : 25

Course Objective:

- Is to calibrate the laboratory equipment.
- Preparation of solution.
- Analysis

Learning Outcomes: Upon successful completion of this course students should be able to:-

- Calibrate apparatus and prepare
- Preparation of solutions of various concentrations.
- Determination of surface tension & viscosity.
- Estimation of components through volumetric analysis.
- Determination of transition temperature thermometric/ dilatometric experiments.
- To understand & draw one and two component phase equilibrium experiments.

Syllabus

Unit	Course Content
I	**Strengths of Solution** 1. Calibrationoffractionalweights,pipettesandburettes.Preparationofstandardssolutions.Dilution–0.1 M to 0.001 M solutions. 2. Mole Concept and Concentration Units : Mole Concept, molecular weight, formula weight, and equivalent weight. Concentration units: Molarity, Formality, Normality, Molality, Mole fraction, Percent by weight, Percent by volume, Parts per thousand, Parts per million, Parts per billion, pH, pOH, milli equivalents, Milli moles
II	**Surface Tension and Viscosity** 1. Determination of surface tension of pure liquid or solution 2. Determination of viscosity of liquid pure liquid or solution
III	**Boiling point and Transition Temperature** 1. Boiling point of common organic liquid compounds **ANYFIVE** *n*-butylalcohol, cyclohexanol, ethyl methyl ketone, cyclohexanone, acetylacetone, isobutyl methyl ketone, isobutyl alcohol, acetonitrile, benzaldehyde and acetophenone. [Boiling points of the chosen organic compounds should preferably be within 180^0C]. 2. Transition Temperature, Determination of the transition temperature of the given substanceby thermometric /dilatometric method (e.g. $MnCl_2.4H_2O/SrBr_2.2H_2O$).
IV	**Phase Equilibrium** 1. To study the effect of a solute (e.g. NaCl, succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenol-water system) and to determine the concentration of that solute in the given phenol-watersystem 2. To construct the phase diagram of two component (e.g. diphenylamine – benzophenone) system by cooling curve method.

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References:

1. Skoog .D.A., West.D.M and Holler .F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing, Philadelphia, (2010).
2. Larry Hargis.G" Analytical Chemistry: Principles and Techniques" Pearson©(1988)

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggestive digital platforms web links

1. https://www.labster.com/chemistry-virtual-labs/
2. https://www.vlab.co.in/broad-area-chemical-sciences

http://chemcollective.org/vlabs

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Preeti

Semester	Semester IV Paper-1 (Theory)	
Course Code	B020401T	
Course Title	Quantum Mechanics and Analytical Techniques	
Credit	4	Maximum Marks : 25+50

Course Objective:

- Students will be able to explore new are as of research in both chemistry and allied fields of science and technology.
- Importance and role of Analytical chemistry in various fields and their impact on society.
- Manufacturing of drugs on commercial level.
- Determination of structures by various spectroscopic techniques.
- To develop basic skills required for purification, solvent extraction, TLC and column chromatography

- **Learning Outcomes:** After successful completion of the syllabus, learners will be able to able describe:-
- Atomic structure, elementary quantum mechanics, wave function and its significance; Schrodinger wave equation and its applications.
- Molecular orbital theory, basic ideas – Criteria for forming molecular orbital from atomic orbitals. Molecular Spectroscopy, Rotational Spectrum, vibrational Electronic Spectrum: photo chemistry and kinetics of photo chemical reaction.
- Role & impact of Analytical chemistry in our society, such as in drug manufacturing, process control in industry, environmental monitoring, medical diagnostics, food production, and forensic surveys.
- Grate role in different research areas.
- Analytical chemistry is a science that is directed towards creating new knowledge so that chemical analysis can be improved to respond to increasing or new demands.
- Students will be able to explore new areas of research in both chemistry and allied fields of science and technology. Students will be able to function as a member of an interdisciplinary problem solving team.
- Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
- Students will gain an understanding of how to determine the structure of organic molecules using IR and NMR spectroscopic techniques
- To develop basic skills required for purification, solvent extraction, TLC and column chromatography

Syllabus

Unit	Course Content
I	**Atomic Structure:** Idea of de-Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, d, orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule. : Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (no derivation) and its defects, Compton effect. **Elementary Quantum Mechanics** Hamiltonian Operator. Schrödinger wave equation (time dependent and time independent) and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one-dimensional box. Molecular orbital theory, basic ideas – Criteria for forming MO from AO, construction of MO by LCAO – H_2 + ion, physical picture of bonding and anti-bonding wave functions, concept of σ, σ*, π, π* orbitals and their characteristics.
II	**Molecular Spectroscopy**: **Introduction:** Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom **Rotational Spectrum**: Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, determination of bond length, qualitative description of non-rigid rotor, isotope effect.

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	Vibrational Spectrum: Infrared spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups. **Raman spectrum:** Concept of polarizability, pure rotational and pure vibrational, Raman spectra of diatomic molecules, selection rules. Electronic Spectrum: Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules.
III	**UV-Visible Spectroscopy:** Origin of spectra. Types of electronic transitions, chromophores and auxochromes, abortion shifts , application of Woodward Rules for calculation of λ max for the conjugated dienes and α and β unsaturated aldehydes and ketones systems: alicyclic, homoannular and heteroannular; distinction between cis and trans isomers (Cis and trans stilbene) . **Infrared Spectroscopy**: Fundamental and non-fundamental molecular vibrations; Hooke's law selection rule, IR absorption positions of various functional groups (C=O, OH, NH, COOH and nitrile), Effect of H-bonding, conjugation, resonance and ring size of cyclic ketones and lactones on IR absorptions; Finger print region and its significance; application in functional group analysis and interpretation of I.R. spectra of simple organic compounds.
IV	**^{1}H-NMR Spectroscopy (PMR)** NMR Spectroscopy: introduction; nuclear spin; NMR active molecules; basic principles of Proton Magnetic Resonance; choice of solvent and internal standard; equivalent and non-equivalent protons; chemical shift and factors influencing it; ring current effect; significance of the terms: up-/downfield, shielded and de-shielded protons; spin coupling and coupling constant (1st order spectra); relative intensities of first-order multiplets; anisotropic effects in alkene, alkyne, aldehydes and aromatics; NMR peak area, integration; relative peak positions with coupling patterns of common organic compounds; interpretation of NMR spectra of simple compounds. NMR spectra of some simple organic molecules such as Ethanol, Ethyl acetate, acetone, acetaldehyde, dimethyl formamide, Cis and trans 1,2-dimethyl cycloprpanone, propene, vinyl chloride, acetophenone, benzaldehyde, phenol. **Introduction to Mass Spectrometry:** Principle of mass spectrometry, the mass spectrum, mass spectrometry diagram, molecular ion, metastable ion, fragmentation process, McLafferty rearrangement

Suggested Readings:

- Alberty, R A, Physical Chemistry, 4 th edition Wiley Eastern Ltd,2001.
- Atkins, PW,the elements of physical chemistry,Oxford,1991
- Barrow, G .M, International student Edition .McGraw Hill,McGraw-Hill,1973.
- Cotton, F.A, Wilkinson, G and Gaus, P. L ,Basic Inorganic Chemistry,3rd Edition ,Wiley1995
- Lee, J.D, Concise Inorganic Chemistry 4th EditionELBS,1977
- Clayden, J., Greeves, N., Warren, S., *Organic Chemistry,* Second edition, Oxford University Press2012.
- Silverstein, R. M., Bassler, G. C., Morrill, T. C. *Spectrometric Identification of Organic Compounds*, John Wiley and Sons, INC, Fifth edition.
- Pavia, D. L. *et al. Introduction to Spectroscopy,* 5th Ed. Cengage Learning India Ed.
- Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wards worth Publishing Company, Belmont, California, USA,1988.
- Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
- Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.

Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher,2009

Suggestive digital platforms web links-

- https://www.coursera.org/courses?query=chemistry&languages=en
- https://www.mooc-list.com/tags/physical-chemistry
- https://www.coursera.org/learn/physical-chemistry
- https://ocw.mit.edu/courses/chemistry/5-61-physical-chemistry-fall-2017/
- http://heecontent.upsdc.gov.in/Home.aspx

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- https://nptel.ac.in/courses/104/108/104108078/
- https://nptel.ac.in/courses/104/108/104108124/
- https://nptel.ac.in/courses/104/106/104106122/

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Preeti

Semester	Semester-IV Paper 2 (Practical)	
Course Code	B020402P	
Course Title	**Instrumental Analysis**	
Credit	2	Maximum Marks : 25

Course Objective:

- Is to know how to determine molecular weight
- Handle spectrophotometer.
- Analysis

Learning Outcomes: Upon completion of this course, chemistry majors are able to employ critical thinking and scientific inquiry in the performance, design, interpretation and documentation of laboratory experiments, at a level suitable to succeed at an entry-level position in chemical industry or a chemistry graduate program.

- Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
- Students will be able to function as a member of an interdisciplinary problem solving team.
- Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems
- Students will gain an understanding of how to determine the structure of organic molecules using IR and NMR spectroscopic techniques
- • To develop basic skills required for purification, solvent extraction, TLC and column chromatograph

Syllabus

Unit	Course Content
I	**Molecular Weight Determination** 1. Determination of molecular weight of a non-volatile solute by Rast method/ Beckmann freezing point method. 2. Determination of the apparent degree of dissociation of an electrolyte (e.g., NaCl) in aqueous solution at different concentrations by ebullioscopy moles
II	**Spectrophotometry** 1. To verify Beer – Lambert Law for KMnO4/K2Cr2O7 and determining the concentration of the given solution of the substance from absorption measurement. 2. Determination of pKa values of indicator using spectrophotometry. 3. Determination of chemical oxygen demand (COD). 4. Determination of Biological oxygen demand (BOD).
III	**Spectroscopy** 1. Assignment of labelled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C-N, C-X, C=C, C=O, N=O, C≡C, C≡N stretching frequencies; characteristic bending vibrations are included. Spectra to be provided). 2. Assignment of labelled peaks in the 1H NMR spectra of the known organic compounds explaining the relative δ-values and splitting pattern. 3. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided)
IV	**Chromatographic Separations** 1. Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Cu(II) and Cd(II). 2. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer Chromatography (TLC).

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	3. Separation and identification of the amino acids present in the given mixture by paper chromatography. Reporting the Rf values. 4. TLC separation of a mixture of dyes (fluoresce in and methylene blue)

Suggested Readings: s

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
2. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wards worth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition.
7. Mikes, O. & Chalmes, R.A. Laboratory Handbook of Chromatographic &Allied Methods, Elles Harwood Ltd. London.
8. Ditts, R.V. Analytical Chemistry: Methods of separation. Van Nostr and, New York, 1974.

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University Suggestive digital platforms web links

1. https://www.labster.com/chemistry-virtual-labs/
2. https://www.vlab.co.in/broad-area-chemical-sciences
3. http://chemcollective.org/vlab

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Preeti

Semester	Semester V, Paper-1 (Theory)	
Course Code	B020501T	
Course Title	Organic Synthesis A	
Credit	4	Maximum Marks : 25+50

Course Objective:

- Understanding of commercial production of plastics, fuels, fuels lubricants, rubber and chemicals.
- Synthesis and uses of DDT and BHC.
- Synthesis of drug and pharmaceutically important compounds.

Learning Outcomes:

- Synthesis and chemical properties of aliphatic and aromatic hydrocarbons
- Synthesis and chemical properties of alcohols, halides carbonyl compounds, carboxylic acids and esters
- How to design and synthesize aliphatic and aromatic hydrocarbons.
- How to convert aliphatic and aromatic hydrocarbons to other industrially important compounds
- Functional group interconversion.
- Synthesis of drug and other pharmaceutically important compounds.

Syllabus

Unit	Course Content
I	**Chemistry of Alkanes and Cycloalkanes** **A) Alkanes**: General methods of preparation, physical and chemical properties of alkanes: Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity **B) Cycloalkanes:** Nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Chair, Boat and Twist boat forms of cyclohexane with energy diagrams rings train in small rings, theory of strain less rings. The case of cyclopropane ring, banana bonds.
II	**Chemistry of Alkynes** Methods of formation of alkynes, Addition to C≡C, mechanism, reactivity, regioselectivity and stereoselectivity; reactions: hydrogenation, halogenations, hydrohalogenation, hydration, oxymercuration demercuration, hydroboration-oxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity; inter conversion of terminal and non-terminal alkynes. **Aromaticity and Chemistry of Arenes** MO picture of benzene, Aromaticity, Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their Mechanism. Directing effects of the groups.
III	**Chemistry of Alcohols** Monohydric alcohols – nomenclature, methods of formation by reduction of Aldehydes, Ketones, Carboxylic acids and Esters, Hydrogen bonding, Acidic nature, Reactions of alcohols. Dihydric alcohols nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacol pinacolone rearrangement. Trihydric alcohols - nomenclature, methods of formation, chemical reactions of glycerol. **Chemistry of Phenols**: preparation of phenols, physical properties and acidic character, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols – electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman syntheis, HaubenHoesch reaction, and Reimer-Tiemann reaction

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IV	**Chemistry of Ethers and Epoxides**: Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions – cleavage and autoxidation, Ziesel's method. Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides. **Chemistry of Organic Halides** Nomenclature and classes of alkyl halides, methods of formation, chemical reactions, Mechanisms of nucleophilic substitution reactions of alkyl halides, SN^2 and SN^1 reactions with energy profile diagrams; Polyhalogen compounds: Chloroform, carbon tetrachloride; Methods of formation of aryl halides, nuclear and side chain reactions; The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions; Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides, Synthesis and uses of DDT and BHC.

Suggested Readings:

- Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education,2003.
- Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
- Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
- Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry,* 2nd edition, Oxford University Press, 2012.
- Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons, Inc.
- Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
- March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.\
- Bariyar and Goyal , Organic Chemistry-II, Krishna Prakashan Media, Meerut , Third Eddition,2019

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Suggested online links:

http://heecontent.upsdc.gov.in
/Home.aspx

- **https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htmhttps://nptel.ac.in/courses/104/103/104103071/# https://nptel.ac.in/courses/104/106/104106096/**

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Preeti

Semester	Semester V, Paper-II (Theory)	
Course Code	B020502T	
Course Title	Rearrangements and Chemistry of Group Elements	
Credit	4	Maximum Marks : 25+50

Course Objective:

- To gain knowledge of General principal, properties of catalyst and their industrial application
- Chemistry of main group elements and their role in biological system.
- The structure of biological macromolecules.
- Knowledge of metal carbonyls.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:-

- This paper will provide detailed knowledge of synthesis of various class of organic compounds and functional groups interconversion.
- Organic synthesis is the most important branch of organic chemistry which provides jobs in production & QC departments related to chemicals, drugs, medicines, FMCG etc.
- It relates and gives an analytical aptitude for synthesizing various industrially important compounds.
- This paper also provides a detailed knowledge on the elements present in our surroundings, their occurrence in nature. Their position in periodic table, their physical and chemical properties as well as their extraction.
- This paper also gives detailed understanding of the s, p, d and f block elements and their characteristics.

Syllabus

Unit	Course Content
I	**Rearrangements** A detailed study of the following rearrangements: Pinacol-pinacolone, Demjanov, BenzilBensilic acid, Favorskii, Hofman, Curtius, Schmidt, Baeyer-Villiger and Friesrearrangement **Catalysis** General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts. Enzyme catalysis; Michaelis-Menten equation, turn-over number.
II	**Chemistry of Main Group Elements:** **S-Block Elements:** Comparative study, diagonal relationship, salient features of hydrides, solvation and complexation tendencies including their function in biosystems. **p-Block Elements**: Comparative study (including diagonal relationship) of groups13-17elements, compounds like hydrides, oxides, oxyacids and halides of group13-16, hydrides of boron-diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), tetrasulphur tetra nitride, basic properties of halogens, interhalogens and polyhalides. **Chemistry of Noble Gasses**: Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds. **Chemistry of Transition Elements:** **Chemistry of Elements of First Transition Series**- Characteristic properties of d-blockelements. Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states. **Chemistry of Elements of Second and Third Transition Series**- General characteristics, comparative treatment of Zr/Hf, Nb/Ta, Mo/W in respect of ionic radii, oxidation states, magnetic behavior, spectral properties.
III	**Chemistry of Lanthanides** Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, ceric ammonium sulphate and its analytical uses. **Chemistry of Actinides**

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	Electronic configuration, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U.
IV	**Metal Carbonyls** Metal carbonyls: 18-electron rule, preparation, structure and nature of bonding in the mononuclear and dinuclearcarbonyls. **Bioinorganic Chemistry** Essential and trace elements in biological processes, metalloporphyrins with special reference to heamoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to Na+ and K+, Ca^{2+}, and Mg^{2+} biological nitrogen fixation.

Suggested Readings:

- Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education, 2003.
- Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
- Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
- Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry,* 2nd edition, Oxford University Press, 2012.
- Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons, Inc.
- Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
- March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.
- Lee, J.D. Concise Inorganic Chemistry, Pearson Education2010
- Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education2006
- Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford,1970
- Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.,* Oxford University Press, 1994.
- Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications1962.
- Francis**, P. G.** Mathematics for Chemists, Springer,1984
- Prakash Satya, Tuli G.D., Basu S.K. Madan R.D., Advanced inorganic Chemistry, S.Chand publishing.
- Bariyar and Goyal , Inorganic Chemistry-II, Krishna Prakashan Media, Meerut , Third Eddition, 2019

Suggested online links: http://heecontent.upsdc.gov.in/Home.aspx https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htmhttps://nptel.ac.in/courses/104/103/104103071/#

https://swayam.gov.in/

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Preeti

Semester	Semester - V, Paper-III (Practical)	
Course Code	B020503P	
Course Title	Qualitative Analysis	
Credit	2	Maximum Marks : 50

Course Objective:

- Qualitative analysis.
- Analysis of organic mixture.
- Determination of melting point.
- Preparation of organic derivatives.

Learning Outcomes: Upon completion of this course the students will have the knowledge and skills to: understand

- The laboratory methods and tests related to inorganic mixtures and organic compounds.
- Identification of acidic and basic radicals in inorganic mixtures
- Separation of organic compounds from mixture
- Elemental analysis in organic compounds
- Identification of functional group in organic compounds.
- Identification of organic compound

Syllabus

Unit	Course Content
I	**Inorganic Qualitative Analysis** Semi micro Analysis – cation analysis, separation and identification of ions from Groups I, II, III, IV, V and VI, Anion analysis. Mixture containing 6 radicals (2+4) or (3+3)
II	**Elemental analysis and identification of functional groups** Detection of extra elements (N, S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds.
III	**Separation of Organic Mixture** Analysis of an organic mixture containing two solid components using water, $NaHCO_3$, NaOH for separation and preparation of suitable derivatives
IV	**Identification of organic compounds** Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.

References:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education,2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson,2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook ofPractical Organic Chemistry, Prentice-Hall, 5th edition,1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
5. Harris,D.C.*ExploringChemical Analysis*, 9th Ed.NewYork, W.H.Freeman, 2016.
6. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.

Suggestive digital platforms web links

1. https://www.labster.com/chemistry-virtual-labs/
2. https://www.vlab.co.in/broad-area-chemical-sciences

http://chemcollective.org/vlabs

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Preeti

Semester	Semester - VI, Paper-1 (Theory)	
Course Code	B020601T	
Course Title	Organic Synthesis B	
Credit	4	Maximum Marks: 25+50

Course Objective:

- Role of reagents in organic synthesis /transformations.
- Understanding of organometallic compounds.
- Synthesis of nitrogen containing organic compounds.
- Introduction to preparation, synthesis and structure of heterocyclic compounds.
- To get jobs in production & QC departments related to chemicals, drugs, medicines, FMCG etc.
- Impotence and key role of natural products in new drug discoveries.

Learning Outcomes: This paper provides detailed knowledge of :-

- Organic reagent
- Synthesis various of organometallic compounds.
- Role of heterocyclic compounds toward identifying novel biological probes for a number of diseases.
- It relates and gives an analytical aptitude for synthesizing various industrially important compounds.
- Learn the different types of alkaloids, & terpenes etc. and their chemistry and medicinal importance.
- Explain the importance of natural compounds as lead molecules for new drug discovery.

Syllabus

Unit	Course Content
I	**Reagents in Organic Synthesis** A detailed study of the following reagents in organic transformations Oxidation with DDQ, CAN and SeO_2, m-CPBA, Jones Oxidation, PCC, PDC. Reduction with NaBH4, LiAlH4, Meerwein-Ponndorf- Verley(MPV) reduction, Wilkinson's catalyst, DIBAL-H. **Organometallic Compounds-** Formation, structure and chemical reactions of Grignard reagents, Organo zinc compounds & Organo lithium compounds.
I	**Chemistry of Aldehydes and ketones:** Nomenclature and structure of the carbonyl groups, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones uses1,3-dithianes, synthesis of ketones from nitrites and from carboxylic acids, Physical properties. Mechanism of nucleophillic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives. Wittig reaction. Oxidation of aldehydes, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, $LiAlH_4$and $NaBH_4$ reductions. An introduction to α, β unsaturated aldehydes and Ketones. **Carboxylic acids and their Functional Derivatives** Nomenclature and classification of aliphatic and aromatic carboxylic acids. Preparation and reactions. Acidity (effect of substituents on acidity) and salt formation, Reactions: Mechanism of reduction, substitution in alkyl or aryl group. Preparation and properties of dicarboxylic acids such as oxalic, malonic, succinic, glutaric, adipic and phthalic acids and unsaturated carboxylic acids such as cinnamic acids, Reactions: Action of heat on hydroxyl and amino acids, and saturated dicarboxylic acids, stereospecific addition to maleic and fumaric acids. Preparation and reactions of acid chlorides, acid anhydrides amides and esters.

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III	**Organic Synthesis via Enolates** Acidity of α-hydrogens, alkylation of diethyl malonate and ethyl acetoacetate, Synthesis of ethyl acetoacetate: the Claisen condensation, Keto-enoltautomerism of ethylacetoacetate. Alkylation of 1, 3-dithianes, **Organic Compounds of Nitrogen-** Preparation of nitroalkanes and nitroarenes, Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media. Halo nitro arenes: reactivity, Structure and nomenclature of amines, physical properties, Stereochemistry of amines, Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase-transfer catalysts, Preparation of alkyl and aryl amines (reduction of nitro compounds, nitrities), reductive amination of aldehydic and ketonic compounds, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous.
IV	**Heterocyclic Chemistry** Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine, Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution, Mechanism of nucleophilic substitution reaction in pyridine derivatives, Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six membered heterocycles, Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Nepieralski synthesis, Mechanism of electrophilc substitution reactions of indole, quinoline and isoquinoline.

Suggested Readings:

- Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (PearsonEducation).
- Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education,2003.
- Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education,2012.
- Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press,2008.
- Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry,* 2nd edition, Oxford University Press,2012.
- Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons,Inc.
- Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing CompanyLimited.
- March, J. *Advanced Organic Chemistry*, Fourth edition,Wiley.
- Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly& Sons(1976).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (PearsonEducation).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry ofNatural
- Products), Dorling Kindersley (India) Pvt. Ltd. (PearsonEducation).
- Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, PragatiPrakashan(2010).
- Organic Chemistry III, Krishna Prakashan Media, Meerut , Third Eddition,2019

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggested online links:

http://heecontent.upsdc.gov.in/Home.aspx

https://nptel.ac.in/courses/104/103/104103111/

https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htmhttps://nptel.ac.in/courses/104/103/104103071/#

- https://swayam.gov.in/

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Semester	Semester - VI, Paper-II (Theory)	
Course Code	B020602T	
Course Title	Chemical Energetics and Radio Chemistry	
Credit	4	Maximum Marks : 25+50

Course Objective:

- Understanding concept of thermodynamic laws and thermal reactions.
- Understanding Principle of Hess's law.
- Understanding the concept of thermo chemistry heat of formation and enthalpy.
- Concept of Electrolytic and Galvanic cells–Reversible and irreversible cells, conventional representation of electrochemical cells.
- Concept of photochemical reactions
- Concept of colligative properties of ideal and non ideal solution.
- Concept of Radiochemistry, radioactivity, calculation of half life.
- Concept of surface chemistry.
- Application in nuclear medicine and radiopharmaceuticals.

Learning Outcomes: After successful completion of the syllabus, learners will be able to:

- Understand this paper and gain the detailed knowledge of synthesis of various class of organic compounds
- Functional groups interconversion.
- It relates and gives an analytical aptitude for synthesizing various industrially important compounds.
- This paper also provides a detailed knowledge on the elements present in our surroundings
- Knowledge of elements occurring in nature.
- Study of periodic table.
- Physical and chemical properties as well as their extraction elements.
- This paper also gives detailed understanding of the s, p, d and f block elements and their characteristics.
- Organic synthesis is the most important branch of organic chemistry which provides jobs in production & QC departments related to chemicals, drugs, medicines, FMCG etc.

Syllabus

Unit	Course Content
I	**Thermodynamics-1 :** **First Law of Thermodynamics**: Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law – Joule- Thomson coefficient and inversion temperature. Calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process. **Thermochemistry:** Standard state, standard enthalpy of formation – Hess's law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy. Kirchhoff's equation. **Thermodynamics II** Second Law of Thermodynamics, Need for the law, different statements of the law, Carnot cycle and its efficiency. Carnot theorem. Thermodynamic scale of temperature. Concept of Entropy, Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, Clausius inequality , entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases. Gibbs and Helmholtz Functions. Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities. A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of G and A with P, V and T.

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	Third Law of Thermodynamics: Nernst heat theorem, statement and concept of residual entropy. Nernst distribution law – Thermodynamic derivation, applications.
II	**Electrochemistry**: Electrical transport:- Conduction in metals and in electrolyte solutions, specific conductance molar and equivalent conductance, measurement of equivalent conductance, variation of molar, equivalent and specific conductance with dilution. Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations. Weak and strong electrolytes. Ostwald's dilution law, its uses and limitations. Debye-Huckel-Onsager equation for strong electrolytes (elementary treatment only). **Ionic Equilibrium**: Electrodereactions, Nernst equation, derivation of cell EMF and single electrode potential, standard hydrogen electrode-reference electrodes and their applications, standard electrode potential, sign conventions, Electrolytic and Galvanic cells–Reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurement. Definition of pH and pKa, determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods. Buffers – Mechanism of buffer action, Henderson-Hazel equation, application of buffer solution.
III	**Photo Chemistry:** Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grothus- Drapper law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions – energy transfer processes (simple examples), kinetics of photochemical reaction. **Colligative Properties**-Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination, Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure, Elevation of boiling point and depression of freezing, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, Van't Hoff factor, Colligative properties of degree of dissociation and association of solutes.
IV	**Surface Chemistry** **Adsorption**: Physical and chemical adsorption; Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm (no derivation required); Gibbs adsorption isotherm and surface excess; Heterogenous catalysis (single reactant). **Colloids**: Lyophobic and lyophilic sols, Origin of charge and stability of lyophobic colloids, Coagulation and Schultz-Hardyrule, Zeta potential and Stern double layer (qualitative eidea), Tyndall effect; Electrokinetic phenomena (qualitative idea only); Stability of colloids and zeta potential; Micelle formation. **Radiochemistry** Natural and induced radioactivity; radioactive decay-a-decay, b-decay, g-decay; neutron emission, positron emission, electron capture; unit of radioactivity (Curie); half life period; Geiger-Nuttalrule, radioactive displacement law, radioactive series. Measurement of radioactivity: ionization chamber, Geiger counters, scintillation counters. Applications: energy tapping, dating of objects, neutron activation analysis, isotopic labelling studies.

Suggested Readings:

1. Foye, W.O., Lemke, T.L. & William, D.A.: Principles of Medicinal Chemistry, 4th ed., B..I. Waverly Pvt. Ltd. New Delhi.
2. Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
3. Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).
4. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13(2006).
5. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
6. Castellan, G. W. Physical Chemistry 4th Edn. Narosa (2004).
7. Allen Bard ,J Larry . Faulkner R ,Fundamentals of Electrochemical methods – fundamentals and applications,newYork John ,Wiley &sons ,2001
8. H. J. Arnikar, *Essentials of Nuclear Chemistry*, 4th ed., New Age International, New

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Delhi,1995.
9. Bariyar, and Goyal, Physical Chemistry-II, Krishna Prakashan Media, Meerut , Third Eddition,2019

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggested online links:

http://heecontent.upsdc.gov.in/Home.aspxhttps://swayam.gov.in/

https://www.coursera.org/learn/physical-chemistryhttps://www.mooc-list.com/tags/physical-chemistry

https://www.openlearning.com/courses/introduction-to-physical-chemistry/

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Semester	Semester VI, Paper-III (Practical)	
Course Code	B020503P	
Course Title	Analytical Methods	
Credit	2	Maximum Marks : 50

Course Objective:

- Gravimetric analysis of inorganic compounds.
- Determination of identification, separation of organic compounds by paper and thin layer chromatography by using spraying agent as a developer.
- Determination of R_f value.
- Determination of solubility, ionization, enthalpy and enthalpy of neutralization.
- Determination of lattice energy by using Born-Haber cycle

Learning Outcomes: Upon successful completion of this course students should be able to:

- Quantify the product obtained through gravimetric method.
- Determination of R*f* values and identification of organic compounds through paper and thin layer chromatography laboratory techniques.
- Learner is able to separate organic mixture by using spraying reagent.
- Are able to perform thermochemical reactions.

Syllabus

Unit	Course Content
I	**Gravimetric Analysis** 1. Analysis of Cu as CuSCN, 2. Analysis of Ni as Ni(dimethylgloxime) 3. Analysis of Ba as BaSO4.
II	**Paper Chromatography** Ascending and Circular. Determination of R*f* values and identification of organic compounds: Separation of a mixture of phenylalanine and glycine. Alanine and aspartic acid Leucine and glutamic acid. Spray reagent – ninhydrin. Separation of a mixture of D, L–alanine,glycine, and L-leucineusingn-butanol:aceticacid:water(4:1:5).Sprayreagent – ninhydrin. Separation of monosaccharaides– a mixture of D- galactose and D -fructose using n- butanol: acetone: water (4:5:1). Spray reagent – aniline hydrogen phthalate
III	**Thin Layer Chromatography** Determination of R*f* values and identification of organic compounds: Separation of green leaf pigments (spinach leaves may be used) Preparation of separation of 2,4- dinitrophenyl hydrazones of acetone, 2-butanone, hexan-2, and 3-one using toluene and light petroleum (40:60) Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5)
IV	**Thermochemistry** 1. To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process. 2. To determine the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionization of the weak acid/weak base. To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born-Haber cycle

References:

1.Skoog .D.A., West.D.M and Holler .F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing, Philadelphia,(2010).

2 Larry Hargis.G" Analytical Chemistry: Principles and Techniques" Pearson©(1988)

Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

Suggestive digital platforms web links

3.https://www.labster.com/chemistry-virtual-labs/

https://www.vlab.co.in/broad-area-chemical-sciences

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Preeti

Semester	**Semester-VII Paper I (Theory)**		
Course Code	B020701T		
Course Title	Inorganic Chemistry		
Credit	4	Maximum Marks : 25+50	

Course Objective: After going through the course, the students will be able to:-

- Understand basic concepts of group theory and its applications.
- Define Symmetry of molecules and relations between molecular spectra and molecular structure.
- This paper focuses on the mathematical tools which are necessary to apply symmetry concepts to spectroscopy.
- Fundamental aspects of classifying molecules based on various symmetry elements, point groups and constructing character table.
- To prepare the students to understand and correlate preparation, structure, bonding and properties of main group elements and complexes.
- Advanced principles of bonding in inorganic compounds. Kinetic and thermodynamic parameters as a measure of stability of coordination compounds.
- Advanced theories of bonding in complexes along with their stereochemistry.
- Mechanisms of inorganic redox reactions involving coordination compounds.

Learning Outcomes:

- Learn the concepts of group theory and its uses in octahedral, tetrahedral, sq. planar and trigonal bipyramidal symmetry.
- Understand the applications of group theory in inorganic& organic systems.
- Understand the aspect of symmetry element & operation.
- Learn matrix and matrix operations
- Understand the nature of pi acid ligands and their bonding in metal-ligand complexes.
- Understand the stereochemistry of main group
- Understand the solution equilibria.
- Learn the stability of metal-ligand complex in solution.
- Learn Thermodynamic& kinetics Consequences of metal-ligand in solution.
- Student will able to understand different types of chemical bonds present in inorganic compounds.

Syllabus

Unit	Course Content
I	Symmetry and Group Theory Symmetry elements and symmetry operations with reference to water, ammonia, ethane, benzene, etc. Classifications of molecules/ions based on their symmetry properties. Derivation of matrices for rotation, reflection, and inversion operations. Symmetry point groups applied to all types of molecules Cnh, Dnh, Cnv, Id, Oh. Group multiplication basis, matrix representation, character of a representation, character table, reducible and irreducible presentation, group, groups and subclasses
II	Stereochemistry and Bonding in Main Group Compounds VSEPR. Walsh diagrams (tri and penta-atomic Molecules), bent rule and energetic of hybridization, some simple reactions of covalently bonded molecules.
III	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.

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IV	Metal-Ligand Bonding Limitation of crystal field theory and molecular orbital theory. Octahedral, tetrahedral and square planar complexes π-bonding and molecular orbital theory.

References:

- . Lee, J.D. Concise Inorganic Chemistry, Pearson Education2010
- Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structureand Reactivity,Pearson Education 2006.
- Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford,1970
- Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.,* Oxford University Press,1994.
- Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications1962.
- Cotton F A and Wilkinson G Advanced Inorganic Chemistry, 6th Edn.(1999), John Wiley & Sons, New York.
- Greenwood N. N. and EarnshawA,Chemistry of the elements Pergammon.
- Lever A.B.P. Inorganic Electronic Spectroscopy, , Elsevier.
- Comprehensive Coordination Chemistry eds., Wilkinson G., Gillars R.D. and McCleverty J. A. Pergammon.
- R.L.Magneto Chemistry, Carlin R.L., Springer Verlag.

Suggested online links:

http://heecontent.updc.gov.in/Home.aspxhttps://nptel.ac.in/crss/104/106/104106/http://heecontent.upsdc.gov.in/Home.xhttps://nptel.ac.in/courses/104/106/104106096/

https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htmhttps://nptel.ac.in/courses/104/103/104103071/#

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Semester	Semester VII, Paper-II(Theory)	
Course Code	B020702T	
Course Title	Organic Chemistry	
Credit	4	Maximum Marks : 25+50

Course Objective:

Learning Objectives- After going through the course the students will be able to.

- To understand principles of organic reaction mechanism, substitution, elimination, homo- and hetero bond addition reactions. Stereochemistry of organic compounds, isomerism, different projection formulae with nomenclature and prochirality.
- Conformation and stability of substituted cyclic systems, nomenclature and conformations Of fused rings and bridged ring systems.
- Mechanisms and evidences for aromatic electrophilic and nucleophilic substitutions, addition reactions, elimination reactions and rearrangements.
- Effect of substrate structure, leaving group and attacking species in the above reactions.
- Know the orientation and stereochemistry of the product formed.

Learning Outcomes: This paper enable the students:

- To study the bonding and aromaticity.
- To study the organic reaction mechanism.
- Lean about stereochemistry & confirmation analysis.
- Study about optical activity.
- Study about Aliphatic nucleophilic substitution reaction mechanism .
- Effect of leaving and attacking group in aliphatic substitution reaction.
- Aromatic electrophilic & nucleophilic substitution reaction mechanism
- Generation, structure & reactivity of reaction intermediates,

Syllabus

Unit	Course Content
I	Nature of bonding in Organic Molecules Delocalized chemical bonding-conjugation, cross conjugation, resonance, Hyperconjugation, bonding in fullerenes. Aromaticity in benzenoid and non-benzenoid Compounds, Huckel's rule, energy level of pi-molecular orbitals, annulenes, antiaromaticity.
II	(a) Reaction mechanism: Structure and reactivity Methods of determining mechanism, isotope effect. Generation structure, stability and reactivity of benzynes, carbenes and nitrenes. Effect of structure on reactivity resonance and field effect, steric effect, quantitative treatment. (b) Stereochemistry: Conformational analysis of cycloalkanes, decalines, effect of conformation of reactivity Elements of symmetry, chirality, molecule with more than one chiral center, threo and erythro isomers, stereospecific and stereoselective synthesis. Asymmetric synthesis. Optical activity in the absence of chiral carbon biphenyl's, alleries. andspiranes.
III	Aliphatic nucleophilic substitution The SN_1, SN_2, mixed SN_1 and SN_2, neighboring group participation by Pi and Sigma bonds, anchimeric assistance Classical and non-classical carbocations. 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, ambident nucleophile, regioselectivity.

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IV	A-Aromatic electrophilic substitution The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The Ortho/Para ratio, ipso attack, orientation in other ring systems. Vilsmeir reaction, Gattemann-Koch reaction. B-Aromatic nucleophilic substitution: The SN_{Ar}. SN_1,SN_2 benzyne and SRNi mechanism. Reactivity effect of substrate structure, leaving group and attacking nucleophile. The Von Richter, Sommelet Hauser, and Smiles rearrangements.

- Suggested Readings:
- Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
- Advanced Organic Chemistry, F.A. Carey and R3. Sundberg. Plenum.
- A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
- Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University press.
- Organic Chemistry, RT. Morrison and RN. Boyd. Prentice Hall.
- Modem Organic Reactions H.O. House, Benjamin
- Principles of Organic Synthesis, R.O.C. Normon and J.M. Coxon, Blackie Academic and professional.
- Pericyclic Reactions. S.M. Mukherji, Macmillan India.
- Reaction Mechanism in Organic Chemistry: S.M. Mukherji and S.P. Singh, Macmillan.
- Stereochemistry of Organic Compounds D. Nasipuri, New Age International.
- Stereochemistry of Organic Compounds, P.S Kalsi, New:Age, International.

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Semester	Semester VII, Paper-III (Theory)	
Course Code	B020703T	
Course Title	Physical Chemistry	
Credit	**4**	Maximum Marks : 25+50

Course Objective:

Learning Objectives- After going through the course the students will be able to.

- To understand principles and instrumentation of different molecular spectroscopic methods
- Application of quantum mechanics in physical models and experiments of chemical systems. It is also called molecular quantum mechanics.
- Time dependent and time independent Schrödinger equations with solutions in simple systems.
- Matrix representation of quantum mechanics is discussed together with approximate methods..
- Qualitatively predict which signals are to be observed in the rotational, vibrational or Raman spectrum of various materials ranging from single atoms (atomic spectroscopy) to molecules.
- The collision model of chemical reactions and how various factors such as temperature and Catalyst can affect reaction rate and mechanism of thermal and photochemical hydrogen halogen reactions.
- Different theories of Unimolecular reactions; Perrin theory, Lindemann-Christiansen
- Hypothesis, Hinshelwood treatment, RRK treatment and RRKM treatment.

Learning Outcomes:

- To study vibrational spectroscopy & unifying principles.
- To study of Infrared spectroscopy and application in determination molecules.
- To study the theory of Raman spectroscopy and &its applications.
- Learn the fundamentals of quantum chemistry.
- Learn the chemical dynamics &methods of determining rate law

Syllabus

Unit	Course Content
I	**Vibrational Spectroscopy** **A. Unifying Principles** Electromagnetic radiation, interaction of Electromagnetic with matter-absorption and transmission, reflection, refraction, dispersion, polarization and scattering. Uncertainty relation and line width and natural line broadening, selection rules, intensity of spectral lines. **B. Infrared Spectroscopy** Review of linear harmonic oscillator. vibrational energies of diatomic molecules, zero point energy, force constant and bond strength: anharmonicity, P.Q.R. branches, vibrations of polyatomic molecules, Selection rules, normal modes of vibration. Factors affecting the band positions and intensities. **C. Raman Spectroscopy** Classical and quantum theories of Raman effect Pure rotational, vibrational and vibrational-rotational Raman spectra. selection rules. mutual exclusion principle. Applications of Raman spectroscopy.
II	**Quantum Chemistry** **A. Fundamental Background of Operators,** Postulates of Quantum Mechanics, Hamiltonian for different systems, Angular momentum. **B. Introduction to Exact quantum Mechanical Results:** The Schrodinger equation. Discussion of solutions of the Schrodinger equation to some model system viz. particle in a box, the harmonic oscillator, the rigid rotator, the hydrogen atom.

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III	**Quantum Chemistry.** **A. Approximate Methods:** The Variation theorem, linear variation principle. Perturbation theory (First order and non-degenerate)\ Application of variation method and perturbation theory to the H_2 molecule and H_2^+ ion. **B. Electronic structures of Atoms**: Russel-Saunders terms and coupling schemes, term symbols for the p^n and d^n configurations Spin orbit coupling and Zeeman splitting, introduction to the methods of self-consistent field, Slaters type orbitals. **C. Molecular orbital theory**: Huckel theory of conjugated systems, bond order and charged density calculations. Application to ethylene, butadiene, cyclobutadiene and Benzene molecules.
IV	**Chemical Dynamics** Methods of determining rate law, collision theory of reaction rates steric factors Activated complex theory, Arrehenius equation and the activated complex theory. Ionic reactions kinetic salt effect, steady state kinetics. Dynamic chain (Hydrogen-bromine reaction, pyrolysis of acetaldehyde) photochemical (hydrogen-bromine reaction hydrogen-chloride reactions). homogeneous catalysis, kinetics of enzyme reaction General features of fast reaction study of fast reaction by relaxation method flash photolysis. Dynamics of unimolecular reactions (Lindemann Hinshelwood theories of unimolecular reactions)

Suggested Readings:

- Modem Spectroscopy. J.M. Hollas, john Wiley.
- Physical methods in chemistry RS. Drago, Saunders College.
- Introduction to 'Molecular Spectroscopy G.M. Barrow, Me Graw Hill.
- Physical Chemistry P.W Atkins PLBS.
- Introduction to Quantum Chemistry, A.K. Chandi., Tata Me Graw Hill .
- Quantum Chemistry. Ira N. I.cvinc. Prentice Hall.
- Coulson's Valence. R.Me Weeny, ELBS.
- Chemical Kinetics. K.J. Laidler. Mcgraw-Hill.

Kinetics and Mechanism of Chemical Transformations J. Rajaraman and J. Kuriacosc McMilian.

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Semester	Semester VII, Paper-IV A (Theory)	
Course Code	B020704T	
Course Title	Computers for Chemists (Compulsory for all students)	
Credit	**2**	Maximum Marks : 40

Course Objective:

Learning Objectives- After going through the course the students will be able to

- To know the power of computers.
- Know the application of computer in chemistry.
- Study the chemistry programme in different language and software.
- Study the formulae for calculation of chemical problems.
- Sketching of chemical structure.

Learning Outcomes:

- Understand the fundamentals of computer.
- Gain knowledge about functioning of computer
- Know about the use of computer in field of chemistry.
- Study the language of computer and programming
- Learner knows the programming logic & language features on experience on a personal PC.
- Learner is able to develop small computer codes & programme involving simple chemical.
- Learners are able to run/operate the packages &software on their PC.

Syllabus

Unit	Course Content
I	**Introduction to Computer and Computing:** Basic structure and functioning of computers with a PC as an illustrative example Memo05ry,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 flowcharts
II	**Computer Programming in FORTRAN/C/BASIC:** The language features are listed here with reference to FORTRAN. The instructor my choose another language such as BASIC or C and the features may be replaced appropriately. Elements of the computer language. Constants and variables. operations and symbols, expressions. Arithmetic assignment statement. Input and Output. Format statement. Termination statements. Branching statements such as IF or GO TO statement. LOGICAL variables. Double precision variables. Subscripted variables and DIMENSION. DO statement FUNCTION and SUBROUTINE. COMMON and DATA statements. (Students learn the programming logic and these language features by hands on experience on a personal computer from the very beginning of this topic) .
III	**Programming in Chemistry:** Development of small computer codes involving simple formulae in chemistry such as van der Waals equation, pH titration. kinetics. Radioactive decay. Evaluation of lattice energy and ionic radii from experimental data. Linear simultaneous equations to solve secular equations within the Huckel theory. Elementary structural features such as bond lengths. bond angles, dihedral angles etc. of molecules extracted from a database such as Cambridge data base.
IV	**Use of Computer Programmes:**The students will learn how to operate a PC and how to run standard programmes and packages. Execution of linear regression. X-Y plot. Numerical intergration and differentiation as well as differential equation solution programmes. Monte Carlo and Molecular dynamics. Programmes with data preferably from physical chemistry laboratory Futher, the students will operate one or two of the packages such as MATLAB EASYPLOT LOTUS FOXPRO and Word processing software such as WORDSTAR/MS WORD.

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Suggested Readings:

After going through the course the students will be able to

- The student will understand the interdisciplinary nature of chemistry and to integrate knowledge of mathematics, physics, and other disciplines to a wide variety of chemical problems.
- The student will learn the laboratory skills needed to design, safely conduct and interpret chemical research.
- The student will acquire a foundation in chemistry of sufficient breadth and depth to enable them to understand and critically interpret the primary chemical literature.
- The student will develop the ability to effectively communicate scientific information and research results in written and oral formats.

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Semester	Semester VII, Paper-IVB (Theory)	
Course Code	B020704T	
Course Title	Mathematics for Chemists. (Compulsory only for those who is the biology students in B.Sc.)	
Credit	2	Maximum Marks : 35

Course Objective:

Learning Objectives- After going through the course the students will be able to

- The student will understand the interdisciplinary nature of chemistry and to integrate knowledge of mathematics, physics, and other disciplines to a wide variety of chemical problems.
- The student will learn the laboratory skills needed to design, safely conduct and interpret chemical research.
- The student will acquire a foundation in chemistry of sufficient breadth and depth to enable them to understand and critically interpret the primary chemical literature.
- The student will develop the ability to effectively communicate scientific information and research results in written and oral formats.

Learning Outcomes: After successful completion of this course students will be able to understand: -

- To gain the knowledge of differential equation, matrix algebra, Elementary Differential Equations, Permutation and Probability
- To know the fundamentals of mathematics.
- To understand the different forms of mathematics which will be useful in chemistry to solve typical equations used in quantum mechanics

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Syllabus

Unit	Course Content
I	**Vectors and matrix Algebra:** **Vectors** Vectors, dot, Cross and triple products etc. The gradient, divergence and curl. **Matrix Algebra** Addition and multiplication: inverse, adjoint and transpose of matrices, special matrices (Symmetric, skew-symmetric Hermitian, skew-Hermitian, unit, diagonal, unitary etc) and their properties Matrix equations: homogeneous, non-homogeneous linear equations and conditions for the solution, matrix eigenvalues diagonalisationdeterminats (examples from Huckel theory)
II	**Calculus** **A-Differential Calculus** Functions, continuity and differentiability, rules for differentiation, applications of differential calculus including maxima and minima (examples related to maximally populated rotational energy levels. Bohr's radius and most probable velocity from Maxwell's distribution etc.) exact and inexact differentials with their applications to thermodynamic properties. **B- Integral calculus.** Basic rules for integration, integration by part partial fraction and substitution. Reduction formulae applications of integral calculus. Functions of several variables, partial differentiation. co-ordinate transformations (e.g. cartessian to spherical polar).
III	**Elementary Differential Equations** Variables-separable and exact first-order differential equations. homogeneous. exact and linear equations. Applications to chemical kinetics. secularequilibria, quantum chemistry etc. Solutions of differential equations by the power series method, Fourier series, solutions of harmonic oscillator and Legendre equation etc, spherical harmonics second order differential equations and their solutions.

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IV	**Permutation and Probability** Permutations and combinations, probability and probability theorems, probability curves, average, root mean square and most probable errors, examples from the Kinetic theory of gases etc.

Suggested Readings:

After going through the course the students will be able to

The chemistry Mathematics Book, E. Steiner, Oxford University Press.

2. Mathematics for Chemistry, Doggett and Sucliffe. Longman.
3. Mathematical preparation for Physical Chemistry. F. Daniels McGraw Hill.
4. Chemical Mathematics, D.M. Hurst, Longman.
5. Applied Mathematics for Physical Chemistry. J.R. Barrante. Prentice Hall.
6. Basic Mathematics for Chemists, Tebbutt. Wiley.

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Semester	Semester VII, Paper-IV C (Theory)	
Course Code	B020704T	
Course Title	Biology for Chemists. (Compulsory only for those, who is the mathematics students in B.Sc.)	
Credit	2	Maximum Marks : 35

Course Objective:

Learning Objectives- After going through the course the students will be able to

- Understand the scientific process, in the context of learning the fundamental biological and chemical 'facts' of molecular biology.
- Students will gain skills required to effectively do scientific research.
- Students will learn to implement the scientific method by proposing hypotheses to explain biological phenomena.
- Designing and conducting experiments to test these hypotheses, and critically interpreting the resulting data.
- Students will learn to effectively communicate their results, both orally and in writing.
- In addition, they will be able to critically evaluate scientific literature and the current state of research progress in their area of interest.

Learning Outcomes: After successful completion of this paper learners are able to understand:-

- Fundamentals of molecular biology
- Structure &function of cell
- Structure & function of carbohydrates and its derivatives
- Role of sugar
- Structure, function & metabolism of fatty acid
- Structure of protein
- Chemical and enzymatic hydrolysis of proteins to peptides
- Amino acid sequencing.
- Knowledge of nucleic acid

Syllabus

Unit	Course Content
I	**A- Cell Structure and Functions** Structure of prokaryotic and eukaryotic cells, intracellular organelles and their functions, comparison of plant and animal cells. Overview biological energy currency. Introduction to biomolecules. building blocks of biomacromolecules. **B-Carbohydrates** Structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars, amino sugars. N-acetylmuramic acid, sialic acid, disaccharides and polysaccharides. Structural polysaccharides-cellulose and chitin. Carbohydrates of glycoproteins and glycolipids. Role of sugars in biological recognition. Blood group substances. Carbohydrate metabolism, Kreb's cycle, glycolysis, glycogenesis,
II	**Lipids.** Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, cholesterol, bile acids, prostaglandins. propertiesof lipid aggregates-micelles and their possible biological functions. Biological membranes. Fluid mosaic model of membrane structure Lipid metabolism β oxidation of fatty acids.
III	**Amino-acids, Peptides and proteins** Chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of proteins, forces responsible for holding of secondary structure α-helix, β sheets. Tertiary structure of protein folding and domain structure. Quaternary structure. Chemistry of oxytocin and tryptophan releasing hormone (TRH).

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IV	**Nucleic Acids** Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding structure of ribonucleic acid (RNA) and deoxyribonucleic acids (DNA), double helix model of DNA and forces responsible for holding it. The chemical basis for heredity and overview of replication of DNA, transcription, translation and genetic code. Chemical synthesis of mono and trinucleoside.

Suggested Readings:

Principles of Biochemistry, A.L Lehniger Worth Publishers.

2. Biochemistry, L. Stryer, W.H. Freeman.
3. Biochemistry, J.David Rawn, Nell Patterson.
4. Biochemistry Voet and Voet, John Wiley.
5. Outlines of Biochemistry, E.E.Conn and P.K. Stumpt, John Wiley.

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Semester	Semester VII, Paper-V (Practical)	
Course Code	B020705P	
Course Title	Practical	
Credit	4	Maximum Marks : 25+75

Course Objective:

- Analyzing ions and mixture through qualitatively & quantitatively.
- Understand Analysis mixture by paper & thin layer chromatography.
- Synthesis of organic compound.
- Preparation derivatives of organic compound.
- Study the adsorption theorem.
- Study the determination of congruent composition and temperature of mixture.
- Study the determination of velocity constant.

Learning Outcomes: Upon successful completion of this course students should be able to:-

- Prepare, synthesize, separation and analyzing the product obtained through semimicro technique.
- Determination of R*f* values and identification of inorganic compounds through paper chromatography laboratory techniques.
- Calculating the order of reaction.
- Hydrolysis constant & velocity constant of chemical reactions.

Syllabus

Unit	Course Content
I	**Inorganic Chemistry** Qualitative analysis of mixtures Qualitative analysis of mixture containing trace elements Tl, Mo, W, Zr, Ti,Th, V, U (Two metal ions in cationic/anionic forms) and insoluble oxides, sulphates and halides. The mixture should not contain more than five cations and should be analyzed by semi micro technique.
II	**Organic Chemistry** **Qualitative Analysis** Separation, purification, and identification of binary mixture. Preparation of derivatives if possible **Organic Synthesis** Adipic acid by chromic acid oxidation of cyclohexanol. Triphenyl methanol from Benzoic acid. Dibenzal acetone from Benzalehyde. p-chlorotolune from p-toludine, Synthesis of p-nitroaniline and p-bromoaniline.
III	**Physical Chemistry (Any one)** 1. Study the adsorption of acetic acid on charcoal and draw the Freundlich isotherm. 2. Show that the order of reaction between acetone and Iodine is zero with respect to Iodine 3. Determination of congruent composition and temperature of a binary mixture e.g. diphenylamine, benzophenone system. 4. Determination of glass transition temperature of a given salt (e.g., $CaCl_2$) conductometrically. 5. Determination of the velocity constant of hydrolysis of an ester / ionic reaction in micellar media. 6. Determination of the velocity Constant of decomposition of Benzene diazonium chloride
IV	**Chromatographic analysis** • Paper chromatography • Paper chromatography separation of a mixture of the following and measurements of R_f values. (a). Pb^{+2}, Ag^{+}, Hg^{+2} (b). Co^{+2}, Ni^{2}, Cu^{+2}(c) Ba^{+2}, Ca^{+2}, Sr^{+2}

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References:

Lab 1 :htpp://uou.ac.in
Advance Practical Inorganic by Gurdeep Raj, Krishna Publication.
Advance Practical Chemistry by J. Singh. PragatiPrakashan.

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Semester	Semester VIII, Paper-I (Theory)	
Course Code	B020801T	
Course Title	Inorganic Chemistry	
Credit	4	Maximum Marks : 25+50

Course Objective:

- To provide a broad learning about the different types of reaction mechanism involved in a variety of metal ligand complexes.
- To learn oxidative addition and reductive reaction of different kinds of metal atom complexes.
- Aims to provide students a deep understanding of electronic spectroscopic. techniques to carry out scientific experiments and interpretation of the data.
- To learn magnetic properties of metal complexes.
- To attain sufficient knowledge about the applications of a variety of spectroscopic techniques.
- To understands the metal-π complexes.
- Aims to understand metal cluster.

Learning Outcomes: Learning Objectives –After going through the course the students will be able to

- Study chemical compounds containing transition metal.
- This paper introduced to M.Sc. classes for detail study of reaction mechanism of transition metals considering substitution, elimination, and addition reaction.
- Mechanisms of Inorganic redox reactions involving coordination compounds.
- Electronic spectroscopy and magnetic properties of coordination compounds.

Syllabus

Unit	Course Content
I	**Reaction mechanism of Transition Metal Complexes** **Energy profile of a reaction,** reaction reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism. Substitution reaction in square planar complexes. Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outer sphere type reactions cross- reactions and Marcus-Hush theory, inner sphere type reactions.
II	**Electronic spectra and Magnetic, Properties of Transition Metal Complexes:** Spectroscopic ground states; Orgel energy level and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states); Charge transfer spectra; electronic spectra of octahedral and tetrahedral Co(II) and Ni(II) complexes and calculation of ligand-field parameters.
III	**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.
IV	**Metal Clusters** Higher boranes, carboranes, metallocarboranes, Isopoly and heteropoly acids and salts

References:

- F.A. Cotton and G. Wilkinson *Advanced Inorganic Chemistry, 6th Edn.(1999),* John Wiley & Sons, New York.
- James E. Huheey, *Inorganic Chemistry,* 4th Edn. (1993), Addison-Wesley Pub. Co., New York.
- Chemistry of the elements, N. N. Greenwood and A. Earnshaw, Pergammon.
- Inorganic Electronic Spectroscopy, A. B. P. Lever, ElsevierComprehensive Coordination Chemistry eds., G Wilkinson, R. D. Gillars and J. A. McCleverty. Pergammon.

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Semester	Semester VIII, Paper-II (Theory)	
Course Code	B020802T	
Course Title	Organic Chemistry	
Credit	4	Maximum Marks : 25+50

Course Objective: After going through the course the students will be able to

- Get an idea about the mechanistic pathway of various substitution reactions.
- To study the property and reaction of carbonyl functionality.
- Learn the mechanistic pathway of organic chemistry under the terms of addition and elimination reactions
- The paper of reactions and pericyclic is introduced to M.Sc. classes for the detailed studies of reaction and concerted (pericyclic) reactions.

Learning Outcomes:

Syllabus

Unit	Course Content
I	**Free radical reactions:** Free radical substitution mechanism, mechanism of an aromatic substrate, neighboring group assistance. Reactivity_for aliphatic and aromatic_substrates at a bridge head. The effect of solvent on reactivity. Arylation of aromatic compounds bydiazonium salt, Hunsdiecker reaction.
II	**Addition to carbon-carbon multiple bond:** Mechanistic and stereochemical aspects of addition reactions involving electrophile, nucleophile and free radicals, regio and chemo selectivity, orientation and reactivity. Hydrogenation of aromatic rings. Hydrobration. Michael reaction. Sharpless asymmetric epoxsidation. **Addition to carbon heteroatom multiple bonds:** Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles, Witting reaction mechanism of condensation reactions involving enolate, Knoevenagel, Mannich, Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.
III	**Elimination reactions:** The E_1, E_J and E_1CB mechanism. Orientation of double bond. Reactivity effect of substrate structures. Attacking base, the *leaving* group' and the medium. Mechanism and orientation on Pyrolytic elimination.
IV	**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 and *alyl* systems. Cycloadditions-antarafacial and Suprafacial 'additions, 4n and 4n+2 system, Sigmatropic rearrangements-superafacial an antarafacial shift of H,sigmatropic shifts *involving* carbon moieties, 3, 3 and 5, 5 sigmatropic rearrangements. *Claisen,* Cope and Azacope rearrangement, Ene reaction.

BOOKS SUGGESTED:

- Advanced Organic Chemistry-Reactions, Mechanism and Structure, *Jerry* March, John Wiley.
- Advanced Organic Chemistry, F.A. Carey and RJ. Sundberg. Plenum.
- A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
- Structure and I\.Jechanism in Organic Chemistry, c.K. Irigold, *Cornell* University press.

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- Organic Chemisty, RT. Morrison and RN. Boyd. Prentice Hall.
- Modem Organic Reactions H.O. House, Benjamin .
- Principles of Organic Synthesis, RO.C. Normon and J.M. Coxon, Blackie Academic and professional.
- Pericyclic Reactions. S.M. Mukherji, Macmillan India.
- Reaction Mechanism in Organic Chemistry S.M.• Mukherji and S.P. Singh, Macmillan.
- Stereochemistry of Organic Compounds D. Nasipuri, New Age International.

Evaluation Methods:

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Semester	Semester VIII, Paper-III (Theory)	
Course Code	B020803T	
Course Title	Physical Chemistry	
Credit	4	Maximum Marks : 25+50

Course Objective: After going through the course the students will be able to

- Get the basic idea about fundamental laws of thermodynamics
- Introduced about non equilibrium thermodynamics
- Impart knowledge on the fundamentals of surface chemistry
- Study the micelle chemistry
- To understand the concept of macromolecules
- Describes concepts and their applications of electrochemistry.

Learning Outcomes: After successful completion of this paper student will able to explain the

- **Theory of Thermodynamics.**
- **Statistical Thermodynamics**
- **Non- Equilibrium Thermodynamics**
- **Surface chemistry**
- **Macromolecules**
- **Electrochemistry**

Syllabus

Unit	Course Content
I	**Thermodynamics** A. **Classical Thermodynamics:** Brief resume of concepts of laws of thermodynamics, free energy and chemical potential. Partial, molar properties partial molar free energy, partial molar volume and its determination, Gibbs-Duhem equation, concept of fugacity (by graphical method), Activity and Activity coefficient. B. **Statistical Thermodynamics:** Concept of distribution, thermodynamic probability and most probable distribution. The Boltzmann distribution law. Fermi-Dirac and Bose-Einstein statistics. Partition Functions-translational, rotational, vibrational and electronic partition function. Calculation of thermodynamic properties and equilibrium constant in terms of partition function. C. **Non- Equilibrium Thermodynamics:** Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, Entropy balance equation for different irreversible processes (e.g. heat flow chemical reaction etc. Onsager's reciprocity relation, electro kinetic phenomena.
II	**Surface chemistry:** A. **Adsorption:** Gibbs adsorption isotherm estimation of surface area (BET equation), surface films on liquids (Electro kinetic phenomenon), catalytic activity at surfaces. B. **Micelles:** Surface active agents, classification of surface active agents, micellization hydrophobic interactions, Critical micellar concentration(CMC) Factors affecting CMC of surfactants counter ion binding to Micelles, solubilization micro emulsion reverse micelles
III	**Macromolecules:** Polymer-definition, types of polymer, electrically conducting fire resistant, liquid crystal polymer, Kinetics of polymerization, Molecular mass, number and mass average molecular mass, molecular mass determination (Osmometry, Viscometry diffusion and light scattering method) sedimentation chain configuration of macromolecules.
IV	**Electrochemistry:** Debye-Huckel theory of activity coefficient of electrolytic solutions, applicability and limitations of Debye-Huckel limiting law, ionic strength, Helmholtz- perrin, Over potentials, exchange current density, Tafel plot. Electrocatalysis, Influence of various parameters, Hydrogen electrode. Polarography theory, interpretation of a polarographic curve, limiting current, residual and charging current, diffusion current. Supporting electrolytes, Ilkovic equation, half wave potential and its significance. Introduction to corrosion, homogeneous theory, forms of corrosion, corrosion monitoring

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	and prevention methods.

BOOKS SUGGESTED

- Kinetics and Mechanism of Chemical Transformations J. Rajaraman and J .Kuriacose Me Millan.
- Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum .
- Modem Electrochemistry Vol. I and Vol. II J.O.M. Bockris and AK.N. Reddy, Plenum.
- Introduction to Polymer Science V.R. Gowarikar, N.V. Vishwanathan and J.Sridhar, Wiley Eastern.

5. Physical Chemistry P.W. Atkins, ELBS.

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Semester	Semester VIII, Paper-IV (Theory)	
Course Code	B020803T	
Course Title	Spectroscopy and Diffraction	
Credit	4	Maximum Marks : 25+50

Course Objective:

- After going through the course the students will be able to
- Explain what it means to use spectroscopic method for qualitative and quantitative analysis
- Analyze spectroscopic information to find structural information of molecules
- Assess structure of inorganic compounds using spectroscopy and learn principle of spectroscopy
- Analysis of structure of different structure of crystals.

- **Learning Outcomes:**
- To learn about electron & molecular spectroscopy.
- To learn basic principle photoelectric effect.
- To predict the number of proton and carbon NMR signals expected from a compound given its structure.
- To predict the splitting pattern in the proton NMR spectrum of a compound given its structure.
- To assign peaks in an NMR spectrum to specific protons in a compound with the aid of a chart of chemical shifts from ^{1}H and ^{13}C NMR.
- To interpret integration of NMR spectra.
- To calculate coupling constants from ^{1}H NMR spectra, and utilize the coupling constants for determining compound structure.
- NMR studies of nuclei other than proton-^{13}C, ^{19}F and ^{31}P. FT NMR, advantages of FT-NMR use of NMR in medical diagnostics.
- Learn EPR spectroscopy:
- Basic principles of photoacoustic spectroscopy.
- Crystal structure determination by X-ray diffraction method.
- Students learn the principles of different molecular spectroscopic methods.

Syllabus

Unit	Course Content
I	**Electronic Spectroscopy** **A. Atomic Spectroscopy** Energies of atomic orbital, spectra of hydrogen atom and alkali metal atoms. **B. Molecular Spectroscopy** Franck-Condon principle, electronic spectra of polyatomic molecules. Emission spectra; radiative and nonradioactive decay, internal conversion, spectra of transition metal complexes, charge-transfer spectra. **C. Photoelectron Spectroscopy** Basic principles; photo-electric effect, ionization process, Koopman's theorem. Photo-electron spectra of simple molecules, ESCA, chemical information from ESCA. Auger electron spectra of simple molecules.
II	**Nuclear Magnetic Resonance Spectroscopy** Nuclear spin, nuclear resonance, shielding of magnetic nuclei, chemical shift and its measurements, factors influencing chemical shift, de-shielding, spin-spin interactions, factors influencing coupling constant 'J'. Effect of chemical exchange, spin decoupling. NMR studies of nuclei other than proton-^{13}C. FT NMR use of NMR in medical diagnostics. **B-Nuclear Quadrupole Resonance Spectroscopy** Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant and splitting.

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III	**Electron Spin Resonance-Spectroscopy** Basic principles, Zero field splitting and Kramer's degeneracy. Factors affecting the 'g' value. Isotropic' and anisotropic hyperfine coupling constants, measurement techniques and applications.
IV	**X-ray Diffraction** Bragg method of X-ray structural analysis of crystals, index reflections. Structure of simple lattices and X-ray intensities. **Electron Diffraction** Scattering intensity vs. scattering angle, Wierl equation, measurement technique, elucidation of structure of Gas phase molecules.

BOOKS SUGGESTED

1. Modem Spectroscopy, J.M. Hollas, John Wiley.
2. Applied Electron Spectroscopy for Chemical Analysis ed. H. Windawi and F.L. Ho. Wiley interscience.
3. NMR, NQR, EPR and Mossbauer Spectroscopy in inorganic Chemistry, R.V. Parish, Ellis Harwood.
4. Introduction to Molecular Spectroscopy G.M. Barrow, Mc Graw Hill.
5. Basic principles of Spectroscopy. R. Chang. Mc Graw Hill.
6. Theory and Applications of UV Spectroscopy, H.H. Jaffer and M. Orchin. IBH-oxford.
7. Introduction to Photoelectron Spectroscopy. P.K. Ghosh. John Wiley.
8. Introduction to Magnetic Resonance, A Carrington and A.D. Maclachalan, Harper &Row.

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Semester	Semester VIII, Paper-V (Practical)	
Course Code	B020805P	
Course Title	Practical	
Credit	4	Maximum Marks : 25+75

Course Objective:

- Gravimetric & volumetric estimation
- Preparation of inorganic compound
- Quantitative determination
- Saponification
- Determination of velocity constant
- Calculation of order of reaction
- Determination of solubility & solubility products electrolytes
- Determination of BOD, COD & DO

- **Learning Outcomes:** Upon successful completion of this course students should be able to: - Separate metal ions through gravimetric& volumetric method, preparation of inorganic compound.
- Determination of the percentage hydroxyl groups in an organic compound of organic compounds through acetylation methods.
- Determination of velocity constant order of reaction & energy of activation of saponification value of oil.
- Determination of DO, *COD* and BOD of water sample.
- Determination of solubility & solubility product, strength of strong weak acids by conductometrically.
- Determination of order of reaction & activation of energy

Syllabus

Unit	Course Content
I	**Inorganic Chemistry** Preparation of selective inorganic compounds (any one) (a) $VO(acac)_2$ (b)$Na[Cr(NH_3)_2(SCN)_4]$ (c)$K_3[Fe(C_20_4)_3]$ (d)Prussian Blue (e)$[Co(Py)_2Cl_2]$ (f) $[Cu(NH_3)_4]SO_4.H_2O$
II	**Organic Chemistry** Quantitative Synthesis (Any Two) 1. Determination of the percentage or number of hydroxyl groups in an organic compound by acetylation method. . 2. Estimation of amine phenols using bromate bromide solution or acetylation method. 3. Determination of iodine and saponification values of an oil sample.
III	**Physical Chemistry (Any one)** 1. Determination of molecular weight of nonvolatile and nonelectrolyte/electrolyte by cryoscopic method and to determine the activity coefficient of an electrolyte. 2. Determination of the degree of disskiation of weak electrolyte and to study the deviation from ideal behavior that occurs with a strong electrolyte. 3. Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically. 4. Determination of solubility and solubility product of sparingly soluble salts (e.g PbSO4, BaSO4) conductometrically. 5. Determination of the strength of strong and weak acids in a given mixture conductometrically

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IV	**Qualitative and Quantitative Analysis** 1. Either both gravimetric and volumetric estimation of two metal ion from following mixtures: (a) Cu^{+2} and Ni^{+2} (b) Cu^{+2} and Zn^{+2} (c) Ni^{+2} and Zn^{+2} (d) Ba^{+2} and Ag^{+2} 2. Determination of DO, COD and BOD of water sample.

References:

Lab 1 :htpp://uou.ac.in
Advance Practical Inorganic by Gurdeep Raj, Krishna Publication.
Advance Practical Chemistry by J. Singh. Pragati Prakashan.

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