DR. BHIM RAO AMBEDKAR UNIVERSITY
AGRA

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NATIONAL EDUCATION POLICY-2020

STRUCTURE AND SYLLABUS OF CHEMISTRY

For

Post Graduate (PG) Programme
Effective From Academic Session 2025-26

DR. BHIM RAO AMBEDKAR UNIVERSITY, AGRA

BOARD OF STUDIES – CHEMISTRY
MINUTES OF MEETING

Meeting of Board of Studies of Chemistry was held on **10**/09/2025 at Academic Department Paliwal Park .Dr.B.R.Ambedkar University , Agra, on the agenda: Inclusion of Chemistry Practicals in VIIth to Xth Semesters of P.G.Classes " Following members attended the meeting –

S. No.	NAME	DESIGNATION	AFFILIATION
MEMBERS OF BOARD OF STUDIES			
	Dr.Shalini Pandey	**Convener of BOS**	**Department of Chemistry, Shri Chitragupt College, Mainpuri.**
1.	Km. Rita Dixit	Associate Professor	Department of Chemistry, M.G,B.V.(PG) College, Firojabad
2.	Prof. Lalit Pal Singh,	Professor	Department of Chemistry, R.B. S. College, Agra
3.	Prof. Harikant	Professor	Department of Chemistry, R.B.S.College, Agra
4.	Dr.Neelesh Pandey	Associate Professor	Department of Chemistry, B.S.A. College, Mathura
5.	Prof. Kalpana Chaturvedi	Professor	Department of Chemistry, Agra College, Agra
6.	Prof. Nisha Rathore	Professor	Department of Chemistry, K.R.P.G.College, Mathura

All the above members recommended the following:

In the Fourth & Fifth Year of Higher Education, the currently running M.Sc. Chemistry Syllabus will remain applicable with certain modifications in its Structure and Syllabus.

Chemistry Practicals will be included in all four semesters (**VIIth** to **Xth**) of the P.G. Chemistry programme , effective from the upcoming academic session (2025-26).

The distribution of credits between theory and practical will be reorganized to maintain a balanced academic load across all semesters.

All the above amendments will be applicable only to the students admitted in the Academic Session 2025-26 in Semester VIIth of Higher Education. All other students will complete their courses as per the previous rules.

Minor Papers related to the Syllabus of Chemistry, that can be opted through Swayam Portal were also discussed.

Purpose of the Program

The purpose of the M.Sc. Program at the University is to provide the key knowledge of various disciplines in Chemistry and on Advances in this field. To prepare students for careers as professional in various Research Institutes and Industries.

STRUCTURE OF CHEMISTRY COURSE IN FOURTH YEAR OF HIGHER EDUCATION FOR DEGREE IN BACHELOR(Research) OF SCIENCE IN CHEMISTRY					
YEAR	**SEMESTER**	**COURSE CODE**	**PAPER TITLE**	**PAPER NATURE**	**CREDIT**
FOURTH	VII	**B020701T**	Computer for chemists	Theory	**4**
		B020702T	Inorganic Chemistry	Theory	4
		B020703T	Organic Chemistry	Theory	4
		B020704T	Physical Chemistry	Theory	4
		B020705T	Adulterant in Foods (Minor For Other Faculty)	Theory	4
		B020706P	Chemistry Practical	Practical	4
		B020707R	Dissertation in Chemistry*	Research	
	VIII	**B020801T**	Group Theory and Spectroscopy	Theory	4
		B020802T	Bio-Inorganic Chemistry	Theory	4
		B020803T	Bio-Physical Chemistry	Theory	4
		B020804T	Spectroscopic Methods of Analysis	Theory	4
		B020805P	Chemistry Practical	Practical	4
		B020806R	Dissertation in Chemistry*	Research	8
Dissertation In Chemistry of both the Semesters (VII and VIII) will be jointly evaluated at the end of the Semester VIII as per University Guidelines					

Students of Science Faculty may choose MINOR paper from Faculty of Commerce/Arts, Humanities and Social Sciences /Languages/Fine Art and Performing Art/ Education/ Rural Science.

SEMESTER-VII

B020701T **COMPUTER FOR CHEMISTS** **M.M. 75**

Credits-04

Unit 1: History of Development of Computer, Classification of Computers, Generation of Computers, General Awareness of Computer Hardware – CPU and other peripheral devices, Input, Output and Auxiliary Storage Devices

Unit II: Softwares and their types(System Software & Application Software), Computer Language and their types (Low Level & High Level Languages), Operating System, requirement of OS, Types of OS : Single User and Multi-user OS with example

Unit III: **Computer and Internet 1:** What is Networking, Different types of Networking (LAN, WAN and MAN), Optical Fibres, Ethernet, Network Interface Card, Hub, Switch, Routers, Modems, Protocols TCP/IP, Internet Service Providers (ISP), Web Search Engine, Intranet, Difference between Internet & Intranet

Unit IV: Educational and Research Resources on Net for Chemical Sciences, Online Tutorials and Lectures Virtual Labs, Electronic Journals, E-books, Digital Libraries, Use of Chemdraws like tools for Chemical Education.

Unit V: MS Word, facilities in MS Word, MS- Excel, Facilities in MS Excel,MS PowerPoint, Oral Presentations using visual aids such as Power Point etc. Adobe Photoshop (Introductory), Multimedia, Digital Arts.

Books Suggested:

1. Computer Fundamentals,(Concepts,systems and Applications),Pradeep K. Sinha,PritiSinha, BPB Publications
2. Computer Basics,G. Manjunath.Vasan Publications
3. Fundamentals of Computers,E. BalagurusamyE. Balagurusamy, McGraw Hill Education
4. Fundamentals of Internet Programming, Mir Shehzad Ahmad, Toronto Academic Press

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B020702T **INORGANIC CHEMISTRY** **M.M. 75**

Credit-4

Unit I: **Mechanism of Inorganic Reactions:**

Mechanisms of redox reactions of metal complexes, Substitution reactions of octahedral and square planar complexes in aqueous solutions, cis-and trans effects.

Unit II: **Nuclear Chemistry**:

Radioactive decay and equilibrium, Nuclear reactions and its types, Q-value, cross section of reactions, chemical effects of nuclear transformation. Nuclear fission–Fission products, Fission Yield and Nuclear Reactors, Nuclear Fusion and Stellar energy.

Radioactive techniques –(1) Tracer techniques (neutron activation analysis),

(2) Counter techniques such as G.M., Ionization and proportional counters.

Unit III: **Metal clusters**:

Cluster compounds; Introduction, classification of clusters, Diborane- structure and properties. Higher boranes- Introduction, classification, STYX rule, classification and structure of carboranes. Metalloboranes and metallocarboranes, isolobal analogy. Metal carbonyl and metal halide clusters- Introduction, classification and structures. Zintel ions, Wade's rule, LNCC & HNCC, Caping rule

Unit IV: **Chemistry of Macrocycles :**

Complexes of crown ethers, porphyrins and cryptands, their synthesis, important characteristics With special reference to hole size and importance in biological systems.

Unit V: **Metal Π-Acid Complexes**

Metal Carbonyls: Structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidations, important reactions of metal carbonyls, preparation, bonding, structure and important reactions of transition metal nitrosyls,

Books Suggested:

1, Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson , John Wiley.

2 .Inorganic Chemistry, J.E. Huhey, Harpes& Row.

3. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.

4. Comprehensive Coordination Chemistry Eds G.Wilkinson, R.D. Gillars and J.AMcCleverty,Pergamo

5. Nuclear Reactions R. Singh & S. N. Mukherjee, New Age International. New Delhi.

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B020703T **ORGANIC CHEMISTRY** **M.M. 75**

Credits-04

Unit-I: (a) **Delocalized chemical bonding** –conjugation, cross conjugation, resonance, hyperconjugation, tautomerism.

(b) **Reaction intermediates-** Generation, geometry, stability and reactions of carbocations, carbanions, free radicals, carbenes, nitrenes and benzynes.

Unit-II: **Substitution reactions:**

Electrophilic substitution reactions in aromatic and aliphatic compounds with their mechanism, Nucleophilic aliphatic and aromatic substitutions reactions.SN^1, SN^2 mechanisms, neighbouring group participation in aliphatic nucleophilic substitutions, Factors affecting the nucleophilicsubstitution reactions

Unit- III: **Elimination reactions:**

The E^1, E^2, E^1CB mechanisms, orientation in E^2 reactions (Saytezeff and Hoffman), Pyrrolyticsyn-elimination, Stereochemistry of elimination reaction.

Unit- IV: **Common Organic Reaction and Mechanism**

Aldol, Perkin, Diekmann condensation, Reformatsky, Benzoin, Wittig, Mannich reaction, Michael reaction, Diels-Alder reaction, Knoevengel reaction.

Unit- V: **Reagents in Organic Synthesis:**

Lithium aluminium hydride, Sodium borohydride, lithium dialkylcuprate, lithium di-isopropylamine, Grignard reagents, mono &dialkylboranes, 1,3-Dithiane, m-chloroperoxybenzoic acid, Osmium tetraoxide. dicyclohexylcarbodimide, N- bromosuccinimide.

Books Suggested:

1. Organic Reagents and Name Reactions Samuel Delvin, Ivy Publishing House
2. Experiments and Techniques in Organic Chemistry, D. Pasto. C. Johnson and M. Miller, Prentice Hall.
3. Organic Reaction Mechanisms, V.K. Ahluwalia&Rakesh K. Parashar,Narosa Publishing House. .
4. Systematic qualitative Organic Analysis, H. Middleton, Adward Arnold.
5. Organic Reaction Mechanisms by Raj K. Bansal, New Age International Private Limited
6. Organic Reactions and Their Mechanisms by P S Kalsi, New Age International Private Limited
7. Reaction and Reagents ,O.P.Agrawal, Krishna Publication, Meerut.

B020704T **PHYSICAL CHEMISTRY** **M.M.75**

Credits-04

Unit-I: Quantum Chemistry:

Approximation Method:The variation theorem, Linear variation principles, Perturbation theory (First order and non degenerates), application of variation method and perturbation theory to be helium molecule.

Unit-II: Thermodynamics:

Chemical thermodynamics ,second law of thermodynamics .Gibbs Helmholtz equation,Direction of reaction,Third law of Thermodynamics, Concept of Entropy at absolute zero,Nernst heat eqation.

Statistical thermodynamics-Partition functions,Application of partition function to determine chemical equilibrium and equilibrium constant , Bose-Einstein and Fermi-Diarc statistics basic ideas.

Unit-III: **Chemical Dynamics:** Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and the activated complex theory, ionic reaction, kinetic salt effects, steady state kinetics, kinetics and thermodynamic control of reaction, treatment of unimolecular reactions. Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde decomposition of ethane, Photochemical (hydrogen-bromine and hydrogen-chlorine reactions)

Unit-IV: **Micelles:** Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factor-affecting the CMC of surfactants.

Macromolecules: Polymer-definition, types of polymers, electrically conducting, fire resistant, liquid crystals polymers, kinetics of polymerization, mechanism of polymerization.

Unit-V: **Electrochemistry:** Electrochemistry of solution, Debye-Huckel-Onsager treatment and its extension, ion solvent interaction, Debye-HuckelJerum mode, thermodynamic of electrified interface equation, over potential, exchange current density.

Book Suggested:

1. Physical chemistry, P.W. Atkins, ELBS
2. Introduction to Quantum chemistry, A.K. Chandra, Tata McGraw Hill.
3. Quantum chemistry, Era N Levine, Prentice Hall.
4. Coulson's Valence, R. McWeeny, ELBS.
5. Chemical Kinetics, K.J. Laidler, McGraw- Hill.
6. Kinetics and mechanism of chemical transformations, J. Rajaraman and J. Kuriacose, McMillan.
7. Micelles, Theoretical and applied aspect, V. Moroi, Plenum.
8. Modern electrochemistry, Vol. 1 and Vol. 2, J.O.M. Bockris and A.K.N. Reddy, Plenum.

B020705T **ADULTRATION IN FOODS** **M.M.75**

(Minor for Other Faculty) **Credits-04**

Unit-1 Introduction

Food and food for life, adulteration, types of adulteration, identification of adulterants. adulteration, problems, Common adulterants, in food and their injurious effects on health.

Unit-II Detection of adulterants

Qualitative Analysis: Qualitative macro,semi-micro and micro techniques involving wet chemical tests, flame Tests.etc.,microscopic examinations .

Quantitative Analysis: Titrametric and gravimetric methods, instrumental methods.

Unit-III Materials to be analysed

Milk analysis; detection of added water, neutrializers. Hydrogen peroxide, formalin, sugar, urea, ammonium sulphate, salt, pulverized soap, detergents, skim milk powder,vegetable fat, benzoic acid, salicylic acid, boraxm borax, boric acid and buffalo milk in cow's milk.

Khoya and Sweet analysis; Detection of starch(maida etc.) aluminium foil replacing silver foil in sweets, Detection of washing powder in ice cream.

Spice analysis ; detection of added starch, lead chromate, Metanil yellow in turmeric powder, powdered dung in coriander powder, identification of artificially coloured foreign seeds shown as cumin seed, poppy seed and black pepper.

Unit-IV False labeling and fake products in food packets; How to read a food label, elements of a food label, list of ingredients, terms used in food label, market survey and analysis of packaged products/materials. Hazards of reckless use of faulty food preservatives in food products.

Unit-V Creation of public awareness; Dissemination of information about the "food safety and standard (Packaging and Labelling) Regulations, Act 2011".Creation of consumer awareness for checking food adulteration and about fake and spurious products through print and view media.

B020706P **M.Sc. CHEMISTRY Practical (Semester VII)** **M.M.100**

Credits-04

INORGANIC CHEMISTRY

Inorganic Preparations: [25]

(i) Reineckel Salt /Ammoniumdiamminetetrathiocyanatochromate(II)$NH_4[Cr(NH_3)_2(SCN)_4]$
(ii) Tetraamine Cupric Sulphate$\{CU(NH_3)_4]SO_4.H_2O$
(iii) Chrome Alum
(iv) Aluminium Chloride Hexahydrate
(v) Nickel Dimethyl Glyoxime $[Ni(dmg)_2]$
(vi) Sodium Cobalt Nitrate
(vii) Potassium Trioxalato Ferrate (III),$K_3[Fe(C_2O_4)_3]$
(viii) *Cis*-Potassium DioxalatoDiaqua Chromate
(ix) *Trans*-Potassium DioxalatoDiaqua Chromate $K[Cr(C_2O_4)(H_2O)_2].2H_2O$
(x) Prussian Blue/Turnbull's Blue $KFe^{III}[Fe^{II}(CN)_6]$
(xi) Hexaamminecobalt(III)hexanitritocobaltate(III),$[Co(NH_3)_6][Co(NO_2)_6]$
(xii) Tris(acetylacetonato)Manganese(III), $Mn(acac)_3$

ORGANIC CHEMISTRY

Qualitative Analysis: [25]

Separation, Purification and Identification of compounds of binary organic mixtures (solid-solid,soid-liquid, liquid-liquid).

PHYSICALCHEMISTRY

[25]

(1) To estimate hardness of water by ethylene diamine tetra-acetic acid (EDTA).

(2) To determine the specific reaction rate of the hydrolysis of methyl acetate/ ethyl acetate catalyzed by hydrogen ions at room temperature.

(3)To titrate the given mixture of CO_3 and HCO_3 ions against a strong acid (HCl) using p-meter and to determine the strength of it.

(4) Preparation of standard solution.

(5) To test the validity of lambert-Beer's Law (using methylene blue) and to determine

I. λmax
II. Molar extinction coefficient (€)

RECORD [15]

VIVA [10]

SEMESTER-VIII

B020801T **GROUP THEORY AND SPECTROSCOPY** **M.M.75**

Credits-04

Unit-I: Symmetry elements and symmetry operation,

Symmetry elements and symmetry operations, point groups and their classification with examples, sub groups. General methods of assigning point groups to molecules with different shapes like Linear, Bent, Trigonal planar, Trigonal pyramidal, Tetrahedral, Trigonal bipyramidal. Octahedral, Square pyramidal, Square planar etc.

Unit-II Vibrational spectroscopy

Basic principles of vibrational spectroscopy of homonuclear and heteronuclear diatomic molecules. Selection rules for diatomic molecules based on Harmonic oscillator approximation. Force constants and amplitudes. Anharmonic oscillator.Overtones and combination bands.Vibration-rotation spectra, P, Q and R branches.Breakdown of the Born-Oppenheimner approximation.

Unit-III: Electronic Spectroscopy

Introduction,Franck-Condon Principle, theory involving electronic transition and applications, spectra of transition metal complexes, charge-transfer spectra.

Unit-IV: Atomic absorption spectroscopy: Introduction, principle, technique instrumentation and applications

Unit-V: Flame photometry:

Introduction, principle, technique, instrumentation, interference and applications

Books Suggested:

1. Modern spectroscopy, J.M. Hollas, John Willey.
2. Applied Electronic Spectroscopy For Chemical Analysis. Ed.H, Windawi and F.L. Ho, Wiley Interscience.
3. Introduction to Molecular Spectroscopy, G.M. Barrow, Mcgraw Hill.
4. Basic Principles of Spectroscopy, R. Chang. McGraw Hill.
5. Theory and Application of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBHOxford.
6. Introduction of Photoelectron Spectroscopy, P.K. Ghosh, John Wiley.
7. Introduction of Magnetic Resonance, A. Carrington and A.D. Maclachlan, Harper and Row

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B020802T **BIO-INORGANIC CHEMISTRY** **M.M.75**

Credits-04

Unit-I: **Metal ions in biology:**
Molecular mechanism of ion transport across membranes sodium and potassium pump, Essential and trace elements.

Unit-II: **Biomolecules:**
Structures and functions of metalloproteins in electron transport process -cytochromes and Iron-Sulphur proteins, DNA polymerisation, glucose storage.

Unit-III: **Bio-inorganic pigments:**
Chlorophyll, Photosystem-I and Photosystem-II in cleavage of water, haemoglobin, myoglobin, haemocyanin and hemerythrin.Storage of oxygen and its transport.

Unit-IV: **Bio-Chemistry:**
Biochemistry of calcium, copper and zinc.Biological Nitrogen fixation (Associative nitrogen fixation, symbiotic nitrogen fixation).

Unit-V: (a) Toxicity of metals (cadmium, mercury, lead, arsenic, copper). Deficiency of Metal ions
(b) Medicinal Inorganic chemistry- Metal ions and chelating agent in medicines. Drug activity, control of metal ion concentration, *In vivo* removal of metal ions, Antimicrobial drugs, anticancer drugs.

Books Suggested:

1. Progress in Inorganic Chemistry, vol. 18 and 38 Ed. J J. Lippard, Wiley.
2. Inorganic Biochemistry vol. I and II ed. G. L. Eichhorn, Elsevier.
3. Principles of Bioinorganic Chemistry, S. J. Lippard and J. M. Berg, University Science Books.

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B020803T **BIO- PHYSICAL CHEMISTRY** **M.M.75**

Credits-04

Unit-I: **Enzymes:**

Introduction, nomenclature and classification, Fischer lock and key: Koshland and Induced hypothesis: Transition state theory, acid base catalysis, Nucleophilic displacement on phosphorous atom. Multiple displacement reaction and the coupling of ATP, cleavage to endergonic processes, Addition and Elimination reaction of enzyme catalyzed carboxylation and decarboxylation

Unit-II **Coenzymes:**

Apoenzymes, structure and biological function of coenzymes, production, purification of enzymes, methods of immobilization of enzyme activity, application of immobilized enzymes, clinical use of enzymes

Unit-III **Bio-energetics:**

Standard and free energy change in biochemical reactions, exergonic endergonic, hydrolysis of ATP, synthesis of ATP from ADP

Unit-IV **Cell membranes and Transport of ions:**

Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamics treatment of membrane transport, nerve conduction.

Unit-V **Biopolymer Interactions:**

Forces involved in biopolymer interactions, electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interaction, multiple equilibrium and various types of binding processes in biological systems.

Books Suggested:

1. Understanding enzymes, Trevor Palmer, Prentice Hall.
2. Enzyme Mechanisms Ed, M. I. Page and A. Williams, RSC.
3. Fundamental ofEnzymology, N. C. Price and L. Stevens, Oxford University Press.
4. Biochemistry, L. Stryer, W.H. Freeman.
5. Macromolecules: Structure and Function, F. Wold. Prentice Wall. 6. Biochemistry, Voet and Voet, John Wiley

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B020804T **SPECTROSCOPIC METHODS OF ANALYSIS** **M.M.75**

Credits-04

Unit I: **Absorption spectroscopy**

Lambert's Beer's Law and its limitations. Instrumentation.Selection rules, Types of electronic transitions, λmax, chromophores and auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Woodward rule for conjugated dienes and carbonyl compounds, applications.

Unit II: **Raman Spectroscopy**

Classical and quantum theories of Raman Effect, pure rotational vibrational and vibrational-rotational, Raman spectra, Selection rules, Mutual exclusion principle, Resonance Raman spectroscopy, Coherent anti stokes raman spectroscopy (CARS)

Unit III: **Nuclear magnetic resonance spectroscopy** (NMR):

Introduction, Theory, relaxation process and saturation, environmental effects on NMR spectra, chemical shift, spin-spin splitting, factors influencing coupling constant 'J', Spin decoupling, basic ideas about instrument, NMR studies of nuclei other than proton ^{13}C, FT-NMR advantages of FT-NMR, use of NMR in medical diagnostics.

Unit IV: **Mass Spectrometry:**

Introduction, molecule ion peak, base peak, isotopic abudance, metastable ions fragmentation mechanism of compounds containing C,H,O,N and halogen, McLafferty rearrangement , nitrogen rule and ring rule and applications.

Unit V: **ESR Spectroscopy:**

Introduction, principle, hyperfine splitting, and significance of g-value, determination of δ - value.Rules for hyperfine splitting and applications.

Books Suggested:

1. Modern spectroscopy, J.M. Hollas, John Willey.
2. Introduction to Molecular Spectroscopy, G.M. Barrow, Mcgraw Hill.
3. Basic Principles of Spectroscopy, R. Chang. McGraw Hill.
4. Theory and Application of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBHOxford.
5. Introduction of Magnetic Resonance, A. Carrington and A.D. Maclachlan, Harper and Row.
6. Spectrometric identification of Organic Compounds, R.M. Silverstein, G. C. Bassler, T. C. Morril, John Wiley & Sons,

B020805P **M.Sc. CHEMISTRY Practical (Semester VIII)** **M.M.100**

Credits-04

INORGANIC CHEMISTRY

Quantitative Analysis: [25]

Separation and determination of two metal ions Cu-Ni, Ni-Zn, Cu-Zn, etc. involving volumetric and gravimetric methods.

ORGANIC CHEMISTRY

Organic Synthesis: [25]

Sulphonation, Diazotization, Aldol Condensation, Friedel Crafts Reaction, Cannizzaro Reaction, Acetylation, Benzoylation, Nitration.

PHYSICALCHEMISTRY [25]

(1) To study the distribution co-efficient of benzoic acid between benzene and water.
(2) To determine the distribution co-efficient of iodine between water and CCl_4 at room temperature.
(3) To determine the amount of chloride ions present in the given KCl solution.
(4) To determine nickel as dimethyl glyoximate complex spectrophotometrically.
(5) Determination of proton coefficient between water and an organic solvent.

RECORD **[15]**

VIVA **[10]**

FOURTH YEAR (VII & VIII SEMESTER)		
COURSE CODE	**TITLE OF PAPER**	**CREDITS**
B020707R	Dissertation in Chemistry	04
B020806R	Dissertation in Chemistry	04

RESEARCH PROJECT

M.M.100

Credits-08

The research project is based on the following topics –

1. Coordination Chemistry
2. Macro Cyclic Chemistry
3. Green Chemistry
4. Nano Chemistry
5. Pesticide Chemistry
6. Polymer Chemistry
7. Polymer Nano Composite
8. Environmental Science
   i. Air Pollution
   ii. Soil Pollution
   iii. Water Pollution
9. Natural Products
10. Synthetic Organic Chemistry
11. Drug Chemistry
12. Industrial Chemistry

STRUCTURE OF CHEMISTRY COURSE IN FIFTH YEAR OF HIGHER EDUCATION FOR

DEGREE IN MASTER OF SCIENCE IN CHEMISTRY

YEAR	SEMESTER	COURSE CODE	PAPER TITLE		PAPER NATURE	CREDITS
FIFTH YEAR	IX	B020901T	Photo and Stereochemistry		Theory	4
		B020902T	Solid State Chemistry, surface Phenomenon and Chemical Equilibria		Theory	4
		B020903T	Coordination Chemistry		Theory	4
		B020904T	Basic Analytical Chemistry	Choose any One	Theory	4
		B020905T	Chemistry of Natural Products		Theory	4
		B020906T	Polymer Chemistry		Theory	4
		B020907P	Chemistry Practical		Practical	4
		B020908R	Research Project		Research	
	X	B021001T	Interdisciplinary Topics		Theory	4
		B021002T	Separation Techniques		Theory	4
		B021003T	Advanced Analytical Methods		Theory	4
		B021004T	Advanced Inorganic Chemistry	Choose any One	Theory	4
		B021005T	Advanced Organic Chemistry		Theory	4
		B021006T	Advanced Physical Chemistry		Theory	4
		B021007T	Chemistry Practical		Practical	4
		B021008T	Research Project		Research	8

PG Dissertation In Chemistry of both the Semesters (IX and X) will be jointly evaluated at the end of the Semester X as per University Guidelines

B020901T **PHOTO AND STEREOCHEMISTRY** **M.M. 75**

Credits-04

Unit-I: General principles- Photochemical energy, Frank-Condon principle, Jablonski diagram, singlet and triplet states, photosensitization, quenching, quantum efficiency and quantum yield, energy transfer process in photochemistry, experimental methods of photochemistry.

Unit-II: Photochemistry of carbonyl compounds, Norrish type-I and Norrish type-II cleavages, Paterno-Buchi reactions, photoreductions, photochemistry of unsaturated systems like olefins, cis-trans isomerisation, dimerizations, hydrogen abstraction, addition. Photochemistry of enones-rearrangement of unsaturated ketones and cyclohexadienones.

Unit-III: A) Concept of chirality, elements of symmetry, R-S nomenclature, E-Z isomerisms. Interconversion of Fischer, Newman and Sawhorse projections

B) Conformation and reactivity in acyclic compound (upto four C-atoms) and cycloalkanes (upto cyclohexane)

C) Transannular effects in medium sized ring compounds.

Unit-IV: Molecular dissymmetry and chiroptical properties, linear and circularly polarized light, circular birefringences and circular dichroism, ORD and CD curves. Plain and Cotton effect curves and their applications. The octant rule and axial haloketone rule with applications

Unit-V: A) Racemates and their classification, method of resolution of recemates.

B) Chemoselectivity, regioselectivity, stereoselective, stereospecific reactions and enantioselectivity with examples.

Books Suggested:

1. Fundamental of Photochemistry, K. K. Rohtagi-Mukherji, Wiley-Eastern.
2. Molecular Photochemistry, N.J. Turro, W. A. Benjamin.
3. Organic Photochemistry, J. Coxon and B. Halton, Cambridge University Press.
4. Photochemistry, R P. Kundall and A. Gilbert, Thomson Nelson
5. Stereoselective Synthesis: A Practical Approach M.Nogradi, VCH.

B020902T **SOLID STATE CHEMISTRY, SURFACE PHENOMENON AND CHEMICAL EQUILIBRIA.** **M.M.75**

Credits-04

Unit-I : Solid State

Crystalline state of solids, unit cells and Bravais lattices, Miller indices, Diffraction of X-rays by crystalline solids, fundamental aspects of X-ray, electron and neutron diffraction studies

Unit-II: Crystal Defects and Non- Stoichiometry

Perfect and imperfect crystals, intrinsic and extrinsic defects-point defects, line and plane defects, vacancies-Schottky defects and frenkeldefects, structural imperfections and properties of solids such as ionic conductivity, diffusion, ferroelectric properties and luminescence, non-stiochiometry and defects.

Unit-III: Electronic properties and Band theory

Metals, insulators and semiconductors, electronic structure of solids-band theory, band structure of metals, insulators and semiconductors, intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, superconductors,

Unit-IV: Surface Phenomenon

Surface tension, adsorption on solids, electrical phenomena at interfaces, including electrokinetic, micelles and reverse micelles: solubilization, micro-emulsion, application of photoelectron spectroscopy, ESCA and Auger spectroscopy to the study of surfaces.

Unit-V: Chemical Equilibria

Free energy and entropy of mixing, partial molar quantities, Gibbs- Duhemequation.Equilibrium constant, temperature- dependence of equilibrium constant, phase diagram of one- and two component systems, phase rule.

Books Suggested:

1. Solid State Chemistry and its Application, Anthony R. West, Wiley Publication, US
2. Solid State chemistry an Introduction, Lesley E.Smart and Elaine A.Moore,Taylor and Francis,London.
3. Principles of Physical Chemistry, Puri, Sharma and Pathania, Vishal Publising, Delhi

B020903T **COORDINATION CHEMISTRY** **M.M.75**

Credits-04

Unit I: Crystal field theory, crystal field splitting of d-orbitals in octahedral,tetrahedral and square planar complexes, crystal field stabilization energy (CFSE) in octahedral (weak and strong fields) and tetrahedral complexes, factor affecting CFSE and uses of CFSE, spectrochemical series.

Unit-II: **(a)** Applications of CFT in colour of transition metal complexes, limitations of CFT, valence bond theory and comparison of VBT and CFT.

(b) Ligand field theory, evidences of covalance and adjusted crystal field thery (ACFT), molecular orbital treatment of octahedral complexes and bonding, molecular orbitals for tetrahedral and square planar complexes, spin cross over coordination compounds.

Unit III: Coordination chemistry of transition metal ions, stability constants of complexes and their determination; stabilization of unusual oxidation states. Stereochemistry of coordination compounds.Jahn-Teller effect; Interpretation of electronic spectra including charge transfer spectra; nephelauxetic series, magnetism: Dia -, para -, ferro – and anti-ferromagnetism quenching of orbital angular moment, spin orbit coupling.

Unit-IV: Inorganic reaction mechanism; substitution reactions, trans effect and electron transfer reactions, photochemical reaction of chromium and ruthenium complexes. Fluxional molecules, iso- and heteropoly acid, metal clusters spin crossover in coordination compounds.

Unit-V: **Studies and Applications of Lanthanides andActinides:**

Spectral and magnetic properties, Modern methods of separation of lanthanides and actinides. Organometallic compound of lanthanides, Applications of lanthanides and actinides compounds in industries. Use of lanthanides compounds as Shift's reagent.

Books Suggested:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson , John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harpes& Row.
3. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
4.Comprehensive Coordination Chemistry EdsG.Wilkinson, R.D. Gillars and J.AMcCleverty,Pergamo
5. Synthesis and Characterization of Inorganic compounds, W.L. Jolly, Prentice Hall.

BO20904T **BASIC ANALYTICAL CHEMISTRY** **M.M. 75**

(Elective-1) **Credits-04**

Unit-I: **Amperometry:** Introduction, principle, types of current, technique, amperometric titrations with DME, amperometric titrations with rotating platinum micro electrode, biampero-metry, applications.

Unit-II: **Coulometry:** Introduction, constant current coulometry, controlled potential coulometry (principle and technique), types of coulometer, applications.

Unit-III: **Conductometry:** Introduction, principle, technique, electrolytic conductivity, measurement of electrolytic conductivity, conductometric titration, applications.

Unit-IV: **Polarography :**Introduction, principle, instrumentation, Ilkovic equation and its verification, half-wave potential and their Significance, D.M.E., residual current, migration current, diffusion current, limiting current, applications.

Unit-V: **Voltammetry :** (a) Introduction, principle, technique and applications

(b)Cyclic voltammetry and anodic stripping voltammetry.

Books Suggested

1. Instrumental Method of Chemical Analysis, B.K. Sharma, Krishna Prakashan, Media, Meerut.
2. Instrumental Method of Chemical Analysis, GurdeepChatwal, Himalaya Publication House, New Delhi.
3. Instrumental Method of Chemical Analysis, H. Kaur, PragatiPrakashan, New Delhi
4. Instrumental Method of Analysis, Willard, Meritt, Dean,Wadsworth Publishing Co. Inc, Australia
5. Basic Concept of analytical Chemistry, S.M. Khopkar,New Age International Publisher, New Delhi.
6. Fundamental of Analytical Chemistry, Holler and Crouch, Brooks Cole, US

B020905T **CHEMISTRY OF NATURAL PRODUCTS** **M.M.75**

(Elective-2) **Credits-04**

Unit-I: **Plant Pigments:**

Introduction, occurrence, general methods of structure determination, isolation and synthesis of apigenin, luteolin, vitexin, myrcetin, quercetin, lycopene, aureusin, cyanidin, hirostidin.

Unit-II: **Alkaloids**:

Introduction, classification, occurrence, isolation of alkaloids, general methods of determination of structure of alkaloids, Constitution and synthesis of cocaine, nicotine, atropine, morphine, reserpine.Biosynthesis of alkaloids.

Unit –III: **Terpenoids and Carotenoids:**

Introduction, classification, occurrence, general methods of structure determination, isoprene rule, constitution and synthesis of citral, zingiberene, farnesol, β- carotenoids, Biosynthesis of terpene.

Unit-IV: **Steroids**:

Introduction, classification, occurrence, isolation, constitution and synthesis of cholesterol, testosterone, progesterone, androsterone. Biosynthesis of steroid.

Unit-V: **Antibiotics:**

Introduction classification, synthesis of penicillin-G, penicillin-V, amoxycillin, tetracyclin, chloramphenicol, streptomycin.

Books Suggested:

1. Natural Products: Chemistry and Biological Significance J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope an J.B. Harborne, Longman Essex

2. Organic Chemistry, Vol 2, I L. Finar. ELBS.

3. Rodd's Chemistry of Carbon Compounds, Ed, S. Coffe Elsevier.

4. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Ed. Kurt Hostettmann, M.P. Gupta and A. Marston, Harwood Academic Publishers.

5. Introduction to Flavonoids, B.A. Bohm, Harwood Academic Publishers.

6. New Trends in Natural Product Chemistry, Atta-Ur-Rahman and M.I. Choudhary, Harwood Academic Publishers.

7. Insecticides of Natural Origin, SukhDev, Harwood Academic Publishers

B020906T **POLYMER CHEMISTRY** **M.M.75**

(Elective-3) **Credits-04**

Unit-1 Basics Importance of polymers basic concepts; Monomers, repeat units, degree of polymerization, Linear, branched and network polymers, classification of polymers. Polymerization : condensation, addition, radical chain-ionic and co-ordination and copolymerization. Polymerization conditions and polymer reactions.Polymerization in homogeneous and heterogeneous systems.

Unit-II. Polymer Characterization Polydispersion - Average molecular weight concept. Number, weight and viscosity average molecular weights. Polydispersity and molecular weight distribution.The practical significance of molecular weight.Measurement of molecular weights.Endgroup, viscosity, light scattering, osmotic and ultracentrifugation methods Analysis and testing of polymers-chemical analysis of polymers, spectroscopic methods, X-ray diffraction study, Microscopy.Thermal analysis and physical testing-tensile strength.Fatigue.impact. Tear resistance. Hardness abrasion resistance.

Unit-III. Structure and Properties Morphology and order in cryststalline polymers-configurations of polymer chains. Crystal structures of polymers Morphology of cryststalline polymers, strain-induced morphology, crystallization and melting. Polymer structure and physical propertiescrystalline melting point Tm. melting points of homogeneous series, effect of chain flexibility and other steric factors, entropy and heat of fusion. The glass transition temperature, Tg relationship between Tm and Tg effects of molecular weight diluents, chemical structure, chain topology, branching and cross linking, property requirements and polymer utilization

Unit- IV. Polymer Processing Plastics, Elastomers and fibres. Compounding Processing Techniques; Calendering, Die casting, rotational casting.Film casting, injection moulding, blow moulding, extrusion moulding, thermoforming, foaming, reinforcing and fibre spinning.

Unit-V. Properties of Commercial Polymers Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins and silicon polymers. Functional polymers - Fire retarding polymers and electrically conducting polymers. Biomedical polymers-contact lens, dental polymers artificial heart, kidney, skin and blood cells.

Books Suggested:

1. Textbook of Polymer Science, F. W. Billmeyer. Jr.Wiley.
2. Polymer Science. V. R. Gowarikar, N.V. Viswanathan and J. Sreedhar, Wiley - Eastern.
3. Functional Monomers and Polymers , K. Takemoto, Y. Inaki and R.M. Ottanbrite.
4. Contemporary Polymer Chemistry, H.R. Alcock and F.W. Lambe, Prentice Hall.
5. Physics and Chemistry of polymers, J.M.G. Cowie, Blackie Academic and Professional.

B020907P **M.Sc. Chemistry Practical (Semester IX)** **M.M. 100**

Credit- 4

M.Sc. (Inorganic Chemistry) Practical **[25]**

1 **Qualitative analysis** [15]

Qualitative analysis of an inorganic mixture of seven radicals including Tl, Mo.W, Te, Ti, Zr, Th, V and U in addition to the radical prescribed for the B.Sc. Course .Semi micro analysis is to be done.

2. **Flame Photometric Determinations** [10]

(a) Sodium and Potassium when present together

(b) Li/ Ca/ Ba/ Sr

(c) Cd and Mg in tap water

M.Sc. (Organic Chemistry) Practical **[25]**

1. Extraction of Organic compounds from natural resources: (One exercise) [15]

(i) Isolation of lactose from milk.

(ii) Isolation of casein from milk.

(iii) Isolation of caffeine from tea leaves.

(iv) Isolation of β- carotene from carrot.

(v) Isolation of lycopene from tomatoes.

(vi) Isolation of cystine fromhuman hair.

(vii) Isolation of Nicotine from tobacco.

2.Paper chromatography, separation and Identification of sugars present in glucose, fructose, sucrose by paper chromatography and determination of Rf values / TLC. [10]

M.Sc. (Physical Chemistry) Practical **[12.5x2=25]**

A list of experiment under different headings are given below.

Typical experiments are to be selected from each type

1. Thermodynamics:

(i) Determination of partial molar volume of solute (e.g. KCl) and solvent in a binary mixture.

N. Pandey

(ii) Determination of the temperature dependence of the solubility of a compound in two solvents having similar intermolecular interaction (benzoic acid in water & in DMSO water mixture) and calculate the partial molar heat of solution.

2. Spectroscopy:

(i) Determination of pka of an indicator (e.g. Methyl red) in (a) aqueous and (b) micellar media

(ii) Determination of stoichiometry and Stability constant of inorganic (e.g. ferric-salicylin acid) and organic (e.g. amine iodine) complexes.

(iii) Characterization of the complexes by electronic and IR Spectral Data.

3. Electronics :

(i) Measurements of resistance with multimeter and calculate the colour code.

(ii) To measure the resistance of the given ammeter

RECORD [15]
VIVA [10]

SEMESTER-X

B021001T **INTERDISCIPLINARY TOPICS** **M.M. 75**

Credits-04

Unit I: Chemistry in Nanoscience and Technology

Introduction to nanotechnology scope of applications, Synthesis of nanomaterials: Top-down processes: physical processes- milling, lithographic processes, machining, vapour phase condensation, plasma assisted deposition; Bottom– up processes; micro emulsion technique. Important nano materials (Nano optics, Nano magnetic, Nano electronics) carbon nanotubes (types, properties and applications)

Unit II: Catalysis and Green Chemistry:

Need for green chemistry, Twelve principles of GreenChemistry with their explanation and examples, Designing a green synthesis using these principles reactions (dry media reactions, microwave assisted reactions, solvent free reactions),Green chemistry in day to day life.

Unit III: Supra Molecular Chemistry:

Introduction, concept and language, molecular recognition, supra molecular reactivity and catalysis, transport processes and carrier design.

Unit IV: Environment and Atmosphere:

Environmental chemistry, chemical composition of atmosphere – particles, ions and radicals and their formation. Heat budget of the earth atmospheric system, vertical stability of atmosphere, chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, O and their effect, Green house effect, acid rain, air pollution controls and their chemistry.

Unit V: Environmental chemistry (Hydrosphere and soils):

The chemical composition of water bodies like lakes, streams, rivers, wetlands, etc. Hydrological cycle.Aquatic pollution – inorganic, organic, pesticide, agricultural, industrial and sewage, detergents, oil spills and oil pollutants, water quality parameters, water quality standards, purification and treatments of waste. Soil composition, micro and macro nutrients, pollution – fertilizers and pesticides, waste treatment.

Books Suggested:

- A Text Took of Nanoscience and Nanotechnology, McGraw Hill Education, New York
- Principles of Physical Chemistry, Puri, Sharma and Pathania, Vishal Publising, Delhi
- New Trends in Green Chemistry, V.K. Ahluwalia, Springer, New York.
- Environmental Chemistry, H.Kaur, PragatiPrakashan, Meerut

B021002T **SEPARATION TECHNIQUES** **M.M. 75**

Credits-04

UNIT I- **AdsorptionChromatography:**

Thin-layer chromatography (TLC): Principle, methodology selection of stationary and mobile phases- preparation of plates, spotting, development, identification and detection, measurement of RF values, Qualitative and quantitative applications.

UNIT II- **Partition Chromatography:**

Paper chromatography (PC): Theory and principle; techniques: one, two dimensional and circular PC, mechanism of separation, structure of cellulose and types of paper, methodology, sample preparation, choice of solvents, location of spots and measurement of RF value, factors affecting RF values, advantages and applications

UNIT III- **Gas Chromatography (GC):** Principles, classification, experimental set up, special features, mechanism of separation procedures, advantages and disadvantages, and applications Plate theory, gas-solid and gas-liquid chromatography, Hyphened technique. GC-MS and its applications.

UNIT IV- **HPLC:** Principles, classification, experimental set up, special features, mechanism of separation procedures, advantages and disadvantages, and applications Super critical fluid chromatography, gel permeation chromatography and molecular sieves.

UNIT V- **Solvent Extraction:** Principles, classification, experimental set up, special features, mechanism of separation procedures, advantages and disadvantages, and applications Extraction equilibria, partition coefficient and extraction coefficient, extraction by chelation and salvation and salvation; solid-phase extraction (SPE)

Books Suggested:

1 Instrumental Method of Chemical Analysis, B.K. Sharma, Krishna Prakashan, Media, Meerut
2 Instrumental Method of Chemical Analysis, GurdeepChatwal, Himalaya Publication House, New Delhi
3 Instrumental Method of Chemical Analysis, H. Kaur, PragatiPrakashan, New Delhi
4 Instrumental Method of Analysis, Willard, Meritt, Dean,Wadsworth Publishing Co. Inc, Australia
5 Basic Concept of analytical Chemistry, S.M. Khopkar,New Age International Publisher, New Del

B021003T **ADVANCED ANALYTICAL METHODS** **M.M.75**

Credits-04

UNIT 1: **Data Analysis:** Errors, classification of errors, mean deviation and standard deviation, accuracy precision, rejection of measurements, confidence interval tests significance, minimization of errors and significant figures.

UNIT II: Principle, Instrumentation, Applications of Inductively Coupled Plasma(ICP) Spectroscopy.

UNIT III: Introduction,Principle, Instrumentation, Applications ofX-Ray Diffraction (XRD)

UNIT IV: Principle, Instrumentation, Applications of Scanning Electron Microscopy (SEM)& TEM

UNIT V: Thermogravimetric analysis (TGA): Principle, instrumentation, factors affecting TGA curve, differential thermal Analysis (DTA), instrumentation of DTA and application of DTA, simultaneous study of TGA, DTA with examples.

Books Suggested:

1. Instrumental Method of Chemical Analysis, B.K. Sharma, Krishna Prakashan, Media, Meerut
2. Instrumental Method of Chemical Analysis, GurdeepChatwal, Himalaya Publication House, New Delhi
3. Instrumental Method of Chemical Analysis, H. Kaur, PragatiPrakashan, New Delhi
4. Instrumental Method of Analysis, Willard, Meritt, Dean,Wadsworth Publishing Co. Inc, Australia

B021004T **ADVANCED INORGANIC CHEMISTRY** **M.M. 75**

(Elective-1)

Credits-04

Unit I- **(i)Transition metal π- complexes:** Transition metal π- complexes with unsaturated organic molecules, alkenes, alkynes, allyl, diene, dienyl, arene and trienyl complexes, preparations, properties, nature of bonding and structural features. Important reactions relating to nucleophilic and electrophilic attack on ligands and to organic synthesis.

(ii) Transition metal compounds with bonds to hydrogen.

Unit II- **(i)** Metal Storage Transport and Biomineralizations, Ferritin, Transferrin and Siderophores.

(ii)Calcium in Biology: Calcium in living cells, Transport and regulation, molecular aspects of intramolecular processes, extracellular binding proteins.

Unit III- **Metalloenzymes:** Zinc enzymes- Carboxypeptidase and carbonic anhydrase, Iron enzymes-catalase, peroxidase and cytochrome P-450. Copper enzymes-superoxide dismutase molybdenum oxatransferase enzymes-xanthine oxidase.Coenzyme Vitamin B_{12}.

Unit IV- **(i) Metal Nucleic Acid Interactions:** Metal ions and Metal complex interaction, metalcomplexes-nucleic acids.

(ii) Metal in Medicine: Metal deficiency and disease, toxic effect of metals, metals used for diagnosis and chemotherapy with particular reference to anticancer drugs.

Unit V- **Excited states of Metal Complexes:** Excited states of metal complexes comparison with organic compounds, electronically excited states of metal complexes, charge-transfer spectra, charge transfer excitations, methods for obtaining charge -transfer spectra.

Books Suggested:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson , John Wiley.

2. Inorganic Chemistry, J.E. Huhey, Harpes& Row.

3.Comprehensive Coordination Chemistry Eds .Wilkinson, R.D. Gillars and J.AMcCleverty,Pergamo

4. Synthesis and Characterization of Inorganic compounds, W.L. Jolly, Prentice Hall.

B0210051T **ADVANCED ORGANIC CHEMISTRY** **M.M.75**

(Elective-2) **Credits-04**

Unit I: **Heterocycles:**

Introduction, classifications, IUPAC names of mono and bicyclic hetero aromatic compounds. Criteria of aromaticity in heterocycles(bond lengths, ring current, Empirical resonance energy, delocalization energy and Dewar resonance energy, diamagneticsusceptibility exaltations). Synthesis and reaction of benzo [b] and benzo [c], benzodiazoles and acridines, pyrazole, imidazole oxazole, thiazole, indole, pyrimidine.

Unit II: **Common Organic Rearrangements and their mechanism:**

Pinacol- Pinacolone, Wagner- Meerwein, BenzilBenzilic acid, Beckmann, Hoffmann, Curtius, Schmidt, Lossen, Sommelet-Hauser, Favoroskii and Baeyer- Villiger rearrangement.

Unit III: **Pericyclic Reactions:**

Classification and examples, Woodword-Hofmann's Rule, Electrolytic reaction, Cycloaddition reaction ([2+2] and [4+2] only) and Sigmatropic shifts [1,3]- shift, [1,5]-shift and [3,3]- shift (Cope rearrangement and Claisen rearrangement), FMO approach only.

Unit IV: **Disconnection Approach**

An introduction to synthons and synthetic equivalents, Guidelines for choosing disconnections, Functional Group Interconversion (FGI), use of protecting group in disconnection approach Synthetic design: Introduction, Retrosynthetic approach, One and two group C-X disconnections, Synthesis of some organic molecules by disconnection approach

Unit V: **Drugs**

Antihistaminic Drugs:- Introduction, preparation and uses of Benadryl, dimenhydrinate, antergan, pyribenzamine.

Anti-inflammatory:- Introduction, Preparation and uses of Steroid and non-steroid drugs (Ibuprofen, mefanamic acid, diclofenac)

Antimalarials:- Synthesis of mepacrine, chloroquin, Pamaquin, paludrin.

Books Suggested:

1. Heterocyclic Chemistry Vol. 1-3, R. R. Gupta, M. Kumar and V. Gupta. Springer Verlag.
2. Heterocyclic Chemistry, J.A. Joule, K. Mills and G. F. Smith, Chapman and Hall.
3. Heterocyclic Chemistry, T. L. Gilchrist, Longman Scientific Technical
4. The Organic Chemistry of Drug Design and drug Action, R.B. Silverman, Academic Press.
5. Organic Synthesis,Jagdamba Singh , L D S Yadav, Jaya Singh,PragatiPrakashan

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BQ21006T **ADVANCED PHYSICAL CHEMISTRY** **M.M. : 75**

(Elective-3)

Credits-04

Unit I – **Thin Film and Langmuir-Blodgett Films:**Preparation techniques, evaporation/sputtering, chemical processes, MOCVD, Sol-gel, etc. Langmuir –Blodgett (LB) films, growth techniques, Photolithography, properties and application of thin & LB films.

Liquid Crystal: Mesmorphicbehavior, thermotropic liquid crystal, positional order, bond orientation order nematic and smeticmesophates, smetic-nematic, transition and clearing temperature, homeotropic, planar and schlieren textures, twisted nematics, chiral nematics, molecular arrangement in smetic A and smetic C phases, Optical properties of liquid crystal, Dielectric description of ordering in liquid crystals.

Unit II – **Polymeric Materials:** Molecular shape, structure and configuration, crystalinity, stress-strain behaviour, thermal behaviour, polymer types and their application, conducting and feno-electric polymers.

Unit III **Ionic Conductors:** Types of ionic conductors, mechanism of conduction, interstitial jumps (Frenkel); Vacancy, mechanism, diffusion superionic conductor, phase transitions and mechanism of conduction in super ionic conductors, examples and application of ionic conductors.

Unit IV – Theoretical and computation treatment of atoms and molecules, Hartree-Fock theory. Review of the principles of quantum mechanics, Born –oppenheimer approximation, Staler Condon rules. HartreeFock equation, Koopmans and Brilloning theories, Roothan equation, Gaussian sets.

Unit V– **General Properties of Liquids:**

(a) Liquids as dense gases, liquids as disordered solids, some thermodynamic relation, internal pressures and its significance in liquids. Equation of state, critical constants. Different types of intermolecular forces in liquids, different potential function for liquids, additivity of pair potential approximation.

(b) A classical partition function for liquids, correspondence principle, configuration integral, configuration properties.

Book Suggested:

1.Physical chemistry, P.W. Atkins, ELBS

2. Advanced Physical Chemistry, Gurdeep Raj, Goel Publishing House, Meerut.

3. Principles of Physical Chemistry, Puri, Sharma and Pathania, Vishal Publising, Delhi

4. Solid State Physics ,N. W. Aschcroft and N.D. Mermin, Holt, Rinehart and Winston, New York, 1976.

5.Textbook of Polymer Science, F. W. Billmeyer. Jr.Wiley.

BO21007P **M.Sc. Chemistry Practical (Semester X)**

M.Sc. (Inorganic Chemistry) Practical **M.M.100**

Credit 4

1.Gravimetric Analysis [30]

To separate and estimate Copper, Nickel, and Zinc in a mixed solution by Gravimetric method.

2. Spectrophotometric Determinations [25]

(a) Fluoride/ Nitrite/ Phosphate

(b) Copper-Ethylene diamine complex; slope ration method

3. Chromatographic Separations [20]

(a) Cd and Zn

(b) Zn and Mg

(c) Thin-layer chromatography

Separation of Ni, Mn, Co & Zn Determination of Rf values.

Record [15]

Viva [10]

M.Sc. (Organic Chemistry) Practical **M.M.100**

Credit 4

1. Multi- step synthesis of organic compounds: (One exercise) [20]

(i) Preparation of p- BromoanilinefromAniline (Bromination)

(ii) Preparation of p-nitroaniline from Aniline (Nitration)

(iii) Preparation of quinoline from aniline (Skraup Synthesis)

(iv) Preparation of 2- phenyl indole from phenyl hydrazine (Fischer- Indole synthesis)

(v) Benzoyl chloride to Benzaniline (Benzoylation)

(vi) Benzene to Acetanilide (Acetylation) .

2. Green chemistry: (One exercise) [15]

(i) Coenzyme catalysed benzoin condensation (Thiamine hydrolysedcatalysed synthesis of benzene)

(ii) Electrophilic aromatic substitution reaction-I (Nitration of Phenol)

(iii) Radical coupling reaction (Preparation of 1,1-Bis-2-naphthol)

(iv) Three component coupling (Synthesis of dihydropyrimidinone)

(v) Transestrification reaction (Synthesis of biodiesl)

(vii) Preparation of Iron (III) acetylacetonate

3. Spectrophotometric estimation/Identification: (One exercise) [15]

(i) Asprin, disprin, Sprintas

(ii) Caffeine

(iii) Ascorbic Acid (Lemon, Amla)

(iv) Carbohydrate (Glucose, Sucrose, Fructose

(v) Amino acids

4. Qualitative Analysis: [25]

Separation, Purification and Identification of compounds of tertiary mixtures (three solids).

Record [15]

Viva [10]

M.Sc. (Physical Chemistry) Practical

M.M.100

Credit 4

A list of experiment under different headings are given below.

Typical experiments are to be selected from each type

1. Thermodynamics: [20]

Determination of the temperature dependence of the solubility of a compound in two solvents having similar intermolecular interaction (benzoic acid in water & in DMSO water mixture) and calculate the partial molar heat of solution

2. Spectroscopy: [20]

(i) Determination of stoichiometry and Stability constant of inorganic (e.g. ferric-salicylin acid) and organic (e.g. amine iodine) complexes.

(ii) Characterization of the complexes by electronic and IR Spectral Data.

3. Polarography: [20]

(i) Estimation of Pb^{2+} and Cd^{2+}/Zn^{2+} and Ni^{2+} ions in a mixture of Pb^{2+} and Cd^{2+}/Zn^{2+} and Ni^{2+} by Polarography.

(ii) Determination of dissolved oxygen in aqueous solution of organic solvents.

4. Electronics : [15]

(iii) To study the characteristics of light emitting diode.

(iv) To study the characteristics of Zener diode.

(v) To study the characteristics of FET

(vi) To plot the characteristics curve of a diode.

(vii) Setting up of a thermostat: Constant temperature both

Record [15]

Viva [10]

BQ21008R **RESEARCH PROJECT** **M.M.100**

Credits-08

The research project is based on the following topics –

1. Coordination Chemistry
2. Macro Cyclic Chemistry
3. Green Chemistry
4. Nano Chemistry
5. Pesticide Chemistry
6. Polymer Chemistry
7. Polymer Nano Composite
8. Environmental Science

i. Air Pollution
ii. Soil Pollution
iii. Water Pollution

9. Natural Products
10. Synthetic Organic Chemistry
11. Drug Chemistry
12. Industrial Chemist

Programme Outcomes

Ensures the students to understand, acquire knowledge in Quantum Chemistry, Group Theory Symmetry, Photochemistry, Advanced Concepts in Spectroscopy, Polymer Science, Green Chemistry, Solid State, Natural Products, disconnection approach as well as role of Modern Synthetic Reagents in Organic Transformations, Nanotechnology, Thermodynamics, Advanced Chemical Kinetics, Surface Analytical Techniques to measure Surface Properties of materials and the Advanced Principles of various Electrochemical Techniques and all branches of Chemistry. This syllabus also ensures the students to understand acquire knowledge and have hands on experience in multistep Inorganic/ Organic Compound Synthesis and Analysis by using Spectroscopic Techniques and have hands on experience in multistep Organic Synthesis and Analysis by using Spectroscopic Techniques.

DR. BHIM RAO AMBEDKAR UNIVERSITY
AGRA

To be uploaded in FYUP folder

NATIONAL EDUCATION POLICY-2020

STRUCTURE AND SYLLABUS OF CHEMISTRY

For

Under Graduate (UG) Programme
Four Year Undergraduate Programme (FYUP)
Post Graduate (PG) Programme

Effective From Academic Session 2025-26

Dr. BHIM RAO AMBEDKAR UNIVERSITY, AGRA

(Formerly: Agra University, Agra)

Course Structure for FYUP (CHEMISTRY)

Under Semester System to come into force from Academic

Session 2025-2026 According to

New Education Policy

FYUP CHEMISTRY

(SEMESTER-WISE)

Syllabus framed & designed by:-

S.NO.	NAME	DEPARTMENT	COLLEGE
1.	Prof. Babita Agrawal	CHEMISTRY	B.S.A. College, Mathura
2.	Km. Rita Dixit	CHEMISTRY	M.G.B.V. PG. College, Firozabad
3.	Prof. Lalit Pal Singh	CHEMISTRY	R.B.S. College, Agra
4.	Prof. Harikant	CHEMISTRY	R.B.S. College, Agra
5.	Dr. Neelesh Pandey	CHEMISTRY	B.S.A. College, Mathura
6.	Prof. Kalpana Chaturvedi	CHEMISTRY	Agra College, Agra

DR. BHIM RAO AMBEDKAR UNIVERSITY, AGRA

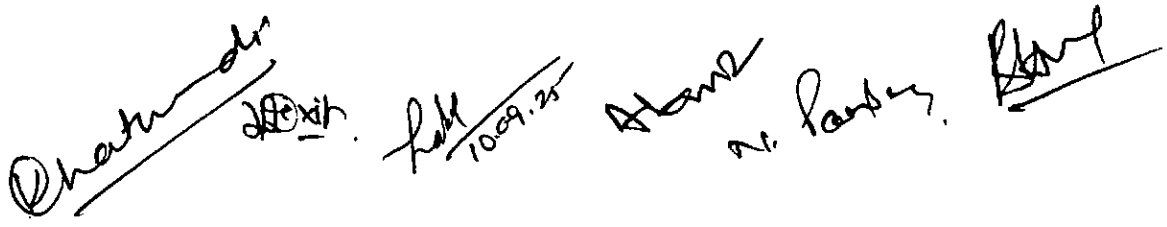
BOARD OF STUDIES – CHEMISTRY
MINUTES OF MEETING

Meeting of Board of Studies of Chemistry was held on **11-03-2025**, Jublee Hall,Paliwal Park .Dr.B.R.Ambedkar Uni. Agra, on the agenda: "Alignment of Chemistry Syllabus for Five Years of Higher Education with Four Year Undergraduate Programme (FYUP)". Following members attended the meeting –

S. No.	NAME	DESIGNATION	AFFILIATION
MEMBERS OF BOARD OF STUDIES			
	Prof. Babita Agarwal	**Professor & Convener of BOS**	**Department of Chemistry, B.S.A. College, Mathura**
1.	Km. Rita Dixit	Associate Professor	Department of Chemistry, M.G,B.V.(PG) College, Firojabad
2.	Prof. Lalit Pal Singh,	Professor	Department of Chemistry, R.B. S. College, Agra
3.	Prof. Harikant	Professor	Department of Chemistry, R.B.S.College, Agra
4.	Dr.Neelesh Pandey	Associate Professor	Department of Chemistry, B.S.A. College, Mathura
5.	Prof. Kalpana Chaturvedi	Professor	Department of Chemistry, Agra College, Agra
6.	Prof. Nisha Rathore	Professor	Department of Chemistry, K.R.P.G.College, Mathura

All the above members recommended the following:

1. In the First Three Years of Higher Education, the currently running Common Minimum Chemistry Syllabus for all U.P. State Universities and Colleges will remain applicable.
2. Indian Knowledge System (IKS), introduced in the first unit of theory paper (B020101T) of Semester I of First Year of Higher Education, has been amplified.
3. Research Project of Credit 3, in Semester V & VI of Third Year of Higher Education has been removed.
4. Research Project of Credit 3, in Semester IV of Second Year of Higher Education has been introduced.
5. In the Fourth & Fifth Year of Higher Education, the currently running M.Sc. Chemistry Syllabus will remain applicable with certain modifications in its Structure and Syllabus so as to align it with FYUP.
6. There will be no Continuous Internal Evaluation (CIE) in Practical Papers and Research Projects / Dissertations under FYUP.
7. **Structure and Syllabus of Chemistry under FYUP is annexed as below:**
   First Three Years - Page 3 to 57 Fourth Year - Page 58 to 73 Fifth Year - Page 74 to 94.
8. **All the above amendments will be applicable only to the students admitted in the Academic Session 2025-26 in Semester 1 of First Year of Higher Education. All other students will complete their courses as per the previous rules.**
9. Papers related to the Syllabus of Chemistry, that can be opted through Swayam Portal were also discussed.



FIRST THREE YEARS
OF
HIGHER EDUCATION

-Department of Higher Education
U.P. Government, Lucknow

National Education Policy-2020

Common Minimum Syllabus for all U.P. State Universities and Colleges
For First Three Years of Higher Education

PROPOSED STRUCTURE OF UG CHEMISTRY SYLLABUS

National Education Policy-2020
Common Minimum Syllabus for all U.P. State Universities/ Colleges
SUBJECT: CHEMISTRY

Name	Designation	Affiliation
Steering Committee		
Mrs. Monika S. Garg, (I.A.S.) Chairperson Steering Committee	Additional Chief Secretary	Dept. of Higher Education U.P., Lucknow
Prof. Poonam Tandan	Professor, Dept. of Physics	Lucknow University, U.P.
Prof. Hare Krishna	Professor, Dept. of Statistics	CCS University Meerut, U.P.
Dr. Dinesh C. Sharma	Associate Professor, Dept. of Zoology	K.M. Govt. Girls P.G. College Badalpur, G.B. Nagar, U.P.
Supervisory Committee-Science Faculty		
Dr. Vijay Kumar Singh	Associate Professor, Dept. of Zoology	Agra College, Agra
Dr. Santosh Singh	Dean, Dept. of Agriculture	Mahatma Gandhi Kashi Vidhyapeeth, Varanasi
Dr. Baby Tabussam	Associate Professor, *Dept. of Zoology*	Govt. Raza P.G. College Rampur, U.P.
Dr. Sanjay Jain	Associate Professor, Dept. of Statistics	St. John's College, Agra

Syllabus Developed by:

S.No.	Name	Designation	Department	College/University
1.	Dr. Susan Verghese P	Associate Professor and Head	Chemistry	St. John's College, Agra
2.	Dr. Mohd Kamil Hussain	Assistant Professor	Chemistry	Govt. Raza P.G. College Rampur, U.P.
3.	Mrs. Neha Tripathee	Assistant Professor	Chemistry	Km. Mayawati Govt. Girls P.G. College, Badalpur, G.B. Nagar

Semester-wise Titles of the Papers in B.Sc. Chemistry

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
Certificate in Bioorganic and Medicinal Chemistry					
1	I	B020101T	Fundamentals of Chemistry	Theory	4
		B020102P	Quantitative Analysis	Practical	2
	II	B020201T	Bioorganic and Medicinal Chemistry	Theory	4
		B020202P	Biochemical Analysis	Practical	2
Diploma in Chemical Dynamics and Analytical Techniques					
2	III	B020301T	Chemical Dynamics & Coordination Chemistry	Theory	4
		B020302P	Physical Analysis	Practical	2
	IV	B020401T	Quantum Mechanics and Analytical Techniques	Theory	4
		B020402P	Instrumental Analysis	Practical	2
		B020403R	Research Project in Chemistry	Research	3
Degree in Bachelor of Science					
3	V	B020501T	Organic Synthesis-A	Theory	4
		B020502T	Rearrangements and Chemistry of Group Elements	Theory	4
		B020503P	Qualitative Analysis	Practical	2
	VI	B020601T	Organic Synthesis-B	Theory	4
		B020602T	Chemical Energetics and Radiochemistry	Theory	4
		B020603P	Analytical Methods	Practical	2

Purpose of the Program

The purpose of the undergraduate chemistry program at the university and college level is to provide the key knowledge base and laboratory resources to prepare students for careers as professionals in various industries and research institutions.

Program's Outcomes

1. Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in analytical, Inorganic, Organic and Physical Chemistries.
2. Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
3. Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
4. Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
5. Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
6. Students will be able to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.
7. Students will be able to function as a member of an interdisciplinary problem solving team.

PROGRAM SPECIFIC OUTCOMES (PSOS)

	CERTIFICATE IN BIOORGANIC AND MEDICINAL CHEMISTRY
First Year	Certificate in Bioorganic and Medicinal Chemistry will give the student a basic knowledge of all the fundamental principles of chemistry like molecular polarity, bonding theories of molecules, Periodic properties of more than 111 elements, mechanism of organic Reactions, Stereochemistry, basic mathematical concepts and computer knowledge, chemistry of carbohydrates, proteins and nucleic acids: medicinal chemistry, synthetic polymers, synthetic dyes, Student will be able to do to qualitative quantitative and bio chemical analysis of the compounds in the laboratory. This certificate course is definitely going to prepare the students for various fields of chemistry and will give an insight into all the branches of chemistry and enable our students to join the knowledge and available opportunities related to chemistry in the government and private sector services particularly in the field of food safety, health inspector, pharmacist etc. Have a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective.
Second Year	**DIPLOMA IN CHEMICAL DYNAMICS AND ANALYTICAL TECHNIQUES**
	Diploma in Chemical Dynamics and Analytical Techniques will provide the theoretical as well as practical knowledge of handling chemicals, apparatus, equipment and instruments. The knowledge about feasibility knowledge of handling chemicals, apparatus, equipment and instruments. The knowledge about feasibility kinetic theories of Gases ,solid and liquid states, coordination chemistry, metal carbonyls and bioinorganic will enable the students to work as chemists in pharmaceutical industries. The knowledge about atomic structure, quantum mechanics, various spectroscopic tools and separation technique will make the students skilled to work in industries: Achieved the skills required to succeed in the chemical industry like cement industries, agro product, paint industries, rubber industries, petrochemical industries, food processing industries, Fertilizer industries, pollution monitoring and control agencies etc. Got exposures of a breadth of experimental techniques using modern instrumentation Learn the laboratory skills and safely measurements to transfer and interpret knowledge entirely in the working environment. monitoring of environment issues: monitoring of environmental pollution problems of atmospheric sciences, water chemistry and soil chemistry and design processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental Considerations
Third Year	**DEGREE IN BACHELOR OF SCIENCE**
	Degree in Bachelor of Science programme aims to introduce very important aspects of modern day course curriculum, namely, chemistry of hydrocarbons, alcohols, carbonyl compounds, carboxylic acids, phenols, amines, heterocyclic compounds, natural products main group elements, qualitative analysis, separation techniques and analytical techniques. It will enable the students to understand the importance of the elements in the periodic table including their physical and chemical nature and role in the daily life and also to understand the concept of chemistry to inter relate and interact to the other subject like mathematics, physics, biological science etc. • Upon completion of a degree, chemistry students 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 • Various research institutions and industry people in the pharmaceuticals, polymers, and food industry sectors will surely value this course.

Subject: Chemistry							Total Credits of the subject
Year	Sem.	Theory Paper	Units	Practical Paper	Units	Research Project	
I	I	Fundamentals of Chemistry	1. Molecular polarity and Weak Chemical Forces 2. Simple Bonding theories of Molecules 3. Periodic properties of Atoms 4. Recapitulation of basics of Organic Chemistry 5. Mechanism of Organic Reactions 6. Stereochemistry 7. Basic Computer system (in brief) 8. Mathematical Concepts for Chemistry	Quantitative Analysis	1. Water Quality analysis 2. Estimation of Metals ions 3. Estimation of acids and alkali contents 4. Estimation of inorganic salts and hydrated water	Nil	4+2=6
	II	Bioorganic and Medicinal Chemistry	1. Chemistry of Carbohydrates 2. Chemistry of Proteins 3. Chemistry of Nucleic Acids 4. Introductory Medicinal Chemistry 5. Solid state 6. Introduction to Polymer 7. Kinetics and Mechanism of Polymerization 8. Synthetic Dyes	Biochemical Analysis	1. Qualitative and quantitative analysis of Carbohydrates 2. Qualitative and quantitative analysis of Proteins, amino acids and Fats 3. Determination and identification of Nucleic Acids 4. Synthesis of simple drug molecules.	Nil	4+2=6
2	III	Chemical Dynamics & Coordination Chemistry	1. Chemical kinetics 2. Chemical Equilibrium 3. Phase Equilibrium 4. Kinetic theories of Gases 5. Liquid states 6. Coordination Chemistry 7. Theories of Coordination Chemistry 8. Inorganic Spectroscopy and Magnetism	Physical Analysis	1. Strengths of Solution 2. Surface tension and viscosity of pure liquids 3. Boiling point and Transition temperature 4. Phase Equilibrium	Nil	4+2=6
	IV	Quantum Mechanics and Analytical Techniques	1. Atomic Structure 2. Elementary Quantum Mechanics 3. Molecular Spectroscopy 4. UV-Visible Spectroscopy 5. Infrared Spectroscopy 6. ^{1}H-NMR Spectroscopy 7. Introduction to Mass Spectrometry 8. Separation Techniques	Instrumental Analysis	1. Molecular Weight Determination 2. Spectrophotometry 3. Spectroscopy 4. Chromatographic Separations	Reacherch Project	4+2+3=9
	V	Organic Synthesis-A	1. Alkane and Cycloalkanes 2. Alkenes 3. Alkynes 4. Arenes and Aromaticity	Qualitative Analysis	1. Inorganic Qualitative Analysis 2. Elemental analysis and identification of functional groups 3. Separation of organic Mixture	Nil	4+4+2=10

			5. Alcohols		4. Identification of organic compounds		
			6. Phenols 7. Ethers and Epoxides 8. Organic Halides				
		Rearrangements and Chemistry of Group Elements	1. Rearrangements 2. Catalysis 3. Chemistry of the Main Group Elements 4. Chemistry of Transition Elements 5. Chemistry of Lanthanides 6. Chemistry of Actinides 7. Metal Carbonyls 8. Bioinorganic Chemistry				
	VI	Organic Synthesis-B	1. Reagents in Organic synthesis 2. Organometallic Compounds 3. Aldehydes and Ketones 4. Carboxylic acids and their Functional Derivatives 5. Organic Synthesis *via* Enolates 6. Organic Compounds of Nitrogen 7. Heterocyclic Compounds 8. Natural Products	Analytical Methods	1. Gravimetric Analysis 2. Paper Chromatography 3. Thin Layer Chromatography 4. Thermochemistry	Nil	4+4+2
		Chemical Energetics and Radiochemistry	1. Thermodynamics-I 2. Thermodynamics-II 3. Electrochemistry 4. Ionic Equilibrium 5. Photo Chemistry 6. Colligative Properties of Solutions 7. Surface Chemistry 8. Radiochemistry				

COURSE		SUBJECT: CHEMISTRY					Total Credits of the subject
Year	Sem.	Paper Title		Prerequisite for Paper	Elective For Major Subject	Hours per Semester	
Certificate in Bioorganic and Medicinal Chemistry	I	Theory-1	Fundamentals of Chemistry	Chemistry in 12Th	Yes Open to all	60	4
		Practical-1	Quantitative Analysis	Chemistry in 12tn	Yes Open to all	**60**	2
	II	Theoty-1	Bioorganic and Medicinal Chemistry	Passed Sem-I, Theory paper-1	**Yes** Zoo/Bot./Physics/Math/Comp Sci	60	4
		Pracical-2	Biochemical Analysis	Opted Sem-II, Theory Ppaer-1	Yes Zoo/Bot./Physics/Math/Comp Sci.	**60**	2
Diploma in Chemical Dynamics and Analytical Techniques	III	Theoty-1	Chemical Dynamics & Coordination Chemistry	Chemistry in 12tn Physics in 12th	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	4
		Pracical-2	Physical Analysis	Opted Sem-III, Theory Ppaer-1	Yes Zoo/Bot./Physics/Math/Comp Sci.	**60**	2
	IV	Theoty-1	Quantum Mechanics and Analytical Techniques	Chemistry in 12th	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	4
		Practical-2	Instrumental Analysis	Chemistry in 12th	Yes Zoo/Bot./Physics/Math/Comp Sci.	**60**	2
		Research Project				45	3
Degree in Bachelor of Science	V	Theory-1	Organic Synthesis-A	Passed Sem-I, Theory paper-	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	4
		Theory-1	Rearrangements and Chemistry of Group Elements	Passed Sem-I, Theory paper-	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	4
		Practical-	Qualitative analysis	Opted Sem-V	Yes	60	

		3		Theory Ppaer-1 &2	Zoo/Bot./Physics/Math.		2

	VI	Theory-1	Organic Synthesis-B	Passed Sem-V Theory paper-1	Yes Zoo/Bot./Physics/Math	60	4
		Theory-1	Chemical Energetics and Radiochemistry	Chemistry in 12^{tn} Physics in 12^{tn}	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	4
		Practical-3	Analytical Methods	Chemistry in 12^{th}	Yes Zoo/Bot./Physics/Math/Comp Sci.	60	2

FIRST YEAR
OF
HIGHER EDUCATION

Certificate in Bioorganic and Medicinal Chemistry					
Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
FIRST	I	B020101T	Fundamentals of Chemistry	Theory	4
		B020102P	Quantitative Analysis	Practical	2
	II	B020201T	Bioorganic and Medicinal Chemistry	Theory	4
		B020202P	Biochemical Analysis	Practical	2

Semester-1,

Paper-1 (Theory)

Course Title: Fundamentals of Chemistry

Programme/Class: Certificate in Bioorganic and Medicinal Chemistry	Year: First	Semester: First
Paper-1 Theory		Subject: Chemistry
Course Code:B020101T	Course Title: Fundamentals of Chemistry	

Course outcomes:

There is nothing more fundamental to chemistry than the chemical bond. Chemical bonding is the language of logic for chemists. Chemical bonding enables scientists to take the 100-plus elements of the periodic table and combine them in myriad ways to form chemical compounds and materials. Periodic trends, arising from the arrangement of the periodic table, provide chemists with an invaluable tool to quickly predict an element's properties. These trends exist because of the similar atomic structure of the elements within their respective group families or periods, and because of the periodic nature of the elements. Reaction mechanism gives the fundamental knowledge of carrying out an organic reaction in a *step-by-step manner. This cour*se will provide a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective. Students will 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 utmost 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 , steriochemistry 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 Steriochemistry gives the clear picture of two-dimensional and three-dimensional structure of the molecules, and their role in reaction mechanism

Credits: 4	Compulsory
Max. Marks: 25+75	Min. Passing Marks:.....

Total No. of Lectures = 60

Unit	Topics	No. of Lectures
I	Introduction to Indian ancient Chemistry and contribution of Indian Chemists, in context to the holistic development of modern science and technology,	10

	Molecular polarity and Weak Chemical Forces : Resonance and resonance energy, 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, polarizing power and polarizability. Fajan's rules and consequences of polarization. Hydrogen bonding and consequences of Hydrogen Bond.	
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)	10
III	**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.	05
IV	**Recapitulation of basics of Organic Chemistry:** Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bonding, Inclusion Compounds, Clatherates, Charge transfer complexes, Hyperconjugation, Dipole moment; Electronic Displacements: Inductive, Electromeric, Resonance ,Mesomeric effects and their applications	05
V	**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).	10
VI	**Steriochemistry**-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, axial	10

	and equatorial bonds, conformation of mono substituted cyclohexane derivatives, Newman projection and Sawhorse formulae, Fischer and flying wedge formulae, Difference between configuration and conformation.	
VII	**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. 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, chemsketch, scilab, matlab, hyperchem, etc.), internet application.	05
VIII	**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	05

Suggested Readings:

1. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
2. Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and
3. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
4. Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.*, Oxford University Press, 1994.
5. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.
6. Singh J.,Yadav L.D.S.,Advanced Organic Chemistry,Pragati Edition
7. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
9. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
10. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry*, 2. edition, Oxford University Press, 2012.
11. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry*, John Wiley & Sons, Inc.
12. Sykes, P. *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003
13. 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.aspx
https://nptel.ac.in/courses/104/106/104106096/
http://heecontent.upsdc.gov.in/Home.aspx
https://nptel.ac.in/courses/104/106/104106096/
https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
https://nptel.ac.in/courses/104/103/104103071/#

This course is compulsory for the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .
Or

Assessment and presentation of Assignment	(10 marks)
04 tests (Objective): Max marks of each test = *10* (average of all 04 tests)	(*10* marks)
Overall performance throughout the semester, Discipline, participation in different activities)	(05 marks)

Course prerequisites: To study this course, a student must have had the chemistry in class 12 th

Suggested equivalent online courses:
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Further Suggestions:
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Semester-I, Paper-2 (Practical)
Course Title: Quantitative Analysis

Programme: Certificate in Bioorganic and Medicinal Chemistry	Year: First	Semester: I
Practical paper-2		Subject: Chemistry
Course Code: B020102P	**Course Title: Quantitative Analysis**	

Course outcomes:

Upon completion of this course the students will have the knowledge and skills to: understand the laboratory methods and tests related to estimation of metals ions and estimation of acids and alkali contents in commercial products.

- Potability tests of water samples.
- Estimation of metal ions in samples
- Estimation of alkali and acid contents in samples
- Estimation of inorganic salts and hydrated water in samples

Credits: 2	Elective
Max. Marks:100	Min. Passing Marks: As per University Norms
Practical	**60 h**

Unit	Topics	No of Lectures
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).	16
II	**Estimation of Metals ions** 1. Estimation of ferrous and ferric by dichromate method. 2. Estimation of copper using thiosulphate.	14
II	**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 $KMnO_4$.	14
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. 3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.	16

Suggested Readings:

1. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
2. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
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
8. **http://chemcollective.org/vlabs**

This course can be opted as an elective by the students of following subjects: Chemistry in 12 th Class

Course prerequisites: To study this course, a student must have had the chemistry in 12th Class

Suggested equivalent online courses:

.....

Further Suggestions:

.....

Semester-II Paper-1

Course Title: Bioorganic and Materials Chemistry

Programme: Certificate in Bioorganic and Medicinal Chemistry	Year: 1	Semester: II
Paper-1	Elective	Subject: Chemistry
Course Code: B020201T	**Course Title: Bioorganic and Medicinal Chemistry**	

Course outcomes: Biomolecules are important for the functioning of living organisms. These molecules perform or trigger important biochemical reactions in living organisms. When studying biomolecules, one can understand the physiological function that regulates the proper growth and development of a human body. This course aims to introduce the students with basic experimental understanding of carbohydrates, amino acids, proteins, nucleic acids and medicinal chemistry. Upon completion of this course students may get job opportunities in food, beverage and pharmaceutical industries.

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks: As per University Norms

Total No. of Lectures = 60

Unit	Topics	No. of Lectures
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. Inter conversions of sugars (ascending and descending of sugar series, conversion of aldoses to ketoses). Lobry de Bruyn-van Ekenstein rearrangement; stepping–up (Kiliani-Fischer method) and stepping–down (Ruff's &Wohl's methods) of aldoses; end-group-interchange of aldoses Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose.)	10
II	**Chemistry of Proteins:** Classification *of amino acids,* zwitter ion structure and Isoelectric point. Overview of primary, secondary, tertiary and quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection & C-activating groups and Merrifield solid phase synthesis. Protein denaturation/ renaturation Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions).	10
III	**Chemistry of Nucleic Acids:** Constituents of Nucleic acids: Adenine, guanine, thymine and Cytosine (Structure only), Nucleosides and nucleotides **(nomenclature)**, Synthesis of nucleic	05

	acids, Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (**types of RNA**), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation	
IV	**Introductory Medicinal Chemistry :** Drug discovery, design and development; Basic Retrosynthetic approach. Drug action-receptor theory. Structure –activity relationships of drug molecules, binding role of –OH group,-NH_2 group, 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); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), HIV-AIDS related drugs (AZT- Zidovudine	10
V	**Solid State** Definition of space lattice, unit cell. Laws of crystallography – (i) Law of constancy of **interfacial angles,** (ii) Law of rationality of indices and iii) Symmetry elements in crystals and law of symmetry .X-ray diffraction by crystals. Derivation of Bragg equation. Determination of crystal structure of NaCl, KCl and CsCl (powder method).	05
VI	**Introduction to Polymer** Monomers, Oligomers, Polymers and their characteristics, Classification of polymers : Natural synthetic, linear, cross linked and network; plastics, elastomers, fibres, 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) Osmometry and Ultracentrifuging. **Silicones and Phosphazenes** –Silicones and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes.	10
VII	**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, urea formaldehyde resins, epoxy resins and polyurethanes.	05
VIII	**Synthetic Dyes:** Colour and constitution (electronic Concept), Classification of dyes, Chemistry and synthesis of Methyl orange, Congo red, Malachite green, crystal violet, phenolphthalein, fluorescein, Alizarin and Indigo.	05

Suggested Readings:

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

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/104/105/104105124/
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/

This course can be opted as an elective by the students of following subjects: Chemistry in 12 th Class

Suggested Continuous Evaluation Methods:

Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)

Course prerequisites: To study this course, a student must have Passed Sem-I, Theory paper-1

Suggested equivalent online courses:

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Further Suggestions:

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N. Pandey

Semester-II , Paper-2 (Practical)
Course Title: Biochemical Analysis

Programme: Certificate in Bioorganic and Medicinal Chemistry	Year: 1	Semester: II
Subject: Chemistry		
Course Code: B020202P	Course Title: Biochemical Analysis	

Course outcomes:
This course will provide basic qualitative and quantitative experimental knowledge of biomolecules such as carbohydrates, proteins, amino acids, nucleic acids drug molecules. Upon successful completion of this course students may get job opportunities in food, beverage and pharmaceutical industries.

Credits: 2	Elective
Max. Marks:100	Min. Passing Marks: As per University Norms

Practical **60-h**

Unit	Topics	No of Lectures
I	**Qualitative and quantitative analysis of Carbohydrates:** . 1. Separation of a mixture of two sugars by ascending paper chromatography 2. Differentiate between a reducing/ nonreducing sugar 3. Synthesis of Osazones.	15
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	20
III	**Determination and identification of Nucleic Acids** 1. Determination of nucleic acids 2. Extraction of DNA from onion/cauliflower	12
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	13

Suggested Readings:

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,* Universities Pres
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
3. **http://chemcollective.org/vlabs**

This course can be opted as an elective by the students of following subjects: Chemistry in 12 th Class

Course prerequisites: To study this course, a student must have Opted Sem-II, Theory Ppaer-1.

Suggested equivalent online courses:

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Further Suggestions:

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SECOND YEAR
OF
HIGHER EDUCATION

Diploma in Chemical Dynamics and Analytical Techniques					
Year	**Sem.**	**Course Code**	**Paper Title**	**Theory/Practical**	**Credits**
2	III	B020301T	Chemical Dynamics & Coordination Chemistry	Theory	4
		B020302P	Physical Analysis	Practical	2
	IV	B020401T	Quantum Mechanics and Analytical Techniques	Theory	4
		B020402P	Instrumental Analysis	Practical	2
		B020403R	Research Project	Project	3

Semester III, Paper-1 (Theory)

Course Title: Chemical Dynamics & Coordination Chemistry

Programme: Diploma in Chemical Dynamics and Analytical Techniques	**Year: Two**	**Semester: III**
Paper-1 Theory		Subject: **Chemistry**
Course Code:B020301T	**Course Title: Chemical Dynamics & Coordination Chemistry**	

Course outcomes: Upon successful completion of this course students should be able to describe the characteristic of the three states of matter and 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, thermodynamic and kinetic aspects of metal complexes.

Credits: 4	**Elective**
Max. Marks: 25+75	Min. Passing Marks: As per University Norms

Total No. of Lectures = 60

Unit	Topics	No. of Lectures
I	**Chemical Kinetics:** Rate of a reaction, molecularity and order of reaction, concentration dependence of rates, mathematical characteristic of simple chemical reactions – zero order, first order, second order, pseudo order, half-life and mean life. Determination of the order of reaction – differential method, method of integration, half-life method and isolation method. **Theories of chemical kinetics:** Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects (no derivation).	10
II	Chemical **Equilibrium :** *Equilibrium constant and free energy,* thermodynamic derivation of law of mass action. Le-Chatelier's principle. reaction isotherm and reaction isochore – Clapeyron-Clausius equation and its applications.	5
III	**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 systems. Phase equilibria of two component systems – Solid - liquid equilibria , simple eutectic – Bi-Cd, Pb-Ag systems.	5
IV	**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.	10

	Molecular Velocities: Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter.	
V	**Liquid State** **Liquid State:** Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholesterol phases. **Liquids in solids (gels):** Classification, preparation and properties, inhibition, general application	5
VI	**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 stereo isomerism, geometrical and optical isomerism in square planar and octahedral complexes.	5
VII	**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	10
	stability of metal complexes and factors affecting the stability, stability constants of complexes and	
	their determination, substitution reactions of square planar complexes	
VIII	**Inorganic Spectroscopy and Magnetis** I)Electronic spectra of Transition Metal Complexes Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, *Orgel-energy level diagram for d1 and d9 states, discussion of the electronic* spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion. II)Magnetic properties of transition metal complexes, types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of μ s	10
	and μ eff values,orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes.	

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 ,Wiley 1995
5. Lee,J.D, Concise Inorganic Chemistry 4th Edition ELBS,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 Wesley 1984.
9. Sharpe,A .G, Inorganic Chemistry, ELBS,3RD edition ,1993
10. Miessler,G.L,Tarr,D.A, Inorganic Chemistry, 2nd edition , Prentice Hall,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:

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

This course can be opted as an elective by the students of following subjects: Chemistry in 12 th Class

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .

Or

Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)

Course prerequisites: To study this course, a student must have had the chemistry in class 12 th , Physics in Class 12th

Suggested equivalent online courses:

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Further Suggestions:

Semester III, Paper-2 (Practical):
Course Title: Physical Analysis

Programme: Diploma in Chemical Dynamics and Analytical Techniques	**Year: Two**	**Semester: III**
Practical paper-2		Subject: Chemistry
Course Code: B020302P	**Course Title: Physical Analysis**	

Course Outcomes: Upon successful completion of this course students should be able to calibrate apparatus and prepare solutions of various concentrations, estimation of components through volumetric analysis; to perform dilatometric experiments: one and two component phase equilibrium experiments.

Credits: 4	Elective
Max. Marks: 100	Min. Passing Marks:
Practical	**60 h**

Unit	Topics	No of Lectures
I	**Strengths of Solution** Calibration of fractional weights, pipettes and burettes. Preparation of standards solutions. Dilution – 0.1 M to 0.001 M solutions. 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	20
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	06
III	**Boiling point and Transition Temperature** 1. Boiling point of common organic liquid compounds **ANY FIVE**]*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 substance by thermometric /dialometric method (e.g. $MnCl_2.4H_2O/SrBr_2.2H_2O$)	14
IV	**Phase Equilibrium**	20

	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. phenolwater system) and to determine the concentration of that solute in the given phenol-water system 2. To construct the phase diagram of two component (e.g. diphenylamine – benzophenone) system by cooling curve method.	

Suggested Readings:

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
3. **http://chemcollective.org/vlabs**

This course can be opted as an elective by the students of following subjects: Chemistry in 12 th Class

Course prerequisites: To study this course, a student must have Opted Sem-III, Theory Ppaer-1

Suggested equivalent online courses:

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Further Suggestions:

Semester IV Paper-1 (Theory)
Course Title: Quantum Mechanics and Analytical Techniques

Programme: Diploma in Chemical Dynamics and Analytical Techniques	Year: **Two**	Semester: **IV**
Paper-1	Elective	Subject: **Chemistry**
Course Code: BO20401T	**Course Title: Quantum Mechanics and Analytical Techniques**	

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

Analytical chemistry plays an enormous role in our society, such as in drug manufacturing, process control in industry, environmental monitoring, medical diagnostics, food production, and forensic surveys. It is also of great importance 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 devclop basic skills required for purification, solvent extraction, TLC and column chromatography

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks: As per University Norms

Total No. of Lectures- = 60

Unit	Topics	No. of Lectures
I	**Atomic Structure:** Idea of de-Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrödinger wave equation, significance of Ψ and Ψ^2, 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.	5
II	**Elementary Quantum Mechanics** : 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. de-Broglie hypothesis. Heisenberg uncertainty principle . Hamiltonian Operator.	10

	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. Schrödinger wave equation for H-atom, separation into three equations (without derivation), quantum numbers and their importance, hydrogen like wave functions, radial wave functions, angular wave functions. Molecular orbital theory, basic ideas – Criteria for forming MO from AO, construction of MO by LCAO – H_2^+ ion, calculation of energy levels from wave functions, physical picture of bonding and anti-bonding wave functions, concept of σ, σ^*, π, π^* orbitals and their characteristics.	
III	**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**:Diatomic molecules . Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect . **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.	10
IV	**UV-Visible Spectroscopy :** Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules. Types of electronic transitions, λmax, chromophores and auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; application of Woodward Rules for calculation of λmax for the conjugated dienes: alicyclic, homoannular and heteroannular; extended conjugated systems distinction between cis and trans isomers (Cis and trans stilbene) .	5
V	**Infrared Spectroscopy:** **IR 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 nitile) , Effect of H-bonding, conjugation, resonance and ring size of cyclic ketones and lactones on IR absorptions; Fingerprint region and its significance; application in functional group analysis and and interpretation of I.R. spectra of simple organic compounds.	5

VI	**^{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 deshielded protons; spin coupling and coupling constant (1st order spectra); relative intensities of first-order multiplets: Pascal's triangle; chemical and magnetic equivalence in NMR ; 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. Applications of IR, UV and NMR spectroscopy for identification of simple organic molecules such as Ethanol, Ethyl acetate, acetone, acetaldehyde, dimethylformamide, Cis and trans 1,2-dimethyl cycloprpanone, propene , vinyl chloride, acetophenone, benzaldehyde, phenol, Toluene and ethyl benzene.	10
VII	**Introduction to Mass Spectrometry:** Principle of mass spectrometry, the mass spectrum, mass spectrometry diagram, molecular ion, metastable ion, fragmentation process, McLafferty rearrangement.	5
VIII	**Separation Techniques: Solvent** extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods.	10

Suggested Readings:

1. Alberty,R A, Physical Chemistry,4 th editionWiley Eastern Ltd ,2001.
2. Atkins,P W,the elements of physical chemistry,Oxford ,1991
3. Barrow,G .M,International student Edition .McGraw Hill, McGraw-Hill,1973.
4. Cotton,F.A, Wilkinson,G and Gaus,P. L ,Basic Inorganic Chemistry,3rd Edition ,Wiley 1995
5. Lee,J.D, Concise Inorganic Chemistry 4th Edition ELBS,1977
6. Clayden, J., Greeves, N., Warren, S., *Organic Chemistry,* Second edition, Oxford University Press 2012.
7. Silverstein, R. M., Bassler, G. C., Morrill, T. C. *Spectrometric Identification of Organic Compounds*, John Wiley and Sons, INC, Fifth edition.
8. Pavia, D. L. *et al. Introduction to Spectroscopy,* 5th Ed. Cengage Learning India Ed.
9. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
10. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
11. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
12. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.

Suggestive digital platforms web links

1. https://www.coursera.org/courses?query=chemistry&languages=en
2. https://www.mooc-list.com/tags/physical-chemistry
3. https://www.coursera.org/learn/physical-chemistry
4. https://ocw.mit.edu/courses/chemistry/5-61-physical-chemistry-fall-2017/
5. http://heecontent.upsdc.gov.in/Home.aspx
6. https://nptel.ac.in/courses/104/108/104108078/
7. https://nptel.ac.in/courses/104/108/104108124/
8. https://nptel.ac.in/courses/104/106/104106122/

This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .

Or

Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)

Course prerequisites: To study this course, a student must have had the chemistry in class 12th

Suggested equivalent online courses:
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Further Suggestions:
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Semester IV, Paper-2 (Practical)
Course Title: Instrumental Analysis

Programme: Diploma in Chemical Dynamics and Analytical Techniques	Year: Two	Semester: V
Practical paper-2		Subject: Chemistry
Course Code: B020402P	**Course Title: Instrumental Analysis**	

Course 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 chromatography

Credits: 2	Elective
Max. Marks: 100	Min. Passing Marks: As per University Norms
Practical	**60 h**

Unit	Topics	No of Lectures
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	**10**
II	**Spectrophotometry** 1. To verify Beer – Lambert Law for $KMnO_4/K_2Cr_2O_7$ 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).	**20**

	4. Determination of Biological oxygen demand (BOD).	
	Spectroscopy	
III	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 ^{1}H 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).~~	**10**
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) 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 (fluoresecin and methylene blue)~~	**20**

Suggested Readings:

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. Wardsworth 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 & AlliedMethods*, Elles Harwood Ltd. London.
8. Ditts, R.V. *Analytical Chemistry: Methods of separation.* Van Nostrand, 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/vlabs**

This course can be opted as an elective by the students of following subjects: Chemistry in 12 th Class

Course prerequisites: To study this course, a student must have had the chemistry in class

Suggested equivalent online courses:

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Further Suggestions:

THIRD YEAR
OF
HIGHER EDUCATION

Degree in Bachelor of Science					
Year	**Sem.**	**Course Code**	**Paper Title**	**Theory/Practical**	**Credits**
3	V	B020501T	Organic Synthesis-A	Theory	4
		B020502T	Rearrangements and Chemistry of Group Elements	Theory	4
		B020503P	Qualitative Analysis	Practical	2
	VI	B020601T	Organic Synthesis-B	Theory	4
		B020602T	Chemical Energetics and Radiochemistry	Theory	4
		B020603P	Analytical Methods	Practical	2

Semester V, Paper-1 (Theory)
Course Title: Organic Synthesis A

Programme: Degree in Bachelor of Science	Year: Three	Semester: **V**
Paper-2 Theory	**Compulsory**	Subject: Chemistry
Course Code: B020501T	Course Title: **Organic Synthesis A**	

Course outcomes: Hydrocarbons are the principal constituents of petroleum and natural gas. They serve as fuels and lubricants as well as raw materials for the production of plastics, fibers, rubbers, solvents and industrial chemicals. This course will provide a broad foundation in for the synthesis of hydrocarbons. Hydroxy and carbonyl compounds are industrially important compounds The industries of plastics, fibers, petroleum and rubbers will specially recognize this course. Students will gain an understanding of which are used as solvents and raw material for synthesis of drug and other pharmaceutically important compounds.

- 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.

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks: As per University Norms

Total No. of Lectures- = 60

Unit	Topics	No. of Lectures
I	**Chemistry of Alkanes and Cycloalkanes** **A) Alkanes** :Classification of carbon atom in 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 ring strain in small rings, theory of strain less rings. The case of cyclopropane ring, banana bonds.	8
II	**Chemistry of Alkenes** Methods of formation of alkenes, Addition to **C=C:** mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions: hydrogenation, halogenation, hydrohalogenation, hydration, oxymercuration demercuration, hydroboration-oxidation, epoxidation, *syn* and *anti*-hydroxylation, ozonolysis, addition of singlet and triplet carbenes; Simmons-Smith cyclopropanation reaction; electrophilic	12

	addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; use of NBS; interconversion of *E*- and *Z*- alkenes.	
III	**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.	06
IV	**Aromaticity and Chemistry of Arenes** Nomenclature of benzene derivatives, 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. Birch reduction, Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl, naphthalene and anthracene.	10
V	**Chemistry of Alcohols** Classification and nomenclature, 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.	8
VI	**Chemistry of Phenols** : Nomenclature, structure and bonding, 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, Hauben Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction	06
VII	**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.	05
VIII	**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	05

	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:

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

https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm

https://nptel.ac.in/courses/104/103/104103071/#

https://nptel.ac.in/courses/104/106/104106096/

This course is compulsory for the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:

Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .

Or

Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)

Course prerequisites: To study this course, a student must have Passed Sem-I, Theory paper

Suggested equivalent online courses:

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Further Suggestions:

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Semester-V Paper-2

Course Title: Rearrangements and Chemistry of Group Elements

Programme: Degree in Bachelor of Science	Year: Three	Semester: V
Paper-2 Theory	**Elective**	Subject: Chemistry
Course Code: B020502T	**Course Title: Rearrangements and Chemistry of Group Elements**	

Course outcomes: This paper provides detailed knowledge of synthesis of various class of organic compounds and functional groups inter conversion. Organic synthesis is the most important branch of organic chemistry which provides jobs in production & QC departments related to chemicals, drugs, medicines, FMCG etc. industries.

- 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.

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks: As per University Norms

Total No. of Lectures- = 60

Unit	Topics	No. of Lectures
I	**Rearrangements** A detailed study of the following rearrangements: Pinacol-pinacolone, Demjanov, BenzilBensilic acid, Favorskii, Hofman, Curtius, Schmidt, Baeyer-Villiger and Fries rearrangement	6
II	**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. Phase transfer catalysts, application of zeolites as catalysts. Enzyme catalysis; Michaelis-Menten equation, turn-over number.	8
III	**Chemistry of Main Group Elements**	10

	s-Block Elements: Comparative study, diagonal relationship, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls. **p-Block Elements**: Comparative study (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides, oxyacids and halides of group 13-16, 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.	
IV	**Chemistry of Transition Elements** **Chemistry of Elements of First Transition Series** -Characteristic properties of d-block elements. 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, coordination number and geometry. **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 and stereochemistry.	06
V	**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.	4
VI	**Chemistry of Actinides** Electronic configuration, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U.	4
VII	**Metal Carbonyls** Metal carbonyls: 18-electron rule, preparation, structure and nature of bonding in the mononuclear and dinuclea carbonyls.	6
VIII	**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 Ca^{2+} . Nitrogen fixation.	6

Suggested Readings:

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education, 2003.
3. Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
4. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
5. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry,* 2nd edition, Oxford University Press, 2012.
6. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry,* John Wiley & Sons, Inc.

7. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
8. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.
9. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
10. Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006
11. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
12. Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.*, Oxford University Press, 1994.
13. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.
14. Francis, **P. G.** Mathematics for Chemists, Springer, 1984
15. Prakash Satya,Tuli G.D.,Basu S.K.Madan R.D.,Advanced inorganic Chemistry,S.Chand publishing.
16. Bariyar and Goyal , Inorganic 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.aspx
https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
https://nptel.ac.in/courses/104/103/104103071/#
https://swayam.gov.in/

This course can be opted as an elective by the students of following subjects: Chemistry in 12 th Class

Suggested Continuous Evaluation Methods:
Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .
Or

Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)

Course prerequisites: To study this course, a student must have Passed Semester-I.

Suggested equivalent online courses:
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Further Suggestions:
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Semester V, Paper-3 (Practical)
Course Title: Qualitative Analysis

Programme: Degree in Bachelor of Science	Year: Three	Semester: V
Practical paper-3		Subject: Chemistry
Course Code: B020503P	**Course Title: Qualitative Analysis**	

Course 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

Credits: 2	Elective
Max. Marks: 100	Min. Passing Marks: As per University Norms
Practical	**60 h**

Unit	Topics	No of Lectures
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 4+ or 3+3	16
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.	14
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	18
IV	**Identification of organic compounds** Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.	12

Suggested Readings:

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 of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
5. Harris, D.C.*Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
6. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.

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

Suggestive digital platforms web links

4. https://www.labster.com/chemistry-virtual-labs/
5. https://www.vlab.co.in/broad-area-chemical-sciences
1. **http://chemcollective.org/vlabs**

This course can be opted as an elective by the students of following subjects: Chemistry in 12 th Class

Course prerequisites: To study this course, a student must have Opted Sem-V Theory Ppaer-1 &2

Suggested equivalent online courses:

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Further Suggestions:

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Semester-VI Paper-1

Course Title: Organic Synthesis B

Programme: Degree in Bachelor of Science	Year: Three	Semester: VI
Paper-1 Theory	**Compulsory**	Subject: Chemistry
Course Code:B020601T	**Course Title: Organic Synthesis B**	

Course outcomes: This paper provides detailed knowledge of synthesis of various class of organic compounds and functional groups inter conversion. Organic synthesis is the most important branch of organic chemistry which provides jobs in production & QC departments related to chemicals, drugs, medicines, FMCG etc. industries.

The study of natural products and heterocyclic compounds offers an excellent strategy toward identifying novel biological probes for a number of diseases. Historically, natural products have played an important role in the development of pharmaceutical drugs for a number of diseases including cancer and infection.

- 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.

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks: As per University Norms

Total No. of Lectures- = 60

Unit	Topics	No. of Lectures
I	**Reagents in Organic Synthesis** A detailed study of the following reagents in organic transformations Oxidation with DDQ, CAN and SeO_2, mCPBA, Jones Oxidation, PCC, PDC, PFC, Collin's reagent and ruthenium tetraoxide. Reduction with $NaBH_4$, $LiAlH_4$, Meerwein-Ponndorf-Verley (MPV) reduction, Wilkinson's catalyst, Birch reduction, DIBAL-H	6

II	**Organometallic Compounds**-Organomagnesium compounds: the Grignard reagents, formation, structure and chemical reactions. Organozinc compounds: formation and chemical reactions. Organolithium compounds: formation and chemical reactions.	4
III	**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 uses 1, 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, Mannich reaction. Oxidation of aldehydes, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, $LiAlH_4$ and $NaBH_4$ reductions. Halogenation of enolizable ketones An introduction to α, β unsaturated aldehydes and Ketones.	10
IV	**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 acrylic, crotonic and cinnamic acids, Reactions: Action of heat on hydroxy 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, acid and alkaline hydrolysis of esters, trans-esterification.	8
V	**Organic Synthesis via Enolates** Acidity of α-hydrogens, alkylation of diethyl malonate and ethyl acetoacetate, Synthesis of ethyl acetoacetate: the Claisen condensation, Keto-enol tautomerism of ethyl acetoacetate. Alkylation of 1, 3-dithianes, Alkylation and acylation of enamines.	5
VI	**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, Picric acid. Halonitroarenes: 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, Gabriel-phthalimide reaction, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic	10

	substituton in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling	
VII	**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	10
VIII	**Natural Products** **Alkaloids & Terpenes:** Natural occurrence, General structural features, their physiological action, Hoffmann's exhaustive methylation, Emde's modification;. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine. Natural Occurrence and classification of terpenes, isoprene rule.	7

Suggested Readings:

17. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
18. Sykes, P. *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003.
19. Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
20. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
21. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry*, 2nd edition, Oxford University Press, 2012.
22. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry*, John Wiley & Sons, Inc.
23. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
24. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.
25. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly& Sons (1976).
26. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
27. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural
28. Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
29. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Pragati Prakashan (2010).
30. 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.htm
https://nptel.ac.in/courses/104/103/104103071/#
https://swayam.gov.in/

This course compulsory for the students of following subjects: Chemistry in 12th Class

Suggested Continuous Evaluation Methods:

Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others .

Or	
Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)
Course prerequisites: To study this course, a student must have Passed Sem-V Theory paper-1	
Suggested equivalent online courses:	
Further Suggestions:	

Semester-VI Paper-2

Course Title: Chemical Energetics and Radio Chemistry

Programme: Degree in Bachelor of Science	Year: Three	Semester: VI
Paper-2 Theory	**Elective**	Subject: Chemistry
Course Code: B020602T	**Course Title: Chemical Energetics and Radio Chemistry**	

Course outcomes: Upon successful completion of this course students should be able to describe laws of thermodynamics and its applications, phase equilibria of one and two component system, electro chemistry ,ionic equilibrium applications of conductivity and potentiometric measurements

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks: As per University Norms

Total No. of Lectures- = 60

Unit	Topics	No. of Lectures
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.	8
II	**Thermodynamics II**	10

	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 Helmhotz 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. Third Law of Thermodynamics ; Nernst heat theorem , statement and concept of residual entropy. Nernst distribution law – Thermodynamic derivation, applications .	
III	**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 conductances 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) . Transport number, definition and determination by Hittorf method and moving boundary method.	8
IV	**Ionic Equilibrium**: Electrode reactions, 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. Hydrolysis of salts	10
V	**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.	04

VI	**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.	6
VII	**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-Hardy rule, Zeta potential and Stern double layer (qualitative idea), Tyndall effect; Electrokinetic phenomena (qualitative idea only); Stability of colloids and zeta potential; Micelle formation	07
VIII	**Radiochemistry** Natural and induced radioactivity; radioactive decay-a-decay, b-decay, g-decay; neutrom emission, positrom emission, electron capture; unit of radioactivity (Curie); half life period; Geiger-Nuttal rule, 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, nuclear medicine-99mTc radiopharmaceuticals	07

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 ,new York John ,Wiley &sons , 2001
8. H. J. Arnikar, *Essentials of Nuclear Chemistry*, 4th ed., New Age International, New Delhi, 1995.
9. Bariyar,and Goyal, Physical Chemistry-II, Krishna Prakashan Media, Meerut , Third Eddition, 2019

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Suggested online links:

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

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/

This course can be opted as an elective by the students of following subjects: Chemistry in 12 th Class	
Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations, among others . **Or**	
Assessment and presentation of Assignment	(10 marks)
04 Unit tests (Objective): Max marks of each unit test = 10 (average of all 04 unit tests)	(10 marks)
Overall performance throughout the semester (Discipline, participation in different activities)	(05 marks)
Course prerequisites: To study this course, a student must have had the chemistry in class 12th , Physics in 12th	
Suggested equivalent online courses:	
Further Suggestions:	

Semester VI, Paper-3 (Practical)

Course Title: Analytical Methods

Programme: Degree in Bachelor of Science	Year: Three	Semester: VI
Practical paper-3		Subject: Chemistry
Course Code: B020603P	**Course Title: Analytical Methods**	

Course 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: perform thermo chemical reactions

Credits: 2	Elective
Max. Marks: 100	Min. Passing Marks: As per University Norms
Practical	**60 h**

Unit	Topics	No of Lectures
I	**Gravimetric Analysis** 1. Analysis of Cu as CuSCN, 2. Analysis of Ni as Ni (dimethylgloxime) 3. Analysis of Ba as $BaSO_4$.	30
II	**Paper Chromatography** Ascending and Circular. Determination of Rf 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-leucine using n-butanol:acetic acid: water (4:1:5). Spray reagent	8

	– 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-dinitrophenylhydrazones 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)	8
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 3. 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	14

Suggested Readings:

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

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

This course can be opted as an elective by the students of following subjects: Chemistry in 12 th Class

Course prerequisites: To study this course, a student must have had the chemistry in 12th class

Suggested equivalent online courses:

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Further Suggestions:

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FOURTH YEAR
OF
HIGHER EDUCATION

STRUCTURE OF CHEMISTRY COURSE IN FOURTH YEAR OF HIGHER EDUCATION FOR DEGREE IN BACHELOR OF SCIENCE (HONOURS) IN CHEMISTRY						
YEAR	**SEMESTER**	**COURSE CODE**	**PAPER TITLE**	**PAPER NATURE**	**CREDIT**	**PAGE NO**
FOURTH YEAR	**VII**	**B020701T**	Computer for chemists	Theory	4	
		B020702T	Inorganic Chemistry	Theory	4	
		B020703T	Organic Chemistry	Theory	4	
		B020704T	Physical Chemistry	Theory	4	
		B020705P	Chemistry Practical	Practical	4	
	VIII	**B020801T**	Group Theory and Spectroscopy	Theory	4	
		B020802T	Bio-Inorganic Chemistry	Theory	4	
		B020803T	Bio-Physical Chemistry	Theory	4	
		B020804T	Spectroscopic Methods of Analysis	Theory	4	
		B020805P	Chemistry Practical	Practical	4	

OR

STRUCTURE OF CHEMISTRY COURSE IN FOURTH YEAR OF HIGHER EDUCATION FOR DEGREE IN BACHELOR OF SCIENCE (HONOURS WITH RESEARCH) IN CHEMISTRY

YEAR	SEM	COURSE CODE	PAPER TITLE		PAPER NATURE	CREDIT	Page
FOURTH YEAR	VII	B020701T	Computer for chemists	CHOOSE ANY THREE	Theory	4	63
		B020702T	Inorganic Chemistry		Theory	4	64
		B020703T	Organic Chemistry		Theory	4	65
		B020704T	Physical Chemistry		Theory	4	66
		B020705P	Chemistry Practical		Practical	4	67
		B020706R	Dissertation in Chemistry*		Research	4	73
	VIII	B020801T	Group Theory and Spectroscopy	CHOOSE ANY THREE	Theory	4	68
		B020802T	Bio-Inorganic Chemistry		Theory	4	69
		B020803T	Bio-Physical Chemistry		Theory	4	70
		B020804T	Spectroscopic Methods of Analysis		Theory	4	71
		B020805P	Chemistry Practical		Practical	4	72
		B020806R	Dissertation in Chemistry*		Research	4	73

*Dissertation In Chemistry of both the Semesters (VII and VIII) will be jointly evaluated at the end of the Semester VIII as per University Guidelines.

OR

STRUCTURE OF CHEMISTRY COURSE IN FOURTH YEAR OF HIGHER EDUCATION FOR DEGREE IN BACHELOR OF SCIENCE ((APPRENTICESHIP / INTERNSHIP EMBEDDED) IN CHEMISTRY

YEAR	SEMESTER	PAPER TITLE	CREDIT
FOURTH YEAR	VII & VIII	As per the Guidelines laid by the University	40

DETAILED CHEMISTRY SYLLABUS
FOR
FOURTH YEAR
OF HIGHER EDUCATION

Purpose of the Program

The purpose of the M.Sc. Program at the University is to provide the key knowledge of various disciplines in Chemistry and on Advances in this field. To prepare students for careers as professional in various Research Institutes and Industries.

SEMESTER-VII

B020701T **COMPUTER FOR CHEMISTS** **M.M. 75**

Credits-04

Unit 1: History of Development of Computer, Classification of Computers, Generation of Computers, General Awareness of Computer Hardware – CPU and other peripheral devices, Input, Output and Auxiliary Storage Devices

Unit II: Softwares and their types(System Software & Application Software), Computer Language and their types (Low Level & High Level Languages), Operating System, requirement of OS, Types of OS : Single User and Multi-user OS with example

Unit III: **Computer and Internet 1:**What is Networking, Different types of Networking (LAN, WAN and MAN), Optical Fibres, Ethernet, Network Interface Card, Hub, Switch, Routers, Modems, Protocols TCP/IP, Internet Service Providers (ISP), Web Search Engine, Intranet, Difference between Internet & Intranet

Unit IV: Educational and Research Resources on Net for Chemical Sciences, Online Tutorials and Lectures Virtual Labs, Electronic Journals, E-books, Digital Libraries, Use of Chemdraws like tools for Chemical Education.

Unit V: MS Word, facilities in MS Word, MS- Excel, Facilities in MS Excel,MS PowerPoint, Oral Presentations using visual aids such as Power Point etc. Adobe Photoshop (Introductory), Multimedia, Digital Arts.

Books Suggested:

1. Computer Fundamentals,(Concepts,systems and Applications),Pradeep K. Sinha,PritiSinha, BPB Publications
2. Computer Basics,G. Manjunath.Vasan Publications
3. Fundamentals of Computers,E. BalagurusamyE. Balagurusamy, McGraw Hill Education
4. Fundamentals of Internet Programming, Mir Shehzad Ahmad, Toronto Academic Press

B020702T **INORGANIC CHEMISTRY** **M.M. 75**

Credits-04

Unit I: **Mechanism of Inorganic Reactions:**

Mechanisms of redox reactions of metal complexes, Substitution reactions of octahedral and square planar complexes in aqueous solutions, cis-and trans effects.

Unit II: **Nuclear Chemistry:**

Radioactive decay and equilibrium, Nuclear reactions and its types, Q-value, cross section of reactions, chemical effects of nuclear transformation. Nuclear fission–Fission products, Fission Yield and Nuclear Reactors, Nuclear Fusion and Stellar energy.

Radioactive techniques –(1) Tracer techniques (neutron activation analysis), (2) Counter techniques such as G.M., Ionization and proportional counters.

Unit III: **Metal clusters:**

Cluster compounds; Introduction, classification of clusters, Diborane- structure and properties. Higher boranes- Introduction, classification, STYX rule, classification and structure of carboranes. Metalloboranes and metallocarboranes, isolobal analogy. Metal carbonyl and metal halide clusters- Introduction, classification and structures. Zintel ions, Wade's rule, LNCC & HNCC, Caping rule

Unit IV: **Chemistry of Macrocycles :**

Complexes of crown ethers, porphyrins and cryptands, their synthesis, important characteristics

With special reference to hole size and importance in biological systems.

Unit V: **Metal Π-Acid Complexes**

Metal Carbonyls: Structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidations, important reactions of metal carbonyls, preparation, bonding, structure and important reactions of transition metal nitrosyls,

Books Suggested:

1, Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson , John Wiley.

2 .Inorganic Chemistry, J.E. Huhey, Harpes& Row.

3. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.

4. Comprehensive Coordination Chemistry EdsG.Wilkinson, R.D. Gillars and J.AMcCleverty,Pergamo

5. Nuclear and Radioactivity- Friedlander G; Kennedy J.M Mamas E.S., Miller J.M., Wiley Inter Science N.Y. (1981).

6. Nuclear Reactions R. Singh & S. N. Mukherjee, New Age International. New Delhi.

B020703T **ORGANIC CHEMISTRY** **M.M. 75**

Credits-04

Unit-I: (a) **Delocalized chemical bonding** –conjugation, cross conjugation, resonance, hyperconjugation, tautomerism.

(b) **Reaction intermediates**- Generation, geometry, stability and reactions of carbocations, carbanions, free radicals, carbenes, nitrenes and benzynes.

Unit-II: **Substitution reactions:**

Electrophilic substitution reactions in aromatic and aliphatic compounds with their mechanism, Nucleophilic aliphatic and aromatic substitutions reactions.SN^1, SN^2 mechanisms, neighbouring group participation in aliphatic nucleophilic substitutions, Factors affecting the nucleophilicsubstitution reactions

Unit- III: **Elimination reactions:**

The E^1, E^2, E^1CB mechanisms, orientation in E^2 reactions (Saytezeff and Hoffman), Pyrrolyticsyn-elimination, Stereochemistry of elimination reaction.

Unit- IV: **Common Organic Reaction and Mechanism**

Aldol, Perkin, Diekmann condensation, Reformatsky, Benzoin, Wittig, Mannich reaction, Michael reaction, Diels-Alder reaction, Knoevengel reaction.

Unit- V: **Reagents in Organic Synthesis:**

Lithium aluminium hydride, Sodium borohydride, lithium dialkylcuprate, lithium di-isopropylamine, Grignard reagents, mono &dialkylboranes, 1,3-Dithiane, m-chloroperoxybenzoic acid, Osmium tetraoxide. dicyclohexylcarbodimide, N- bromosuccinimide.

Books Suggested:

1. Organic Reagents and Name Reactions Samuel Delvin, Ivy Publishing House
2. Experiments and Techniques in Organic Chemistry, D. Pasto. C. Johnson and M. Miller, Prentice Hall.
3. Organic Reaction Mechanisms, V.K. Ahluwalia&Rakesh K. Parashar,Narosa Publishing House. .
4. Systematic qualitative Organic Analysis, H. Middleton, Adward Arnold.
5. Organic Reaction Mechanisms by Raj K. Bansal, New Age International Private Limited
6. Organic Reactions and Their Mechanisms by P S Kalsi, New Age International Private Limited
7. Reaction and Reagents ,O.P.Agrawal, Krishna Publication, Meerut.

B020704T **PHYSICAL CHEMISTRY** **M.M.75**

Credits-04

Unit-I: Quantum Chemistry:

Approximation Method:The variation theorem, Linear variation principles, Perturbation theory (First order and non degenerates), application of variation method and perturbation theory to be helium molecule.

Unit-II: Thermodynamics:

Chemical thermodynamics ,second law of thermodynamics .Gibbs Helmholtz equation,Direction of reaction,Third law of Thermodynamics, Concept of Entropy at absolute zero,Nernst heat eqation.

Statistical thermodynamics-Partition functions,Application of partition function to determine chemical equilibrium and equilibrium constant , Bose-Einstein and Fermi-Diarc statistics basic ideas.

Unit-III: **Chemical Dynamics:** Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and the activated complex theory, ionic reaction, kinetic salt effects, steady state kinetics, kinetics and thermodynamic control of reaction, treatment of unimolecular reactions. Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde decomposition of ethane, Photochemical (hydrogen-bromine and hydrogen-chlorine reactions)

Unit-IV: **Micelles:** Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factor-affecting the CMC of surfactants.

Macromolecules: Polymer-definition, types of polymers, electrically conducting, fire resistant, liquid crystals polymers, kinetics of polymerization, mechanism of polymerization.

Unit-V: **Electrochemistry:** Electrochemistry of solution, Debye-Huckel-Onsager treatment and its extension, ion solvent interaction, Debye-HuckelJerum mode, thermodynamic of electrified interface equation, over potential, exchange current density.

Book Suggested:

1. Physical chemistry, P.W. Atkins, ELBS
2. Introduction to Quantum chemistry, A.K. Chandra, Tata McGraw Hill.
3. Quantum chemistry, Era N Levine, Prentice Hall.
4. Coulson's Valence, R. McWeeny, ELBS.
5. Chemical Kinetics, K.J. Laidler, McGraw- Hill.
6. Kinetics and mechanism of chemical transformations, J. Rajaraman and J. Kuriacose, McMillan.
7. Micelles, Theoretical and applied aspect, V. Moroi, Plenum.
8. Modern electrochemistry, Vol. 1 and Vol. 2, J.O.M. Bockris and A.K.N. Reddy, Plenum.

B020705P **M.Sc. CHEMISTRY Practical (Semester VII)** **M.M.100**

Credits-04

INORGANIC CHEMISTRY

Inorganic Preparations: **[25]**

(i) Reineckel Salt /Ammoniumdiamminetetrathiocyanatochromate(II)$NH_4[Cr(NH_3)_2(SCN)_4]$

(ii) Tetraamine Cupric Sulphate$\{CU(NH_3)_4\}SO_4.H_2O$

(iii) Chrome Alum

(iv) Aluminium Chloride Hexahydrate

(v) Nickel Dimethyl Glyoxime $[Ni(dmg)_2]$

(vi) Sodium Cobalt Nitrate

(vii) Potassium Trioxalato Ferrate (III),$K_3[Fe(C_2O_4)_3]$

(viii) *Cis*-Potassium DioxalatoDiaqua Chromate

(ix) *Trans*-Potassium DioxalatoDiaqua Chromate $K[Cr(C_2O_4)(H_2O)_2].2H_2O$

(x) Prussian Blue/Turnbull's Blue $KFe^{III}[Fe^{II}(CN)_6]$

(xi) Hexaamminecobalt(III)hexanitritocobaltate(III),$[Co(NH_3)_6][Co(NO_2)_6]$

(xii) Tris(acetylacetonato)Manganese(III), $Mn(acac)_3$

ORGANIC CHEMISTRY

Qualitative Analysis: **[25]**

Separation, Purification and Identification of compounds of binary organic mixtures (solid-solid,soid-liquid, liquid-liquid).

PHYSICALCHEMISTRY

[25]

(1) To estimate hardness of water by ethylene diamine tetra-acetic acid (EDTA).

(2) To determine the specific reaction rate of the hydrolysis of methyl acetate/ ethyl acetate catalyzed by hydrogen ions at room temperature.

(3)To titrate the given mixture of CO_3 and HCO_3 ions against a strong acid (HCl) using p-meter and to determine the strength of it.

(4) Preparation of standard solution.

(5) To test the validity of lambert-Beer's Law (using methylene blue) and to determine

I. λmax

II. Molar extinction coefficient (€)

RECORD **[15]**

VIVA **[10]**

SEMESTER-VIII

B020801T **GROUP THEORY AND SPECTROSCOPY** **M.M.75**

Credits-04

Unit-I: Symmetry elements and symmetry operation,

Symmetry elements and symmetry operations, point groups and their classification with examples, sub groups. General methods of assigning point groups to molecules with different shapes like Linear, Bent, Trigonal planar, Trigonal pyramidal, Tetrahedral, Trigonal bipyramidal. Octahedral, Square pyramidal, Square planar etc.

Unit-II Vibrational spectroscopy

Basic principles of vibrational spectroscopy of homonuclear and heteronuclear diatomic molecules. Selection rules for diatomic molecules based on Harmonic oscillator approximation. Force constants and amplitudes. Anharmonic oscillator.Overtones and combination bands.Vibration-rotation spectra, P, Q and R branches.Breakdown of the Born-Oppenheimner approximation.

Unit-III: Electronic Spectroscopy

Introduction,Franck-Condon Principle, theory involving electronic transition and applications, spectra of transition metal complexes, charge-transfer spectra.

Unit-IV: Atomic absorption spectroscopy: Introduction, principle, technique instrumentation and applications

Unit-V:Flame photometry:

Introduction, principle, technique, instrumentation, interference and applications

Books Suggested:

1. Modern spectroscopy, J.M. Hollas, John Willey.
2. Applied Electronic Spectroscopy For Chemical Analysis. Ed.H, Windawi and F.L. Ho, Wiley Interscience.
3. Introduction to Molecular Spectroscopy, G.M. Barrow, Mcgraw Hill.
4. Basic Principles of Spectroscopy, R. Chang. McGraw Hill.
5. Theory and Application of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBHOxford.
6. Introduction of Photoelectron Spectroscopy, P.K. Ghosh, John Wiley.
7. Introduction of Magnetic Resonance, A. Carrington and A.D. Maclachlan, Harper and Row

B020802T **BIO-INORGANIC CHEMISTRY** **M.M.75**

Credits-04

Unit-I: **Metal ions in biology:**
Molecular mechanism of ion transport across membranes sodium and potassium pump, Essential and trace elements.

Unit-II: **Biomolecules:**
Structures and functions of metalloproteins in electron transport process -cytochromes and Iron-Sulphur proteins, DNA polymerisation, glucose storage.

Unit-III: **Bio-inorganic pigments:**
Chlorophyll, Photosystem-I and Photosystem-II in cleavage of water, haemoglobin, myoglobin, haemocyanin and hemerythrin.Storage of oxygen and its transport.

Unit-IV: **Bio-Chemistry:**
Biochemistry of calcium, copper and zinc.Biological Nitrogen fixation (Associative nitrogen fixation, symbiotic nitrogen fixation).

Unit-V: (a) Toxicity of metals (cadmium, mercury, lead, arsenic, copper). Deficiency of Metal ions
(b) Medicinal Inorganic chemistry- Metal ions and chelating agent in medicines. Drug activity, control of metal ion concentration, *In vivo* removal of metal ions, Antimicrobial drugs, anticancer drugs.

Books Suggested:

1. Progress in Inorganic Chemistry, vol. 18 and 38 Ed. J J. Lippard, Wiley.
2. Inorganic Biochemistry vol. I and II ed. G. L. Eichhorn, Elsevier.
3. Principles of Bioinorganic Chemistry, S. J. Lippard and J. M. Berg, University Science Books.

B020803T **BIO- PHYSICAL CHEMISTRY** **M.M.75**

Credits-04

Unit-I: **Enzymes:**
Introduction, nomenclature and classification, Fischer lock and key: Koshland and Induced hypothesis: Transition state theory, acid base catalysis, Nucleophilic displacement on phosphorous atom. Multiple displacement reaction and the coupling of ATP, cleavage to endergonic processes, Addition and Elimination reaction of enzyme catalyzed carboxylation and decarboxylation

Unit-II **Coenzymes:**
Apoenzymes, structure and biological function of coenzymes, production, purification of enzymes, methods of immobilization of enzyme activity, application of immobilized enzymes, clinical use of enzymes

Unit-III **Bio-energetics:**
Standard and free energy change in biochemical reactions, exergonic endergonic, hydrolysis of ATP, synthesis of ATP from ADP

Unit-IV **Cell membranes and Transport of ions:**
Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamics treatment of membrane transport, nerve conduction.

Unit-V **Biopolymer Interactions:**
Forces involved in biopolymer interactions, electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interaction, multiple equilibrium and various types of binding processes in biological systems.

Books Suggested:

1. Understanding enzymes, Trevor Palmer, Prentice Hall.
2. Enzyme Mechanisms Ed, M. I. Page and A. Williams, RSC.
3. Fundamental ofEnzymology, N. C. Price and L. Stevens, Oxford University Press.
4. Biochemistry, L. Stryer, W.H. Freeman.
5. Macromolecules: Structure and Function, F. Wold. Prentice Wall. 6. Biochemistry, Voet and Voet, John Wiley

B020804T **SPECTROSCOPIC METHODS OF ANALYSIS** **M.M.75**

Credits-04

Unit I: **Absorption spectroscopy**

Lambert's Beer's Law and its limitations. Instrumentation.Selection rules, Types of electronic transitions, λmax, chromophores and auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Woodward rule for conjugated dienes and carbonyl compounds, applications.

Unit II: **Raman Spectroscopy**

Classical and quantum theories of Raman Effect, pure rotational vibrational and vibrational-rotational, Raman spectra, Selection rules, Mutual exclusion principle, Resonance Raman spectroscopy, Coherent anti stokes raman spectroscopy (CARS)

Unit III: **Nuclear magnetic resonance spectroscopy (NMR):**

Introduction, Theory, relaxation process and saturation, environmental effects on NMR spectra, chemical shift, spin-spin splitting, factors influencing coupling constant 'J', Spin decoupling, basic ideas about instrument, NMR studies of nuclei other than proton ^{13}C, FT-NMR advantages of FT-NMR, use of NMR in medical diagnostics.

Unit IV: **Mass Spectrometry:**

Introduction, molecule ion peak, base peak, isotopic abudance, metastable ions fragmentation mechanism of compounds containing C,H,O,N and halogen, McLafferty rearrangement , nitrogen rule and ring rule and applications.

Unit V: **ESR Spectroscopy:**

Introduction, principle, hyperfine splitting, and significance of g-value, determination of δ - value.Rules for hyperfine splitting and applications.

Books Suggested:

1. Modern spectroscopy, J.M. Hollas, John Willey.
2. Introduction to Molecular Spectroscopy, G.M. Barrow, Mcgraw Hill.
3. Basic Principles of Spectroscopy, R. Chang. McGraw Hill.
4. Theory and Application of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBHOxford.
5. Introduction of Magnetic Resonance, A. Carrington and A.D. Maclachlan, Harper and Row.
6. Spectrometric identification of Organic Compounds, R.M. Silverstein, G. C. Bassler, T. C. Morril, John Wiley & Sons,

B020805P **M.Sc. CHEMISTRY Practical (Semester VIII)** **M.M.100**

Credits-04

INORGANIC CHEMISTRY

Quantitative Analysis: [25]

Separation and determination of two metal ions Cu-Ni, Ni-Zn, Cu-Zn, etc. involving volumetric and gravimetric methods.

ORGANIC CHEMISTRY

Organic Synthesis: [25]

Sulphonation, Diazotization, Aldol Condensation, Friedel Crafts Reaction, Cannizzaro Reaction, Acetylation, Benzoylation, Nitration.

PHYSICALCHEMISTRY [25]

(1) To study the distribution co-efficient of benzoic acid between benzene and water.
(2) To determine the distribution co-efficient of iodine between water and CCl_4 at room temperature.
(3) To determine the amount of chloride ions present in the given KCl solution.
(4) To determine nickel as dimethyl glyoximate complex spectrophotometrically.
(5) Determination of proton coefficient between water and an organic solvent.

RECORD [15]

VIVA [10]

FOURTH YEAR (VII & VIII SEMESTER)		
COURSE CODE	**TITLE OF PAPER**	**CREDITS**
B020706R	Dissertation in Chemistry	**04**
B020806R	Dissertation in Chemistry	**04**

RESEARCH PROJECT M.M.100

Credits-08

The research project is based on the following topics –

1. Coordination Chemistry
2. Macro Cyclic Chemistry
3. Green Chemistry
4. Nano Chemistry
5. Pesticide Chemistry
6. Polymer Chemistry
7. Polymer Nano Composite
8. Environmental Science
   i. Air Pollution
   ii. Soil Pollution
   iii. Water Pollution
9. Natural Products
10. Synthetic Organic Chemistry
11. Drug Chemistry
12. Industrial Chemistry

FIFTH YEAR
OF
HIGHER EDUCATION

STRUCTURE OF CHEMISTRY COURSE IN FIFTH YEAR OF HIGHER EDUCATION FOR

DEGREE IN MASTER OF SCIENCE IN CHEMISTRY

YEAR	SEMESTER	COURSE CODE	PAPER TITLE		PAPER NATURE	CREDITS
FIFTH YEAR	IX	**B020901T**	Coordination Chemistry		Theory	4
		B020902T	Solid State Chemistry, surface Phenomenon and Chemical Equilibria		Theory	4
		B020903T	Photo and Stereochemistry	Choose any One	Theory	4
		B020904T	Basic Analytical Chemistry		Theory	4
		B020905T	Chemistry of Natural Products		Theory	4
		B020906T	Polymer Chemistry		Theory	4
		B020907P	Chemistry Practical		Practical	4
		B020908R	Research Project		Research	4
	X	**B021001T**	Interdisciplinary Topics	Choose any Two	Theory	4
		B021002T	Separation Techniques		Theory	4
		B021003T	Advanced Analytical Methods		Theory	4
		B021004T	Advanced Inorganic Chemistry	Choose any One	Theory	4
		B021005T	Advanced Organic Chemistry		Theory	4
		B021006T	Advanced Physical Chemistry		Theory	4
		B021007T	Chemistry Practical		Practical	4
		B021008R	Research Project		Research	4
PG Dissertation In chemistry of both the Semesters (IX and X) will be jointly evaluated at the end of the Semester X as per University Guidelines						

B020901T **COORDINATION CHEMISTRY** **M.M.75**

Credits-04

Unit I: Crystal field theory, crystal field splitting of d-orbitals in octahedral,tetrahedral and square planar complexes, crystal field stabilization energy (CFSE) in octahedral (weak and strong fields) and tetrahedral complexes, factor affecting CFSE and uses of CFSE, spectrochemical series.

Unit-II: **(a)** Applications of CFT in colour of transition metal complexes, limitations of CFT, valence bond theory and comparison of VBT and CFT.

(b) Ligand field theory, evidences of covalance and adjusted crystal field thery (ACFT), molecular orbital treatment of octahedral complexes and bonding, molecular orbitals for tetrahedral and square planar complexes, spin cross over coordination compounds.

Unit III: Coordination chemistry of transition metal ions, stability constants of complexes and their determination; stabilization of unusual oxidation states. Stereochemistry of coordination compounds.Jahn-Teller effect; Interpretation of electronic spectra including charge transfer spectra; nephelauxetic series, magnetism: Dia -, para -, ferro – and anti-ferromagnetism quenching of orbital angular moment, spin orbit coupling.

Unit-IV: Inorganic reaction mechanism; substitution reactions, trans effect and electron transfer reactions, photochemical reaction of chromium and ruthenium complexes. Fluxional molecules, iso- and heteropoly acid, metal clusters spin crossover in coordination compounds.

Unit-V: **Studies and Applications of Lanthanides andActinides:**

Spectral and magnetic properties, Modern methods of separation of lanthanides and actinides. Organometallic compound of lanthanides, Applications of lanthanides and actinides compounds in industries. Use of lanthanides compounds as Shift's reagent.

Books Suggested:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson , John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harpes& Row.
3. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
4. Comprehensive Coordination Chemistry EdsG.Wilkinson, R.D. Gillars and J.AMcCleverty,Pergamo
5. Synthesis and Characterization of Inorganic compounds, W.L. Jolly, Prentice Hall.
6. Concise Inorganic Chemistry, J.D.Lee, Wiley Publication

B020902T **SOLID STATE CHEMISTRY, SURFACE PHENOMENON AND CHEMICAL EQUILIBRIA.** **M.M.75**

Credits-04

Unit-I : **Solid State**

Crystalline state of solids, unit cells and Bravais lattices, Miller indices, Diffraction of X-rays by crystalline solids, fundamental aspects of X-ray, electron and neutron diffraction studies

Unit-II: **Crystal Defects and Non- Stoichiometry**

Perfect and imperfect crystals, intrinsic and extrinsic defects-point defects, line and plane defects, vacancies-Schottky defects and frenkeldefects, structural imperfections and properties of solids such as ionic conductivity, diffusion, ferroelectric properties and luminescence, non-stiochiometry and defects.

Unit-III: **Electronic properties and Band theory**

Metals, insulators and semiconductors, electronic structure of solids-band theory, band structure of metals, insulators and semiconductors, intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, superconductors,

Unit-IV: **Surface Phenomenon**

Surface tension, adsorption on solids, electrical phenomena at interfaces, including electrokinetic, micelles and reverse micelles: solubilization, micro-emulsion, application of photoelectron spectroscopy, ESCA and Auger spectroscopy to the study of surfaces.

Unit-V: **Chemical Equilibria**

Free energy and entropy of mixing, partial molar quantities, Gibbs-Duhemequation.Equilibrium constant, temperature- dependence of equilibrium constant, phase diagram of one- and two component systems, phase rule.

Books Suggested:

1. Solid State Chemistry and its Application, Anthony R. West, Wiley Publication, US
2. Solid State chemistry an Introduction, Lesley E.Smart and Elaine A.Moore,Taylor and Francis,London.
3. Principles of Physical Chemistry, Puri, Sharma and Pathania, Vishal Publising, Delhi

B020903T **PHOTO AND STEREOCHEMISTRY** **M.M. 75**

(Elective-1)

Credits-05

Unit-I: General principles- Photochemical energy, Frank-Condon principle, Jablonski diagram, singlet and triplet states, photosensitization, quenching, quantum efficiency and quantum yield, energy transfer process in photochemistry, experimental methods of photochemistry.

Unit-II: Photochemistry of carbonyl compounds, Norrish type-I and Norrish type-II cleavages, Paterno-Buchi reactions, photoreductions, photochemistry of unsaturated systems like olefins, cis-trans isomerisation, dimerizations, hydrogen abstraction, addition. Photochemistry of enones-rearrangement of unsaturated ketones and cyclohexadienones.

Unit-III: A) Concept of chirality, elements of symmetry, R-S nomenclature, E-Z isomerisms. Interconversion of Fischer, Newman and Sawhorse projections

B) Conformation and reactivity in acyclic compound (upto four C-atoms) and cycloalkanes (upto cyclohexane)

C) Transannular effects in medium sized ring compounds.

Unit-IV: Molecular dissymmetry and chiroptical properties, linear and circularly polarized light, circular birefringences and circular dichroism, ORD and CD curves. Plain and Cotton effect curves and their applications. The octant rule and axial haloketone rule with applications

Unit-V: A) Racemates and their classification, method of resolution of recemates.

B) Chemoselectivity, regioselectivity, stereoselective, stereospecific reactions and enantioselectivity with examples.

Books Suggested:

1. Fundamental of Photochemistry, K. K. Rohtagi-Mukherji, Wiley-Eastern.
2. Molecular Photochemistry, N.J. Turro, W. A. Benjamin.
3. Organic Photochemistry, J. Coxon and B. Halton, Cambridge University Press.
4. Photochemistry, R P. Kundall and A. Gilbert, Thomson Nelson
5. Stereoselective Synthesis: A Practical Approach M.Nogradi, VCH.

B020904T **BASIC ANALYTICAL CHEMISTRY** **M.M. 75**

(Elective-2) *Credits-04*

Unit-I: **Amperometry:** Introduction, principle, types of current, technique, amperometric titrations with DME, amperometric titrations with rotating platinum micro electrode, biampero-metry, applications.

Unit-II: **Coulometry:** Introduction, constant current coulometry, controlled potential coulometry (principle and technique), types of coulometer, applications.

Unit-III: **Conductometry:** Introduction, principle, technique, electrolytic conductivity, measurement of electrolytic conductivity, conductometric titration, applications.

Unit-IV: **Polarography** :Introduction, principle, instrumentation, Ilkovic equation and its verification, half-wave potential and their Significance, D.M.E., residual current, migration current, diffusion current, limiting current, applications.

Unit-V: **Voltammetry** : (a) Introduction, principle, technique and applications
(b)Cyclic voltammetry and anodic stripping voltammetry.

Books Suggested

1. Instrumental Method of Chemical Analysis, B.K. Sharma, Krishna Prakashan, Media, Meerut.
2. Instrumental Method of Chemical Analysis, GurdeepChatwal, Himalaya Publication House, New Delhi.
3. Instrumental Method of Chemical Analysis, H. Kaur, PragatiPrakashan, New Delhi
4. Instrumental Method of Analysis, Willard, Meritt, Dean,Wadsworth Publishing Co. Inc, Australia
5. Basic Concept of analytical Chemistry, S.M. Khopkar,New Age International Publisher, New Delhi.
6. Fundamental of Analytical Chemistry, Holler and Crouch, Brooks Cole, US

B020905T **CHEMISTRY OF NATURAL PRODUCTS** **M.M.75**

(Elective-3) *Credits-04*

Unit-I: **Plant Pigments:**

Introduction, occurrence, general methods of structure determination, isolation and synthesis of apigenin, luteolin, vitexin, myrcetin, quercetin, lycopene, aureusin, cyanidin, hirostidin.

Unit-II: **Alkaloids:**

Introduction, classification, occurrence, isolation of alkaloids, general methods of determination of structure of alkaloids, Constitution and synthesis of cocaine, nicotine, atropine, morphine, reserpine.Biosynthesis of alkaloids.

Unit –III: **Terpenoids and Carotenoids:**

Introduction, classification, occurrence, general methods of structure determination, isoprene rule, constitution and synthesis of citral, zingiberene, farnesol, β- carotenoids, Biosynthesis of terpene.

Unit-IV: **Steroids:**

Introduction, classification, occurrence, isolation, constitution and synthesis of cholesterol, testosterone, progesterone, androsterone. Biosynthesis of steroid.

Unit-V: **Antibiotics:**

Introduction classification, synthesis of penicillin-G, penicillin-V, amoxycillin, tetracyclin, chloramphenicol, streptomycin.

Books Suggested:

1. Natural Products: Chemistry and Biological Significance J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope an J.B. Harborne, Longman Essex
2. Organic Chemistry, Vol 2, I L. Finar. ELBS.
3. Rodd's Chemistry of Carbon Compounds, Ed, S. Coffe Elsevier.
4. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Ed. Kurt Hostettmann, M.P. Gupta and A. Marston, Harwood Academic Publishers.
5. Introduction to Flavonoids, B.A. Bohm, Harwood Academic Publishers.
6. New Trends in Natural Product Chemistry, Atta-Ur-Rahman and M.I. Choudhary, Harwood Academic Publishers.
7. Insecticides of Natural Origin, SukhDev, Harwood Academic Publishers

B020906T **POLYMER CHEMISTRY** **M.M.75**

(Elective-4) ***Credits-04***

Unit-1 Basics Importance of polymers basic concepts; Monomers, repeat units, degree of polymerization, Linear, branched and network polymers, classification of polymers. Polymerization : condensation, addition, radical chain-ionic and co-ordination and copolymerization. Polymerization conditions and polymer reactions.Polymerization in homogeneous and heterogeneous systems.

Unit-II. Polymer Characterization Polydispersion - Average molecular weight concept. Number, weight and viscosity average molecular weights. Polydispersity and molecular weight distribution.The practical significance of molecular weight.Measurement of molecular weights.Endgroup, viscosity, light scattering, osmotic and ultracentrifugation methods Analysis and testing of polymers-chemical analysis of polymers, spectroscopic methods, X-ray diffraction study, Microscopy.Thermal analysis and physical testing-tensile strength.Fatigue.impact. Tear resistance. Hardness abrasion resistance.

Unit-III. Structure and Properties Morphology and order in cryststalline polymers-configurations of polymer chains. Crystal structures of polymers Morphology of cryststalline polymers, strain-induced morphology, crystallization and melting. Polymer structure and physical propertiescrystalline melting point Tm. melting points of homogeneous series, effect of chain flexibility and other steric factors, entropy and heat of fusion. The glass transition temperature, Tg relationship between Tm and Tg effects of molecular weight diluents, chemical structure, chain topology, branching and cross linking, property requirements and polymer utilization

Unit- IV. Polymer Processing Plastics, Elastomers and fibres. Compounding Processing Techniques; Calendering, Die casting, rotational casting.Film casting, injection moulding, blow moulding, extrusion moulding, thermoforming, foaming, reinforcing and fibre spinning.

Unit-V. Properties of Commercial Polymers Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins and silicon polymers. Functional polymers - Fire retarding polymers and electrically conducting polymers. Biomedical polymers-contact lens, dental polymers artificial heart, kidney, skin and blood cells.

Books Suggested:

1. Textbook of Polymer Science, F. W. Billmeyer. Jr.Wiley.
2. Polymer Science. V. R. Gowarikar, N.V. Viswanathan and J. Sreedhar, Wiley - Eastern.
3. Functional Monomers and Polymers , K. Takemoto, Y. Inaki and R.M. Ottanbrite.
4. Contemporary Polymer Chemistry, H.R. Alcock and F.W. Lambe, Prentice Hall.
5. Physics and Chemistry of polymers, J.M.G. Cowie, Blackie Academic and Professional.

B020907P **M.Sc. Chemistry Practical (Semester IX)** **[M.M. 100]**

Credit 4

M.Sc. (Inorganic Chemistry) Practical **[25]**

1 Qualitative analysis [15]

Qualitative analysis of an inorganic mixture of seven radicals including Tl, Mo.W, Te, Ti, Zr, Th, V and U in addition to the radical prescribed for the B.Sc. Course .Semi micro analysis is to be done.

2. **Flame Photometric Determinations** [10]

(a) Sodium and Potassium when present together

(b) Li/ Ca/ Ba/ Sr

(c) Cd and Mg in tap water

M.Sc. (Organic Chemistry) Practical **[25]**

1. Extraction of Organic compounds from natural resources: (One exercise) [15]

(i) Isolation of lactose from milk.

(ii) Isolation of casein from milk.

(iii) Isolation of caffeine from tea leaves.

(iv) Isolation of β- carotene from carrot.

(v) Isolation of lycopene from tomatoes.

(vi) Isolation of cystine fromhuman hair.

(vii) Isolation of Nicotine from tobacco.

2.Paper chromatography, separation and Identification of sugars present in glucose, fructose, sucrose by paper chromatography and determination of Rf values / TLC. [10]

M.Sc. (Physical Chemistry) Practical **[12.5x2=25]**

A list of experiment under different headings are given below.

Typical experiments are to be selected from each type

1. Thermodynamics:

(i) Determination of partial molar volume of solute (e.g. KCl) and solvent in a binary mixture.

(ii) Determination of the temperature dependence of the solubility of a compound in two solvents having similar intermolecular interaction (benzoic acid in water & in DMSO water mixture) and calculate the partial molar heat of solution.

2. Spectroscopy:

(i) Determination of pka of an indicator (e.g. Methyl red) in (a) aqueous and (b) micellar media

(ii) Determination of stoichiometry and Stability constant of inorganic (e.g. ferric-salicylin acid) and organic (e.g. amine iodine) complexes.

(iii) Characterization of the complexes by electronic and IR Spectral Data.

3. Electronics :

(i) Measurements of resistance with multimeter and calculate the colour code.

(ii) To measure the resistance of the given ammeter

RECORD [15]
VIVA [10]

SEMESTER-X

B021001T **INTERDISCIPLINARY TOPICS** **M.M. 75**

(Elective-1) *Credits-04*

Unit I: Chemistry in Nanoscience and Technology

Introduction to nanotechnology scope of applications, Synthesis of nanomaterials: Top-down processes: physical processes- milling, lithographic processes, machining, vapour phase condensation, plasma assisted deposition; Bottom– up processes; micro emulsion technique. Important nano materials (Nano optics, Nano magnetic, Nano electronics) carbon nanotubes (types, properties and applications)

Unit II: Catalysis and Green Chemistry:

Need for green chemistry, Twelve principles of GreenChemistry with their explanation and examples, Designing a green synthesis using these principles reactions (dry media reactions, microwave assisted reactions, solvent free reactions),Green chemistry in day to day life.

Unit III: Supra Molecular Chemistry:

Introduction, concept and language, molecular recognition, supra molecular reactivity and catalysis, transport processes and carrier design.

Unit IV: Environment and Atmosphere:

Environmental chemistry, chemical composition of atmosphere – particles, ions and radicals and their formation. Heat budget of the earth atmospheric system, vertical stability of atmosphere, chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, O and their effect, Green house effect, acid rain, air pollution controls and their chemistry.

Unit V: Environmental chemistry (Hydrosphere and soils):

The chemical composition of water bodies like lakes, streams, rivers, wetlands, etc. Hydrological cycle.Aquatic pollution – inorganic, organic, pesticide, agricultural, industrial and sewage, detergents, oil spills and oil pollutants, water quality parameters, water quality standards, purification and treatments of waste. Soil composition, micro and macro nutrients, pollution – fertilizers and pesticides, waste treatment.

Books Suggested:

- A Text Took of Nanoscience and Nanotechnology, McGraw Hill Education, New York
- Principles of Physical Chemistry, Puri, Sharma and Pathania, Vishal Publising, Delhi
- New Trends in Green Chemistry, V.K. Ahluwalia, Springer, New York.
- Environmental Chemistry, H.Kaur, PragatiPrakashan, Meerut

B021002T **SEPARATION TECHNIQUES** **M.M. 75**

(Elective-2) *Credits-04*

UNIT I- **AdsorptionChromatography:**

Thin-layer chromatography (TLC): Principle, methodology selection of stationary and mobile phases- preparation of plates, spotting, development, identification and detection, measurement of RF values, Qualitative and quantitative applications.

UNIT II- **Partition Chromatography:**

Paper chromatography (PC): Theory and principle; techniques: one, two dimensional and circular PC, mechanism of separation, structure of cellulose and types of paper, methodology, sample preparation, choice of solvents, location of spots and measurement of RF value, factors affecting RF values, advantages and applications

UNIT III- **Gas Chromatography (GC):** Principles, classification, experimental set up, special features, mechanism of separation procedures, advantages and disadvantages, and applications Plate theory, gas-solid and gas-liquid chromatography, Hyphened technique. GC-MS and its applications.

UNIT IV- **HPLC:** Principles, classification, experimental set up, special features, mechanism of separation procedures, advantages and disadvantages, and applications Super critical fluid chromatography, gel permeation chromatography and molecular sieves.

UNIT V- **Solvent Extraction:** Principles, classification, experimental set up, special features, mechanism of separation procedures, advantages and disadvantages, and applications Extraction equilibria, partition coefficient and extraction coefficient, extraction by chelation and salvation and salvation; solid-phase extraction (SPE)

Books Suggested:

1 Instrumental Method of Chemical Analysis, B.K. Sharma, Krishna Prakashan, Media, Meerut
2 Instrumental Method of Chemical Analysis, GurdeepChatwal, Himalaya Publication House, New Delhi
3 Instrumental Method of Chemical Analysis, H. Kaur, PragatiPrakashan, New Delhi
4 Instrumental Method of Analysis, Willard, Meritt, Dean,Wadsworth Publishing Co. Inc, Australia
5 Basic Concept of analytical Chemistry, S.M. Khopkar,New Age International Publisher, New Del

B021003T **ADVANCED ANALYTICAL METHODS** **M.M.75**

(Elective -3)

Credits-04

UNIT 1: **Data Analysis:** Errors, classification of errors, mean deviation and standard deviation, accuracy precision, rejection of measurements, confidence interval tests significance, minimization of errors and significant figures.

UNIT II: Principle, Instrumentation, Applications of Inductively Coupled Plasma(ICP) Spectroscopy.

UNIT III: Introduction,Principle, Instrumentation, Applications ofX-Ray Diffraction (XRD)

UNIT IV: Principle, Instrumentation, Applications of Scanning Electron Microscopy (SEM)& TEM

UNIT V: Thermogravimetric analysis (TGA): Principle, instrumentation, factors affecting TGA curve, differential thermal Analysis (DTA), instrumentation of DTA and application of DTA, simultaneous study of TGA, DTA with examples.

Books Suggested:

1. Instrumental Method of Chemical Analysis, B.K. Sharma, Krishna Prakashan, Media, Meerut
2. Instrumental Method of Chemical Analysis, GurdeepChatwal, Himalaya Publication House, New Delhi
3. Instrumental Method of Chemical Analysis, H. Kaur, PragatiPrakashan, New Delhi
4. Instrumental Method of Analysis, Willard, Meritt, Dean,Wadsworth Publishing Co. Inc, Australia

B021004T **ADVANCED INORGANIC CHEMISTRY** **M.M. 75**

(Elective-1)

Credits-04

Unit I- **(i)Transition metal π- complexes:** Transition metal π- complexes with unsaturated organic molecules, alkenes, alkynes, allyl, diene, dienyl, arene and trienyl complexes, preparations, properties, nature of bonding and structural features. Important reactions relating to nucleophilic and electrophilic attack on ligands and to organic synthesis.

(ii) Transition metal compounds with bonds to hydrogen.

Unit II- **(i)** Metal Storage Transport and Biomineralizations, Ferritin, Transferrin and Siderophores.

(ii)Calcium in Biology: Calcium in living cells, Transport and regulation, molecular aspects of intramolecular processes, extracellular binding proteins.

Unit III- **Metalloenzymes:** Zinc enzymes- Carboxypeptidase and carbonic anhydrase, Iron enzymes-catalase, peroxidase and cytochrome P-450. Copper enzymes-superoxide dismutase molybdenum oxatransferase enzymes-xanthine oxidase.Coenzyme Vitamin B_{12}.

Unit IV- **(i) Metal Nucleic Acid Interactions:** Metal ions and Metal complex interaction, metalcomplexes-nucleic acids.

(ii) Metal in Medicine: Metal deficiency and disease, toxic effect of metals, metals used for diagnosis and chemotherapy with particular reference to anticancer drugs.

Unit V- **Excited states of Metal Complexes:** Excited states of metal complexes comparison with organic compounds, electronically excited states of metal complexes, charge-transfer spectra, charge transfer excitations, methods for obtaining charge -transfer spectra.

Books Suggested:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson , John Wiley.

2. Inorganic Chemistry, J.E. Huhey, Harpes& Row.

3.Comprehensive Coordination Chemistry Eds .Wilkinson, R.D. Gillars and J.AMcCleverty,Pergamo

4. Synthesis and Characterization of Inorganic compounds, W.L. Jolly, Prentice Hall.

B0210051T **ADVANCED ORGANIC CHEMISTRY** **M.M.75**

(Elective-2) ***Credits-04***

Unit I: **Heterocycles:**

Introduction, classifications, IUPAC names of mono and bicyclic hetero aromatic compounds. Criteria of aromaticity in heterocycles(bond lengths, ring current, Empirical resonance energy, delocalization energy and Dewar resonance energy, diamagneticsusceptibility exaltations). Synthesis and reaction of benzo [b] and benzo [c], benzodiazoles and acridines, pyrazole, imidazole oxazole, thiazole, indole, pyrimidine.

Unit II: **Common Organic Rearrangements and their mechanism:**

Pinacol- Pinacolone, Wagner- Meerwein, BenzilBenzilic acid, Beckmann, Hoffmann, Curtius, Schmidt, Lossen, Sommelet-Hauser, Favoroskii and Baeyer- Villiger rearrangement.

Unit III: **Pericyclic Reactions:**

Classification and examples, Woodword-Hofmann's Rule, Electrolytic reaction, Cycloaddition reaction ([2+2] and [4+2] only) and Sigmatropic shifts [1,3]- shift, [1,5]-shift and [3,3]- shift (Cope rearrangement and Claisen rearrangement), FMO approach only.

Unit IV: **Disconnection Approach**

An introduction to synthons and synthetic equivalents, Guidelines for choosing disconnections, Functional Group Interconversion (FGI), use of protecting group in disconnection approach Synthetic design: Introduction, Retrosynthetic approach, One and two group C-X disconnections, Synthesis of some organic molecules by disconnection approach

Unit V: **Drugs**

Antihistaminic Drugs:- Introduction, preparation and uses of Benadryl, dimenhydrinate, antergan, pyribenzamine.

Anti-inflammatory:- Introduction, Preparation and uses of Steroid and non-steroid drugs (Ibuprofen, mefanamic acid, diclofenac)

Antimalarials:- Synthesis of mepacrine, chloroquin, Pamaquin, paludrin.

Books Suggested:

1. Heterocyclic Chemistry Vol. 1-3, R. R. Gupta, M. Kumar and V. Gupta. Springer Verlag.
2. Heterocyclic Chemistry, J.A. Joule, K. Mills and G. F. Smith, Chapman and Hall.
3. Heterocyclic Chemistry, T. L. Gilchrist, Longman Scientific Technical
4. The Organic Chemistry of Drug Design and drug Action, R.B. Silverman, Academic Press. Strategies for Organic Drug Synthesis and design. D. Leilnicer. John Wiley.
5. Organic Synthesis,Jagdamba Singh , L D S Yadav, Jaya Singh,PragatiPrakashan
6. Organic Synthesis,Jagdamba Singh , L D S Yadav, Jaya Singh,PragatiPrakashan

BO21006T **ADVANCED PHYSICAL CHEMISTRY** **MM : 75**

(Elective-3)

Credits-04

Unit I – **Thin Film and Langmuir-Blodgett Films:**Preparation techniques, evaporation/sputtering, chemical processes, MOCVD, Sol-gel, etc. Langmuir –Blodgett (LB) films, growth techniques, Photolithography, properties and application of thin & LB films.

Liquid Crystal: Mesmorphicbehavior, thermotropic liquid crystal, positional order, bond orientation order nematic and smeticmesophates, smetic-nematic, transition and clearing temperature, homeotropic, planar and schlieren textures, twisted nematics, chiral nematics, molecular arrangement in smetic A and smetic C phases, Optical properties of liquid crystal, Dielectric description of ordering in liquid crystals.

Unit II – **Polymeric Materials:** Molecular shape, structure and configuration, crystalinity, stress-strain behaviour, thermal behaviour, polymer types and their application, conducting and feno-electric polymers.

Unit III **Ionic Conductors:** Types of ionic conductors, mechanism of conduction, interstitial jumps (Frenkel); Vacancy, mechanism, diffusion superionic conductor, phase transitions and mechanism of conduction in super ionic conductors, examples and application of ionic conductors.

Unit IV – Theoretical and computation treatment of atoms and molecules, Hartree-Fock theory. Review of the principles of quantum mechanics, Born –oppenheimer approximation, Staler Condon rules. HartreeFock equation, Koopmans and Brilloning theories, Roothan equation, Gaussian sets.

Unit V– **General Properties of Liquids:**

(a) Liquids as dense gases, liquids as disordered solids, some thermodynamic relation, internal pressures and its significance in liquids. Equation of state, critical constants. Different types of intermolecular forces in liquids, different potential function for liquids, additivity of pair potential approximation.

(b) A classical partition function for liquids, correspondence principle, configuration integral, configuration properties.

Book Suggested:

1.Physical chemistry, P.W. Atkins, ELBS

2. Advanced Physical Chemistry, Gurdeep Raj, Goel Publishing House, Meerut.

3. Principles of Physical Chemistry, Puri, Sharma and Pathania, Vishal Publising, Delhi

4. Solid State Physics ,N. W. Aschcroft and N.D. Mermin, Holt, Rinehart and Winston, New York, 1976.

5.Textbook of Polymer Science, F. W. Billmeyer. Jr.Wiley.

BO21007P **M.Sc. Chemistry Practical (Semester X)**

M.Sc. (Inorganic Chemistry) Practical **M.M.100**

Credit 4

1.Gravimetric Analysis [30]

To separate and estimate Copper, Nickel, and Zinc in a mixed solution by Gravimetric method.

2. Spectrophotometric Determinations [25]

(a) Fluoride/ Nitrite/ Phosphate

(b) Copper-Ethylene diamine complex; slope ration method

3. Chromatographic Separations [20]

(a) Cd and Zn

(b) Zn and Mg

(c) Thin-layer chromatography

Separation of Ni, Mn, Co & Zn Determination of Rf values.

Record [15]

Viva [10]

M.Sc. (Organic Chemistry) Practical **M.M.100**

Credit 4

1. Multi- step synthesis of organic compounds: (One exercise) [20]

(i) Preparation of p- BromoanilinefromAniline (Bromination)

(ii) Preparation of p-nitroaniline from Aniline (Nitration)

(iii) Preparation of quinoline from aniline (Skraup Synthesis)

(iv) Preparation of 2- phenyl indole from phenyl hydrazine (Fischer- Indole synthesis)

(v) Benzoyl chloride to Benzaniline (Benzoylation)

(vi) Benzene to Acetanilide (Acetylation) .

2. Green chemistry: (One exercise) [15]

(i) Coenzyme catalysed benzoin condensation (Thiamine hydrolysedcatalysed synthesis of benzene)

(ii) Electrophilic aromatic substitution reaction-I (Nitration of Phenol)

(iii) Radical coupling reaction (Preparation of 1,1-Bis-2-naphthol)

(iv) Three component coupling (Synthesis of dihydropyrimidinone)

(v) Transestrification reaction (Synthesis of biodiesl)

(vii) Preparation of Iron (III) acetylacetonate

3. Spectrophotometric estimation/Identification: (One exercise) [15]

(i) Asprin, disprin, Sprintas

(ii) Caffeine

(iii) Ascorbic Acid (Lemon, Amla)

(iv) Carbohydrate (Glucose, Sucrose, Fructose

(v) Amino acids

4. Qualitative Analysis: [25]

Separation, Purification and Identification of compounds of tertiary mixtures (three solids).

Record [15]

Viva [10]

M.Sc. (Physical Chemistry) Practical

M.M.100 *Credit 4*

A list of experiment under different headings are given below.

Typical experiments are to be selected from each type

1. Thermodynamics: [20]

Determination of the temperature dependence of the solubility of a compound in two solvents having similar intermolecular interaction (benzoic acid in water & in DMSO water mixture) and calculate the partial molar heat of solution

2. Spectroscopy: [20]

(i) Determination of stoichiometry and Stability constant of inorganic (e.g. ferric-salicylin acid) and organic (e.g. amine iodine) complexes.

(ii) Characterization of the complexes by electronic and IR Spectral Data.

3. Polarography: [20]

(i) Estimation of Pb^{2+} and Cd^{2+}/Zn^{2+} and Ni^{2+} ions in a mixture of Pb^{2+} and Cd^{2+}/Zn^{2+} and Ni^{2+} by Polarography.

(ii) Determination of dissolved oxygen in aqueous solution of organic solvents.

4. Electronics : [15]

(iii) To study the characteristics of light emitting diode.

(iv) To study the characteristics of Zener diode.

(v) To study the characteristics of FET

(vi) To plot the characteristics curve of a diode.

(vii) Setting up of a thermostat: Constant temperature both

Record : [15]

Viva : [10]

BO21008R **RESEARCH PROJECT**

M.M.100

Credits-08

The research project is based on the following topics –

1. Coordination Chemistry
2. Macro Cyclic Chemistry
3. Green Chemistry
4. Nano Chemistry
5. Pesticide Chemistry
6. Polymer Chemistry
7. Polymer Nano Composite
8. Environmental Science

i. Air Pollution
ii. Soil Pollution
iii. Water Pollution

9. Natural Products
10. Synthetic Organic Chemistry
11. Drug Chemistry
12. Industrial Chemist

Programme Outcomes

Ensures the students to understand, acquire knowledge in Quantum Chemistry, Group Theory Symmetry, Photochemistry, Advanced Concepts in Spectroscopy, Polymer Science, Green Chemistry, Solid State, Natural Products, disconnection approach as well as role of Modern Synthetic Reagents in Organic Transformations, Nanotechnology, Thermodynamics, Advanced Chemical Kinetics, Surface Analytical Techniques to measure Surface Properties of materials and the Advanced Principles of various Electrochemical Techniques and all branches of Chemistry. This syllabus also ensures the students to understand acquire knowledge and have hands on experience in multistep Inorganic/ Organic Compound Synthesis and Analysis by using Spectroscopic Techniques and have hands on experience in multistep Organic Synthesis and Analysis by using Spectroscopic Techniques.