CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY KANPUR

Four Year Undergraduate Programme (FYUP)

CHEMISTRY

Syllabus of

4 YEAR B.Sc. (HONOURS)

4 YEAR B.Sc. (HONOURS WITH RESEARCH)

AND

4+1 YEAR (B.Sc. HONOURS/ B.Sc. HONOURS WITH RESEARCH + M.Sc.) IN CHEMISTRY

SESSION 2025-2026 ONWARDS

REVISED SYLLABUS OF CHEMISTRY

Curricular & Credit Framework
For
Four Year Undergraduate Programme
(FYUP)
In Accordance With
NATIONAL EDUCATION POLICY – 2020

For C.S.J.M. University, Kanpur

As Proposed By
Board of Studies (Chemistry)
C.S.J.M. University, Kanpur

Minutes of Meeting of Board of Studies of Chemistry for Four Year Undergraduate Programme (FYUP) @ CSJMU

a) A meeting of Board of Studies was held in online mode on 2nd June 2025 at 2:00 pm.

b) The meeting was attended by the following members: -

1. Prof. Arti Saxena, Convener BoS Chemistry, Dean Faculty of Science, HoD Chemistry, A.N.D. College, Kanpur

External Members-

2. Prof. C.L. Gehlot, Dept. of Chemistry, H.B.T.U. Kanpur
3. Prof. U.N. Tripathi, Dept. of Chemistry, D.D.U. Gorakhpur
4. Prof. R.N. Singh, Dept. of Chemistry, Lucknow University, Lucknow
5. Prof. S.S.S. Kushwaha, Ex – Principal, Dept. of Chemistry, P.P.N. College, Kanpur

Internal Members-

6. Dr. Sanjay Asthana, Dept. of Chemistry, D.A-V. College, Kanpur
7. Prof. Jai Veer Singh, Dept. of Chemistry, Nehru P.G. College, Chhibramau, Kannauj
8. Prof. Om Kumari, Dept. of Chemistry, K.K. P.G. College, Etawah

Special Invitee-

9. Dr. Dhananjay Dey, HoD Chemistry, School of Basic Science, C.S.J.M. University, Kanpur

c) This syllabus of FYUP Chemistry was unanimously passed through the Board, following all the norms of FYUP guidelines, with no addition or deletion of any paper in any semester of NEP 2020 Syllabus.

Prof. Arti Saxena	Prof. C.L. Gehlot	Prof. U.N. Tripathi	Prof. R.N. Singh	Prof. S.S.S. Kushwaha
Convener, BoS Chemistry Dean, Faculty of Science	H.B.T.U. Kanpur	D.D.U. Gorakhpur	Lucknow University, Lucknow	Ex – Principal, P.P.N. College, Kanpur

Dr. Sanjay Asthana	Prof. Jai Veer Singh	Prof. Om Kumari	Dr. Dhananjay Dey
D.A-V. College, Kanpur	Nehru P.G. College, Chhibramau, Kannauj	K.K. P.G. College, Etawah	School of Basic Science, C.S.J.M. University, Kanpur

CURRICULUM & CREDIT FRAMEWORK FOR FYUP

Semester - Wise Titles of the Papers in FYUP of B.Sc. Chemistry

Year	Semester	Course Code	Paper Title	Theory / Practical	Credits
Certificate in Bioorganic and Medicinal Chemistry					
1	I	B020101T	Fundamentals of Chemistry	Theory	4
		B020101P	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 Dynamic and 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
	* Out of 2 major subjects, Research Project is to be conducted in one Major subject, after 4th semester, if not then in 5th semester (credits of research projects will only be transferred in the second year after its completion.)				
Degree in Bachelor of Science					
3	V	B020501T	Organic Synthesis - A	Theory	4
		B020502T	Rearrangement 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

The Fourth Year						
Bachelor of Science with Honours Degree						
4	VII	B020701T	Inorganic Chemistry - I		Theory	4
		B020702T	Organic Chemistry - I		Theory	4
		B020703T	Physical Chemistry - I		Theory	4
		B020704T	Spectroscopy		Theory	4
		B020705P	Practical		Practical	4
	VIII	B020801T	Inorganic Chemistry - II		Theory	4
		B020802T	Organic Chemistry - II		Theory	4
		B020803T	Physical Chemistry - II		Theory	4
		B020804T	Environmental Chemistry	***ELECTIVE (SELECT ANY 1)**	Theory	4
		B020805T	Symmetry and Group Theory			
		B020806T	Practical		Practical	4
OR						
Bachelor of Science Degree Honours with Research (Only for students who secure 75% marks in the first 6 semesters)						
4	VII	B020701T	Inorganic Chemistry - I	***ELECTIVE (SELECT ANY 3)**	Theory	4
		B020702T	Organic Chemistry - I		Theory	4
		B020703T	Physical Chemistry - I		Theory	4
		B020704T	Spectroscopy			
		B020705P	Practical		Practical	4
		B020706R	Research Projects / Dissertation **(Progressive)**		Project	4
	VIII	B020801T	Inorganic Chemistry - II	***ELECTIVE (SELECT ANY 3)**	Theory	4
		B020802T	Organic Chemistry - II		Theory	4
		B020803T	Physical Chemistry - II			
		B020804T	Environmental Chemistry		Theory	4
		B020805T	Symmetry and Group Theory			
		B020806P	Practical		Practical	4
		B020807R	Research Projects/Dissertation **(Summited)**		Project	4

Beyond the Fourth Year

P.G (M.Sc. in Chemistry)						
5	IX	B020901T	Bioinorganic, Bioorganic, Biophysical Chemistry		Theory	4
		B020902T	Applications of Spectroscopy		Theory	4
		B020903T	Solid State Chemistry	***ELECTIVE (SELECT ANY 1)**	Theory	4
		B020904T	Photochemistry			
		B020905T	Organotransition Metal Chemistry			
		B020906T	Analytical Chemistry			
		B020907P	Practical		Practical	4
		B020908R	Research Project **(Progressive)**		Project	4
5	X	B021001T	Organic Synthesis	***ELECTIVE (SELECT ANY 3)**	Theory	4
		B021002T	Heterocyclic Chemistry			
		B021003T	Chemistry of Natural Products			
		B021004T	Medicinal Chemistry			
		B021005T	Polymers			4
		B021006T	Nuclear and Radio Chemistry			
		B021007T	Computational Chemistry			
		B021008T	Bioinorganic and Supramolecular Chemistry			
		B021009T	Industrial Chemistry			4
		B021010T	Green Chemistry			
		B021011P	Practical		Practical	4
		B021012R	Research Projects **(Summited)**		Project	4

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 course 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, should be included under Continues Evaluation (CIE)*	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, van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction.	
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, Van der Waals interactions, 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. **Numericals based on Chemical Reactions.**	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 Reactivity, Pearson Education 2006.
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*, 2nd 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 12th

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: 25+75 = 100	Min. Passing Marks:

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 12th Class

Suggested Continuous Evaluation Methods:

Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

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:……

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 Bioch*emistry *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 12th 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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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: 25+75 = 100	Min. Passing Marks:

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 12th Class

Suggested Continuous Evaluation Methods:

Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

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

Suggested equivalent online courses:

……..

Further Suggestions:

……..

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:……

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	Chem**ical 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.	05

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. **Molecular Velocities**: Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter.	10
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 stability of metal complexes and factors affecting the stability, stability constants of complexes and their determination, substitution reactions of square planar complexes	10
VIII	**Inorganic Spectroscopy and Magnetism** 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 and μ eff	10

	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 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 , Physics in Class 12th

Suggested equivalent online courses:

……..

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: 25 +75	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 12th Class

Suggested Continuous Evaluation Methods:

Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

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

Suggested equivalent online courses:

……..

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 develop basic skills required for purification, solvent extraction, TLC and column chromatography

Credits: 4	Elective
Max. Marks: 25+75	Min. Passing Marks:……

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.	3
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.	07

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:
……..

Further Suggestions:
……..

Semester IV, Paper-2 (Practical)
Course Title: Instrumental Analysis

Programme: Diploma in Chemical Dynamics and Analytical Techniques	Year: Two	Semester: V
Practical paper-3		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: 25 + 75	Min. Passing Marks:
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).	
III	**Spectroscopy** 1. Assignment of labelled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C-N, C-X, C=C, C=O, N=O, C≡C, C≡N stretching frequencies; characteristic bending vibrations are included. Spectra to be provided). 2. Assignment of labelled peaks in the ^{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 (fluorescein 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 12th Class

Suggested Continuous Evaluation Methods:

Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

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:

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:
……..

Further Suggestions:
……..

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:

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 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:
……..

Further Suggestions:
……..

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: 25+75	Min. Passing Marks:
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 12th Class

Suggested Continuous Evaluation Methods:	
Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

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

Suggested equivalent online courses:

……..

Further Suggestions:

……..

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:

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:
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
VI I	**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
VI II	**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 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 , 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: IV
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: 25+75	Min. Passing Marks:
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 R*f* values and identification of organic compounds: Separation of a mixture of phenylalanine and glycine. Alanine and aspartic acid Leucine and glutamic acid. Spray reagent – ninhydrin. Separation of a mixture of D, L – alanine, glycine, and L-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 12th Class

Suggested Continuous Evaluation Methods:

Viva voce	(10 marks)
Mock test	(10 marks)
Overall performance	(05marks)

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

Suggested equivalent online courses:

……..

Further Suggestions:

……..

B020701T Inorganic Chemistry-I Semester-VII

I Stereochemistry and Bonding in Main Group Compounds

VSEPR, Walsh diagrams (Tri- and Penta atomic molecules), dπ-pπ bonds, Bent rule and energetics of hybridizations, some simple reactions of covalently bonded molecules.

II Metal-Ligand Equilibria in solution

Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and it's thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry.

III Reaction Mechanism of Transition Metal Complexes

Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factor affection, acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anation reaction, reaction without metal ligand, bond cleavage. Substitution reaction in square planar complexes, the trans effect, mechanism of the substitution reaction. Redox reactions, electron transfer reactions, outer sphere type reaction, cross reaction and Marcus-HushTheory, inner sphere type reactions.

IV Metal –Ligand Bonding

Limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral and square planar complexes, π-bonding and molecular orbital theory.

Books Suggested:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson , John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
3. Chemistry of the elements, N.N. Greenwoods and A. Earnshow, Pergamon.
4. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
5. Magnetochemistry, R.L. Carlin, Springer Verlag.
6. Comprehensive Coordination Chemistry Eds G.Wilkinson, R.D. Gillars and J.A. McCleverty, Pergamon.

B020702T Organic Chemistry-I Semester-VII

I Nature of Bonding in Organic Molecules

Delocalized chemical bonding-conjugation, cross conjugation, resonance, hyper conjugation, bonding in fullerenes, tautomerism. Aromaticity in benzenoid and nonbenzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule,

Energy level of π- molecular orbitals, annulenes, antiaromaticity, ψ-aromaticity, homo aromaticity, PMO approach.

Bonds weaker than covalent-Crown ether complexes and cryptands, inclusion compounds, cyclodextrins, catenanes and rotaxanes

II Stereochemistry

Conformational analysis of cycloalkanes, decalins effect of conformation on reactivity, Conformation of sugars, steric strain due to unavoidable crowding.

Elements of symmetry. chirality, molecules with more than one chiral center, threo and erythro isomers, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis. Asymmetric synthesis. Optical activity in the absence chiral carbon (biphenyl, allenes & spiranes) Chirality due to helical shape. Stereochemistry of the compounds containing nitrogen, sulphur and phosphorous.

III Reaction Mechanism: Structure and Reactivity

Types of mechanism, types of reaction, thermodynamic and kinetic requirements, kinetic And thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining mechanism, isotope effects. Hard and soft acids and bases. Generation, structure, stability and reactivity of carbocations, carbanion, free radicals, carbenes and nitrenes.

Effect of Structure on Reactivity

Resonance and field effects, steric effect, quantitative treatment. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft equation.

IV Aliphatic Nucleophilic Substitution

The SN_2, SN_1, mixed SN_1 and SN_2 and SET mechanisms. The neighbouring group mechanism, neighbour group participation by π and σ bonds, anchimeric assistance. Classical and non-classical carbocations, phenonium ions, carbonyl system, common carbocation rearrangements. Application of NMR spectroscopy in the detection of carbocations. The SN_1 mechanism, Nucleophilic substitution at an allylic, aliphatic trigonal and a vinyl carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambident nucleophile, regioselectivity.

V Aliphatic Electrophilic Substitution

Bimolecular mechanism- SE_2 and SE_1. The SE_1 mechanism, electrophilic substitution accompanied by double bond shift. Effect of substrate, leaving group and the solvent polarity on the reactivity.

Book Suggested:

1. Advanced Organic Chemistry- Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A. Corey and R.J. Sunderberg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Skyes, Longman.
4. Structure and Mechanism in Organic Chemistry, C.K Ingold, Cornell University Press.
5. Organic Chemistry, R.T. Morrison and R.N. Boyd Prentice Hall.
6. Modern Organic Reactions, H.O. House, Benjamin.
7. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic Professional.
8. Pericyclic Reactions, S.M. Mukherji, Macmillan, India.
9. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.

B020703T Physical Chemistry-I Semester-VII

I Quantum chemistry

A. Introduction to Exact Quantum Mechanical Results
The Schrodinger equation and the postulates of quantum mechanics. Discussion of solutions of the Schrodinger equation to some model systems viz,. particle in a box, the harmonic oscillator, the rigid rotor, the hydrogen atom.

B. Approximate Methods
The variation theorem, linear variation principle, Perturbation theory (first order and non degenerate). Application of variation method and perturbation theory to the Helium atoms.

C. Angular Momentum
Ordinary angular momentum, generalized angular momentum, eigenfunction for angular momentum, eigenvalue of angular momentum , operator using ladder operators, addition of angular momentum , spin, antisymmetry and Pauli exclusion principle.

D. Electronic Structure of Atoms
Electronic configuration, Russell- Saunders terms and coupling schemes, Slater Codon parameters, terms separation energies for the p^n and d^n configuration, magnetic effect, spin orbit coupling and Zeeman splitting, Introduction to method of self-consistent field the varial theorem.

E. Molecular Orbital Theory
Huckel theory of conjugated system ,bond order and charge density calculation application to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene etc. Introduction to extended Huckel theory.

II Thermodynamics

A. Classical Thermodynamics

Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropy, Partial molar properties, partial molar free energy, partial molar volume and partial molar heat content and their significance. Determination of these quantities.
Concept of Fugacity and determination of fugacity.

Non ideal systems, excess function for non ideal solutions. Activity, activity coefficient, Debye Huckel theory for activity coefficient of electrolyte solutions, determination of activity and activity coefficient, ionic strength.

Application of phase rule to three component system, second order phase transition.

B. Statistical Thermodynamics

Concept of distributions, thermodynamic probability and most probable distribution. Ensemble averaging, postulate of ensemble averaging . Canonical, grand canonical and microcanonical ensembles, Corresponding distribution law (using Lagrange's method of undetermined multipliers).

Partition functions- translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition functions. Application of partition functions.

Heat capacity behaviour of solids- chemical equilibrium and equilibrium constant in term of partition functions. Fermi- Dirac statistics, distribution law and application of metal. Bose-Einstein statistics- distribution law and application to helium.

C. Non equilibrium thermodynamics

Thermodynamics criteria for non-equilibrium states, entropy production and entropy flow, entropy balance equation for different irreversible process (eg. heat flow, chemical reaction etc) transformations of the generalized fluxes and forces, non aquarium stationary states, phenomenological equations, microscopic reversibility and Onsager reciprocity relations, Electrokinetic phenomena, diffusion, electric conduction, Irreversible thermodynamics for biological systems, coupled reactions.

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.
9. Introduction to polymer science, V.R. Gowarikar, N.V. Vishwanathan and J. Sridhar, Wiley Eastern.

A Saxena

B020704T Spectroscopy Semester-VII

I Microwave spectroscopy

Classification of molecules, rigid rotor model, effect of isotopic substitution on the transition frequencies, intensities, non-rigid rotor. Stark effect, nuclear and electron spin interaction and effect of external field.

II Vibrational spectroscopy

A. Infrared Spectroscopy

Review of linear harmonic oscillator, vibrational energy of diatomic molecules, zero point energies, force constant and bond strengths, anharmonicity, Morse potential energy diagram, vibration- rotation spectroscopy, P,Q,R, Branches. Breakdown of Oppenheimer approximation; vibration of polyatomic molecules. Selection rules, normal mode of vibration, group frequencies, overtones, hot bands, factors affecting the band positions and intensities, far IR region, metal-ligand vibrations, normal co-ordinate analysis.

B. Raman spectroscopy

Classical and quantum theory of Raman effect, pure rotational, vibrational and vibration- rotational, Raman spectra, selection rules, mutual exclusion principle. Resonance Raman spectroscopy, coherent anti-Stokes Raman spectroscopy (CARS).

III Electronic Spectroscopy

A. Atomic Spectroscopy

Energies to atomic orbitals, vectors, representation of momenta, and vector coupling, spectra of hydrogen atom and alkali metal atoms

B. Molecular Spectroscopy

Energy levels, molecular orbitals, vibranic transitions, vibrational transition and geometry of the excited states. Franck-Condon Principle, electronic spectra of polyatomic molecules. Emission spectra; radiative and non-radiative decay, internal conversion, spectra of transition metal complexes , charge-transfer spectra.

C. Photoelectron Spectroscopy

Basic principles; Photo-electric effect, ionization process, Koopman's theorem. Photoelectron spectra of simple molecules, ESCA, chemical information from ESCA. Auger electron spectroscopy-basic idea.

IV Magnetic resonance spectroscopy

A. Nuclear Magnetic Resonance spectroscopy

Nuclear spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift and its measurement, factors influencing chemical shift, deshielding, spin-spin

interaction, factor influencing coupling constant 'J', classification (ABX,AMX, ABC,A_2 B_2 etc), spin decoupling, basic idea about instrument, NMR study of nuclei other than proton- ^{13}C, ^{19}F and ^{31}P, FT NMR, advantage of FT NMR, use of NMR in medical diagnostics.

B. Electron Spin Resonance spectroscopy

Basic principles, zero field splitting and Kramer's degeneracy, factors affecting the "g" value. Isotropic and anisotropic hyperfine coupling constant, spin Hamiltonian, spin densities and McConnell relationship, measurement techniques, applications.

C. Nuclear Quadruple Resonance Spectroscopy

Quadruple nuclei, quadruple moments, electric field gradient, coupling constant, splitting. Applications.

V Photoacoustic Spectroscopy

Basic principle of photoacoustic spectroscopy (PAS), PAS- gases and condensed system, chemical and surface 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. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood.
4. Physical Method in Chemistry, R.S. Drago, Saunders College.
5. Introduction to Molecular Spectroscopy, G.M. Barrow, Mcgraw Hill.
6. Basic Principles of Spectroscopy, R. Chang. McGraw Hill.
7. Theory and Application of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBH-Oxford.
8. Introduction of Photoelectron Spectroscopy, P.K. Ghosh, John Wiley.
9. Introduction of Magnetic Resonance, A. Carrington and A.D. Maclachlan, Harper and Row.

B020705P Practical Semester-VII

The duration of Practical Examination will be of Eight Hours and will comprise two exercises.

The Distribution of marks will be as follows.

(a) Inorganic Exercise (one) 25
(At least six ions including minimum one rare element)
(b) Organic Exercise (one) 25
(c) Viva-voce 10
(d) Record/Assessment 15

Inorganic Chemistry

Qualitative Analysis

(a) Rare metal ions- Tl, Mo, W, Ti, Zr, Th, Zr, V, U (Two metal ions in cationic/anionic forms).

(b) Insoluble oxides, sulphates and halides.

Chromatography

Separation of cations and anions by

(a) Paper Chromatography

(b) Column Chromatography

Organic Chemistry

Qualitative Analysis

Separation, purification and identification of compounds of binary mixture (one liquid and one solid) using TLC and Column chromatography, chemical tests. IR spectra to be used for functional group identifications.

Books Suggested

1. Vogel's Text book of Quantitative Analysis, revised. J. Bassett, R. C. Denney. G.H. Jeffery and J. Mendham ELBS.
2. Synthesis and Characterization of Inorganic compounds, W.L. Jolly, Prentice Hall.
3. Experiments and Techniques in Organic Chemistry, D. Pasto. C. Johnson and M. Miller, Prentice Hall.
4. Macroscale and Microscale Organic experiments, K.L. Williamson. D.C. Heath.
5. Systematic qualitative Organic Analysis, H. Middleton, Adward Arnold.
6. Handbook of Organic Analysis Qualitative and Quantitative. H. Clark, Adward Arnold.
7. Vogel's text book of Practical Organic Chemistry, A.R. Tatchell, John Wiley.

B020801T Inorganic Chemistry-II Semester-VIII

I Electronic Spectra and Magnetic Properties of Transition Metal Complexes

Spectroscopic ground states, correlation, Orgel and Tanabe-Sugano diagrams for Transition metal complexes (d^1-d^9 states), calculations of Dq, B and β parameters, charge-transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

II Metal π- Complexes

Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyl for bonding and structural elucidation, important reactions of metal carbonyl; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand.

III Metal Clusters

Higher boranes, carboranes, metalloboranes and metallocarboranes. Metal carbonyl and halide clusters, compounds with metal – metal multiple bonds.

IV Isopropyl and Heterophyl Acids and Salts

Books Suggested:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson , John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
3. Chemistry of the elements, N.N. Greenwoods and A. Earnshow, Pergamon.
4. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
5. Magnetochemistry, R.L. Carlin, Springer Verlag.
6. Comprehensive Coordination Chemistry Eds G.Wilkinson, R.D. Gillars and J.A. McCleverty, Pergamon.

B020802T Organic Chemistry-II Semester-VIII

I Aromatic Electrophilic Substitution

The arenium ion mechanism. Orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in the other ring system. Quantitative treatment of reactivity in substrate and electrophiles. Diazonium coupling. Vilsmeir reaction, Gattermann-Koch reaction.

II Aromatic Nucleophilic Substitution

The SNAr. SN_1, benzyne and SRN_1 mechanism. Reactivity effect of substrate, leaving group and attacking nucleophile. The Von Richter, Sommelet-Hauser and Smile rearrangements.

III Free radical Reactions

Types of free radical reactions, free radical substitution mechanism, mechanism at aromatic substrate, neighour group assistance. Reactivity of aliphatic and aromatic substrate at a bridgehead. Reactivity in the attacking radicals. The effect of solvent on reactivity. Allylic halogention (NBS), oxidation of aldehyde to carboxylic acids, auto oxidation, coupling of alkyne and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Free radical rearrangement. Hansdiecker reaction.

IV Addition to Carbon- Carbon Multiple Bonds

Mechanistic and stereochemical aspects of addition reaction involving electrophiles, nucleophiles and free radicals, region and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds. Hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.

V Addition to Carbon-Hetero Multiple Bonds

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compound. Wittig reaction. Mechanism of condensation reactions involving enolates- Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reaction. Hydrolysis of esters and amides, ammonolysis of esters.

VI Elimination Reactions

The E_1, E_2 and E_1cB mechanisms and their spectrum. Orientation of the double bonds. Reactivity effects of substrate structures. Attacking base, the leaving group and the medium. Mechanism and orientation in the pyrolytic elimination.

VII Pericyclic Reaction

Molecular orbital symmetry, frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions-conrotatory and disrotatory motions, 4n, 4n+2 and allylic systems. Cycloadditions-antarafacial and suprafacial additions 4n and 4n+2 systems, 2+2 addition of ketene, 1,3 dipolar cycloadditions and cheleotropic reactions.

Sigmatropic rearrangements-suprafacial and antarafacial shift of H, sigmatropic shift involving carbon moieties, 3,3- and 5,5- sigmatropic rearrangements. Claisen, Cope and aza-Cope rearrangements. Fluxional tautomerism. Ene reaction.

Book Suggested:

1. Advanced Organic Chemistry- Reactions, Mechanism and Structure, Jerry March, John Wiley.

2. Advanced Organic Chemistry, F.A. Corey and R.J. Sunderberg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Skyes, Longman.
4. Structure and Mechanism in Organic Chemistry, C.K Ingold, Cornell University Press.
5. Organic Chemistry, R.T. Morrison and R.N. Boyd Prentice Hall.
6. Modern Organic Reactions, H.O. House, Benjamin.
7. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic Professional.
8. Pericyclic Reactions, S.M. Mukherji, Macmillan, India.
9. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.

B020803T Physical Chemistry-II Semester-VIII

I Chemical dynamics

Method of determining rate law, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and activated complex theory, and ionic reaction, kinetic salt effects, steady state kinetics, kinetics and thermodynamic control of reaction, treatment of uni molecular reactions.

Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of Ethane) , photochemical (hydrogen -bromine and hydrogen-chlorine reactions) and oscillatory reaction (Belousov-Zhabotinsky Reactions), homogeneous catalysis, kinetics of enzyme reactions, general feature of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and the nuclear magnetic resonance method. Dynamics of molecular motion, probing the transition state, dynamics of barrier less chemical reactions in solution, dynamics of uni molecular reactions (Lindemann- Hinshelwood Kerala and Rice Ramsperger-Kassel-Marcus [RRKM]. Theory of unimolecular reactions).

II Surface chemistry

A. Adsorption

Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation) , Gibbs adsorption isotherm , estimation of surface area (BET equation), surface film on liquids (Electrokinetic phenomena), catalytic activity at surfaces.

B. Micelles

Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factor affecting the the CMC of surfactant, counter ion binding to micelles, thermodynamics of micellization-phase separation and mass action models, solubilization, micro emulsion, reverse micelles.

C. Macromolecules

Polymer- definition, types of polymers, electrically conducting, fire resistant, liquid crystal polymers, kinetics of polymerization, mechanism of polymerization.
Molecular mass, number and mass average molecular mass, molecular mass determination (osmometry viscometry, diffusion and light scattering methods), sedimentation, chain configuration of macro molecules, calculation of average dimensions of various chain structures.

III Electrochemistry

Electrochemistry of solution, Debye-Huckel-Onsager treatment and its extension, ion solvent interactions, Debye-Huckel-Jerum mode. Thermodynamics of electrified interface equations. Derivation of Electro-capillarity, Lippmann equations (surface excess), methods of determination. Structure of electrified interfaces. Guoy-Chapman, Graham- Devanathan-Mottwatts, Tobin, Bockris, Devanathan models.

Over potentials, Exchange current density, derivation of Butler-Volmer equation, Tafel plot.

Quantum aspects of charge transfer at electrodes-solution interfaces, quantization of charge transfer, tunneling.

Semiconductor interfaces- theory of double layer at semiconductor, electrolytic solution interfaces, structure of double layer interfaces. Effect of light at semiconductor solution interface.

Electrocatalysis- influence of various parameters. Hydrogen electrode.

Bioelectrochemistry, threshold membrane phenomenon, Nernst-Planck equation, Hodges-Huxley equations, core conductor models, Electrocardiography.

Polarography theory, Ilkovic equation; Half wave potential and its significance.
Introduction to corrosion, homogenous theory, forms of corrosion, corrosion monitoring and prevention methods.

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.
9. Introduction to polymer science, V.R. Gowarikar, N.V. Vishwanathan and J. Sridhar, Wiley Eastern.

B020804T Environmental Chemistry Semester-VIII

1. Environment

Introduction, the composition of the atmosphere, vertical temperature, heat budget of the earth atmospheric system, vertical stability atmosphere, biogeochemical cycles of C, N, P, S, and O, Biodistribution of elements.

2. Hydrosphere

The chemical composition of water bodies is lakes, streams, rivers, wetlands, etc. Hydrological cycle. Aquatic pollution-inorganic, organic, pesticides, agricultural, industrial and sewage, detergents, oil spills, and oil pollutants, water quality parameters-dissolved oxygen, biochemical oxygen demand, solids, metals, the content of chloride, sulphate, phosphate, nitrate, and micro-organisms, water quality standards, Analytical methods for measuring BOD, DO, COD, F, oils, metals (As, Cd, Cr, Hg, Pb), Residual chlorine and chlorine demand, purification and treatment of water.

3. Soils

Composition, micro, and macronutrients, Pollution-fertilizers, pesticides, plastics and metals, waste treatment.

4. Atmosphere

Chemical composition of atmosphere-particles, ions and radical and photochemical reactions in the atmosphere, smog formation, oxides of N,C,S,O and their effect, pollution by chemicals, petroleum, minerals, chlorofluorohydrocarbons, greenhouse effect, acid rain, air pollution controls, and their chemistry. Analytical methods for measuring air pollutants, continuous monitoring instruments.

5. Industrial pollution

Cement, sugar, distillery, drug, paper and pulp, thermal power plants, nuclear power plants, metallurgy. Radionuclide analysis, disposal of wastes and their management.

6. Environmental Toxicology

Chemical solutions to environmental problems, biodegradability, principles of decomposition, better industrial processes.

Books Suggested:

1. Environmental Chemistry, S.E. Manahan, Lewis Publishers.

A Saxena

2. Standard Methods of Chemical Analysis, F. J. Welcher vol. III, Van Nostrand Reinhold Co.
3. Environmental Chemistry, C. Baird, W. H. Freeman.
4. Environmental Toxicology, Ed. J. Rose, Gordon and Breach Science Publication.
5. Environmental Chemistry, A.K. De, Wiley Eastern.

B020805T Symmetry and Group Theory Semester-VIII

Symmetry elements and symmetry operation, definitions of group, subgroup, relation between orders of a finite group and its subgroup.

Conjugacy relation and classes. Point symmetry group. Schonflies symbols, representations of groups of matrices (representation for the Cn, Cnv, Cnh, Dnh etc. groups to be worked explicitly).

Character of a representation. The great orthogonality theorem (without proof) and its importance.

Character tables and their use; spectroscopy.

B020806P Practical Semester-VIII

The Distribution of marks will be as follows.

(a) Inorganic Exercise (One preparation)	25
(b) Organic Exercise (One exercise from given list)	25
(c) Viva-voce	10
(d) Record/Assessment	15

Inorganic Chemistry

Preparation of following inorganic compounds-

(1) $VO(acac)_2$
(2) $TiO(C_9H_8NO)_2\ 2H_2O$
(3) cis-$K[Cr(C_2O_4)_2\ (H_2O)_2]$
(4) $Na[Cr(NH_3)_2\ (SCN)_4]$
(5) $Mn(acac)_3$
(6) $K_3[Fe(C_2O_4)_3]$
(7) Prussian Blue, Turnbull's Blue
(8) $[Co(NH_3)_6]\ [Co(NO_2)_6]$
(9) cis-$[Co(trien)\ (NO_2)_2]\ Cl.H_2O$
(10) $Hg[Co\ (SCN)_4]$
(11) $[Co(Py)_2\ Cl_2]$
(12) $[Ni(NH_3)_6]Cl_2$
(13) $Ni(dmg)_2$
(14) $[Cu(NH_3)_4]\ SO_4.\ H_2O$

Organic Synthesis

Acetylation: Acetylation of cholesterol and separation of cholesteryl acetate by Column chromatography.
Oxidation: Adipic acid by chromic acid, oxidation of cyclohexanol.
Grignard reaction: Synthesis of triphenylmethanol from benzoic acid.
Aldol condensation: Dibenzal acetone from benzaldehyde.
Sandmeyer reaction: p-chlorotoluene from p-toluidine.
Acetoacetic ester condensation: Synthesis of ethyl-n-butylacetoacetate by A.E.E. condensation.
Cannizzaro reaction: 4-chlorobenzaldehyde as substrate.
Friedal Craft Reaction: Benzoyl propionic acid from succinic anhydride and benzene.
Aromatic electrophilic substitutions: Synthesis of p-nitroaniline and p-bromoaniline.
The Products may be characterized by Spectral Techniques.

Quantitative Analysis

Determination of the percentage or number of hydroxyl groups in an organic compound by acetylation methods.

Estimation of amines/phenols using bromate bromide solution/ or acetylation method.

Determination of Iodine and Saponification values of an oil samples.

Determination of DO, COD and BOD of water sample.

Books Suggested

1. Vogel's Text book of Quantitative Analysis, revised. J. Bassett, R. C. Denney. G.H. Jeffery and J. Mendham ELBS.
2. Synthesis and Characterization of Inorganic compounds, W.L. Jolly, Prentice Hall.
3. Experiments and Techniques in Organic Chemistry, D. Pasto. C. Johnson and M. Miller, Prentice Hall.
4. Macroscale and Microscale Organic experiments, K.L. Williamson. D.C. Heath.
5. Systematic qualitative Organic Analysis, H. Middleton, Adward Arnold.
6. Handbook of Organic Analysis Qualitative and Quantitative. H. Clark, Adward Arnold.
7. Vogel's text book of Practical Organic Chemistry, A.R. Tatchell, John Wiley.

B020901T Bio-Inorganic, Bio-Organic and Biophysical Chemistry Semester-IX

A. BIO-INORGANIC CHEMISTRY

1. Metal Ions in Biological Systems: Essential and trace metals.

2. Na^+/K^+ Pump: Role of metals ions in biological processes,

3. Bioenergetic and ATP Cycle: DNA polymerization, glucose storage, metal complexes in the transmission of energy, chlorophylls, photosystem I and photosystem II in water cleavage, model systems.

4. Transport and storage of Dioxygen: Heme protein and oxygen uptake, structure and function of hemoglobin, myoglobin, and hemerythrin, model synthetic complexes of iron, and copper.

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.

B. BIO-ORGANIC CHEMISTRY

1. Enzymes: Introduction and historical perspective, chemical, and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation, nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis, concept, and active site identification by using inhibitors, affinity labeling, and enzyme modification by site-directed mutagenesis.

2. Mechanism of enzyme action: Transport state theory, orientation, and steric effect, acid-base catalysis, covalent catalysis, strain or distortion, examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease.

3. Co-Enzyme Chemistry: Cofactors as derived from Vitamins, coenzymes, prosthetic groups, apoenzymes, structure, and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxalphosphate, NAD^+, $NADP^+$, FMN, FAD, lipoic acid, vitamin B12, mechanism of reactions catalyzed by the above cofactors.

C. BIOPHYSICAL CHEMISTRY

1. Biological cell and its constituents: Biological cell, structure and functions of proteins, enzymes, DNA and RNA in living systems, Helix coil transition.

2. Bioenergetics: Standard free energy change in biochemical reactions, exergonic, endergonic, hydrolysis of ATP, synthesis of ATP from ADP.

3. Thermodynamics of biopolymer solutions: Thermodynamics of biopolymer solutions, osmotic pressure, membrane equilibrium, muscular contraction, and energy generation in the mechanochemical system.

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.

B020902T Applications of Spectroscopy Semester-IX

Inorganic Chemistry

1. Vibrational spectroscopy: Symmetry and shapes of AB_2, AB_3, AB_4, AB_5, and AB_6, Mode of bonding of ambidentate ligands, ethylenediamine, and diketonato complexes, Application of resonance Raman spectroscopy, particularly for the study of active sites of metalloproteins.

2. Electron Spin Resonance Spectroscopy: Hyperfine coupling, spin polarization for atoms and transition metal ions, spin-orbit coupling and significance of g-tensors, Application to transition metal complexes (having one unpaired electron) including biological systems and to inorganic free radicals such as PH_4,

3. Mossbauer Spectroscopy: Basic principles, spectral parameters, and spectrum display, Application of the technique to the studies of (1) bonding and structures of Fe^{2+} and Fe^{3+} compounds including those of intermediate spin, (2) Sn^{+2} and Sn^{+4} compounds-nature of M-L bond, coordination number, structure and (3) detection of oxidation state and inequivalent MB atoms.

Organic Chemistry

1. Ultraviolet and Visible Spectroscopy: Various electronic transitions (185-800nm), Beer-Lambert law. The effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, Fieser-Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds, steric effects in biphenyls.

2. Infrared Spectroscopy: Instrumentation and sample handling, characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, and amines, detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams, and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance, FTIR, IR of gaseous, solids, and polymeric materials.

3. Nuclear Magnetic resonance spectroscopy: General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, mechanism of measurement, chemical shift values, and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic, and aromatic) and other nuclei (alcohols,

phenols, enols, carboxylic acids, amines, amides & mercapto), chemical exchange, the effect of deuteration, complex spin-spin interaction between two, three, four and five nuclei (first-order spectra), virtual coupling, stereochemistry, hindered rotation, Fourier transform technique, Nuclear Overhauser Effect (NOE), resonance of other nuclei-F, P.

4. ^{13}C NMR Spectroscopy: General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic, and carbonyl carbon), coupling constants, Two-dimension NMR Spectroscopy – COSY, NOESY, DEPT, INEPT, APT and INADEQUATE techniques.

5. Mass Spectrometry: Introduction, ion production-EI, CI, FD, and FAB, factors affecting fragmentation, ion analysis, ion abundance, mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, meta stable peak, McLafferty rearrangement, Nitrogen rule, high- resolution mass spectrometry, examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

Books Suggested:

1. Infrared and Raman Spectra: Inorganic and Coordination Compounds, N. Nakamoto, Wiley
2. Physical Methods of Inorganic Chemistry, R. S. Drago, Saunders Company.
3. NMR, NQR, EPR, and Mossbauer Spectroscopy Inorganic Chemistry. R. V. Parish, Ellis Horwood.
4. Spectrometric Identification of Organic Compounds, Silverstein, Bassler and TMorrill, John Wiley.
5. Introduction to NMR Spectroscopy, R. J. Abraham, J. Fisher and P. Loftus, Wiley.
6. Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall.
7. Spectroscopic Methods in Organic Chemistry, D.H. Williams, I. Fleming, Tata McGraw-Hill.
8. Organic Spectroscopy, William Kemp, Mac publsihers, 3rd Edition, 2011.
9. C. N. Banwell and E. M. McCash; Fundamentals of Molecular Spectroscopy, 4th ed. Tata McGraw Hill, 1994.
10. D. L. Pavia, G.M. Lampman, G.S. Kriz and J. R. Vyvyan; Introduction to Spectroscopy, 5th ed. Cengage India, 2015.

B020903T Solid State Chemistry Semester-IX

1. Solid State reactions

General principles, experimental procedures, co-precipitation as a precursor to solid-state reactions, kinetics of solid-state reactions.

2. Crystal Defects and Non-Stoichiometry

Perfect and imperfect crystals, intrinsic and extrinsic defects-point defects, line and plane defects, vacancies-Schottky defects and Frenkel defects, thermodynamics of Schottky and Frenkel defect formation, color centers, non-Stoichiometry defects.

3. Electronic properties and band theory

Metals, insulators, and semiconductors, electronic structure of solid-band theory, the band structure of metals, insulators and semiconductors, intrinsic and extrinsic semiconductors, doping semiconductor, p-n-junction, superconductors, optical properties - optical reflectance, photoconduction-photoelectric effects, Magnetic properties-classification of materials, quantum theory of paramagnetic-cooperative phenomena-magnetic domains, hysteresis.

4. Organic solids

Electrically conducting solids, organic charge transfers complex, organic metals, new superconductors.

Books Suggested:

1. Solid State Chemistry and its Applications, A. R. West Plenum.
2. Principles of the Solid State, H.V. Keer, Wiley Eastern.
3. Solid State Chemistry, N.B. Hannay.

B020904T Photochemistry Semester-IX

1. Photochemical Reactions

Interaction of electromagnetic radiation with matter, types of excitations, the fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.

2. Determination of reaction mechanism

Classification, rate constants, and life times of reactive energy states-determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions, types of photochemical reactions-photo dissociation, gas-phase photolysis**.**

3. Photochemistry of alkenes

Intramolecular reactions of the olefinic bond-geometrical isomerization, cyclisation reactions, rearrangement of 1,4- and 1,5-dienes.

4. Photochemistry of carbonyl compounds

Intramolecular reactions of the carbonyl compounds-saturated, cyclic and acyclic, β, γ-saturated and α, β-unsaturated compounds, cyclohexadienones. Intermolecular cycloaddition reactions-dimerization, and oxetane formation.

5. Photochemistry of aromatic compounds

Isomerization, addition, and substitutions.

6. Miscellaneous photochemical reactions

Photo-Fries reactions of anilides, Photo-Fries rearrangement. Barton reaction,

Singlet molecular oxygen reactions, Photochemical formation of smog, Photodegradation of polymers, photochemistry of vision.

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.

B020905T Organotransition Metal Chemistry Semester-IX

I Alkyls and Aryls of Transition Metals

Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis.

II Compounds of Transition Metal-Carbon Multiple Bonds

Alkylidenes, alkylidynes, low valent carbenes and carbynes- synthesis, nature of bond, structural characteristics, nucleophilic and electrophilic reactions on the ligands, role in organic synthesis.

III Transition Metal π- complexes

Transition metalπ - 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.

IV Transition Metal Compounds with bonds to Hydrogen

Transition metal compounds with bonds to hydrogen.

V Homogenous Catalysis

Stoichiometric reactions for catalysis, homogeneous catalytic hydrogenation, Zeigler-Natta polymerization of olefins, catalytic reactions involving carbon monoxide such as hydrocarbonylation of olefins (oxo reaction), oxopalladation reactions, activation of C-H bond.

VI Fluxional Organometallic Compounds

Fluxionality and dynamic equilibria in compounds such as η^2-olefin, η^3-allyl and dienyl complexes.

Books Suggested:

1. Principles and application of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
2. The Organometallic Chemistry of the Transition Metals, R.H. Crabtree, John Wiley.
3. Metallo-organic Chemistry, A.J. Pearson, Wiley.
4. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.

B020906T Analytical Chemistry Semester-IX

I Introduction

Role of analytical chemistry. Classification of analytical methods-classical and instrumental. Types of Instrumental analysis. Selecting an analytical method. Neatness and cleanliness. Laboratory operations and practices. Analytical balance. Techniques of weighing, errors. Volumetric glassware-cleaning and calibration of glassware. Sample preparations- dissolution and decomposition. Gravimetric techniques. Selecting and handling of reagents. Laboratory notebooks, Safety in the analytical laboratory.

II Errors and Evaluation

Definition of terms in mean and median. precision-standard deviation, relative standard deviation. Accuracy-absolute error, relative error. Types of error in experimental data determinate (systematic), indeterminate (or random) and gross. Sources of errors and the effects upon the analytical results. Methods for, reporting analytical data. Statistical evaluation of data-indeterminate errors. The uses of statistics in chemical analysis.

III Food Analysis

Moisture, ash, crude protein, fat, crude fibre, carbohydrates, calcium, potassium, sodium and phosphate. Food adulteration common adulterants in food, contamination of food stuffs. Microscopic examination of foods for adulterants. Pesticide analysis in food products. Extraction and purification of sample. HPLC Gas chromatography for organophosphates. Thin-layer chromatography for identification chlorinated pesticides in food products.

IV Analysis of Water Pollution

Origin of waste water, types, water pollutants and the effects. Sources of water pollution-domestic, industrial agricultural soil and radioactive wastes as sources of pollution. Objectives of analysis parameter for analysis colour, turbidity, total solids, conductivity, acidity, alkalinity, hardness, chloride, sulphate, fluoride, silicon phosphates and different forms of nitrogen. Heavy metal pollution-public health significance of cadmium, chromium, copper, lead, zinc, manganese, mercury and arsenic. General survey of instrumental technique for the analysis of heavy metals in aqueous systems. Measurements of DO, BOD and COD. Pesticides as water pollutants and analysis. Water pollution laws and standards.

V Analysis of Soil, Fuel, Body Fluids and Drugs

(a) **Analysis of soil:** moisture, pH, total nitrogen, phosphorus, silica, lime, magnesia, manganese, sulphur and alkali salts.
(b) **Fuel analysis:** solid, liquid and gas, Ultimate and proximate analysis- heating values grading of coal. Liquid fuels-flash point, aniline point, octane number and carbon residue. Gaseous fuels-producer gas and gas-calorific value.
(c) **Clinical chemistry:** Composition of blood-collection and preservation of samples. Clinical analysis, serum electrolytes, blood glucose, blood urea, nitrogen, uric acid, albumin, globulins, barbiturates, acid and alkaline phosphatases. Immunoassay: principles of radio immunoassay (RIA) and applications. The blood gas analysis-trace elements in the body.
(d) **Drug analysis:** Narcotics and dangerous drugs Classification of drugs. Screening by gas and thin-layer chromatography and spectrophotometric measurements.

Books Suggested:

1. Analytical Chemistry, G.D. Christian, J. Wiley.
2. Fundamentals of Analytical Chemistry, D. A. Skoog, D. M. West and F.J. Holler, W.B. Saunders
3. Analytical Chemistry- Principles, J.H. Kennedy, W.B. Saunders.
4. Analytical Chemistry-Principles and Techniques, L.G. Hargis, Prentice Hall.
5. Principles of Instrumental Analysis, D.A. Skoog and J.L. Loary, W.B. Saunders
6. Principles of Instrumental Aanalysis. D.A. Skoog, W.B. Saunders.
7. Quantitative Analysis, R.A. Daty, Jr. and A.L. Underwood, Prentice Hall.
8. Environmental Solution Analysis, S.M. Khopkar, Wiley Eastern.
9. Basic Concepts of Analytical Chemistry, S.M. Khopkar, Wiley Eastern.
10. Handbook of Instrumental Techniques For Analytical Chemistry, F. Settle, Prentice Hall.

B020907P Practical Semester-IX

The Distribution of marks will be as follows.

(a) Inorganic Exercise (one)	25
(b) Physical Exercise (one)	25
(c) Viva-voce	10
(d) Record/Assessment	15

Inorganic Chemistry

Selection can be made from the following-

1. Sodium amide. Inorg. Synth., 1946,2 ,128.
2. Synthesis and thermal analysis of group (II) metal oxalate hydrate. J. Chem. Ed., 1988, 65,1024.
3. Atomic absorption analysis of Mg and Ca.
4. Trialkoxyboranes- Preparation, IR and NMR spectra.
5. $PhBCl_2$ Dichlorophenylborane- Synthesis in Vacuum line.
6. Preparation of Tin(IV) iodide, Tin(IV) chloride and Tin(II) iodide. Inorg. Synth., 1953, 4, 119.
7. Relative stability of Tin(IV) and Pb(IV). Preparation of ammonium hexochlorostannate $(NH_4)_2$ $SnCl_6$. ammonium hexachloroplumbate $(NH_4)_2PbCl_6$.
8. Hexa- bis (4-nitrophenoxy) cyclotriphosphazene.
9. Synthesis of trichlorodiphenylantimony(V) hydrate. Inorg. Synth., 1985, 23, 194.
10. Sodium tetrathionate $Na_2S_4O_6$.
11. Metal complexes of dimethyl sulfoxide (IR): $CuCl_2$. 2DMSO, $PdCl_2$. 2DMSO, $RuCl_2$. 4DMSO. J. Chem. Educ., 1982, 59, 57
12. Synthesis of metal acetylacetonate; magnetic moment, IR, NMR., Inorg. Synth. 1957, 5, 130; 1963, 1, 183.
13. Bromination of $Cr(acac)_3$. J. Chem. Edu., 1986,63,90.
14. Magnetic Moment of $Cu(acac)_2.H_2O$.
15. Cis- and Trans $[Co(en)_2Cl_2]^+$.
16. Separation of optical isomer of cis-$[Co(en)_2Cl_2]Cl$. J. Chem. Soc., 1960,4369.
17. Ion exchange separation of oxidation state, of vanadium. J. Chem. Educ. 1980, 57, 316; 1978, 55, 55.

18. Determination of Cr(III) complexes. $[Cr(H_2O)_6]NO_3.3H_2O$, $[Cr(H_2O)_4Cl_2]Cl.2H_2O$, $[Cr(en)_3]Cl_3$, $Cr(acac)_3$. Inorg. Synth., 1972, 13,184.
19. Preparation of N,N bis(salicyldehyde)ethylenediamine, salen H_2, Co(salen) J. Chem. Educ., 1977, 54,443; 1973; 50,670. Determination of O_2 absorption by Co(salen) Acct. Chem. Res., 1975, 8, 384. Reaction of oxygen adduct with $CHCl_3$ (deoxygenation).
20. Preparation of Fe(II) chloride (use it as Friedel-Crafts chlorination source). J.Org. Chem., 1978, 43, 2423; J. Chem. Edu., 1984, 61,645; 1986, 63, 361.
21. Reaction of Cr(III) with a multidentate ligand; a kinetics experiment (visible spectra Cr-EDTA complex.) J.A.C.S., 1953. 75, 5670.
22. Preparation of [Co(phenanthroline-5,6- quinone]. J. Chem. Soc., A., 1970, 447, J. Chem. Edu, 1977, 54,710.
23. Preparation and use of Ferrocene. J. Chem. Edu, 1966,43,73; 1976, 53,730.
24. Preparation of copper glycine complex-cis and trans bis glycinato Copper(II). J. Chem. Soc. Dalton , 1979, 1901, J. Chem. Edu, 1982, 59,1052.
25. Preparation of phosphine Ph_3P and its transition metal complexes.
26. Any other experiment such as Conversion of p-xylene to terephthalic acid catalyzed by $CoBr_2$ (homogeneous catalysis).

Spectrophotometric Determinations
(a) Manganese /Chromium/Vanadium in steel sample.
(b) Nickel/ Molybdenum/Tungsten/Vanadium/Uranium by extractive spectrophotometric method.
(c) Fluoride/nitrite /phosphate
(d) Iron-phenanthroline complex: Job's Method of continuous variations.
(e) Zirconium-Alizarin Red-S complex: Mole-ratio method.
(f) copper-Ethylene diamine complex: Slope ratio Method.

Flame Photometric Determinations
(a) Sodium and potassium when present together
(b) Lithium/calcium/barium/strontium
(c) Cadmium and magnesium in tap water.

Chromatographic Separations
(a) Cadmium and zinc
(b) Zinc and magnesium
(c) Thin-layer chromatography-separation of nickel, manganese, cobalt and zinc.
Determination of Rf values.
(d) Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of Rf values.

Physical Chemistry

Adsorption

To study the surface tension concentration relationship for solutions (Gibbs equation).

Phase Equilibria

(i) Determination of congruent composition and temperature of a binary system (e.g. diphenylamine-benzophenone system).

(ii) Determination of glass transition temperature of given salt (e.g. $CaCl_2$) conductometrically.

(iii) To construct the phase diagram for three component system (e.g. Chloroform-acetic acid -water).

Chemical Kinetics

(i) Determination of the effect of (a) change of temperature (b) change of concentration of reactants and catalyst and (c) Ionic strength of the media on the velocity constant of hydrolysis of an ester/ionic reactions.

(ii) Determination of the velocity constant of hydrolysis of an ester/ionic reaction in micellar media.

(iii) Determination of the rate constant for the oxidation of iodide ions by hydrogen peroxide studying the kinetics as an iodine clock reaction.

(iv) Flowing clock reactions (Ref: Experiments in Physical Chemistry by Showmaker).

(v) Determination of the primary salt effect on the kinetics of ionic reactions and testing of the Bronsted relationship (iodide ion is oxidized by persulphate ion).

Solutions

(i) Determination of molecular weight of non volatile and non electrolyte / electrolyte by cryoscopic method and to determine the activity coefficient of an electrolyte.

(ii) Determination of the degree of dissociation of weak electrolyte and to study the deviation from ideal behavior that occurs with a strong electrolyte.

Electrochemistry

Conductometry

(i) Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically.

(ii) Determination of solubility and solubility product of sparingly soluble salts (e.g. $PbSO_4$, $BaSO_4$) conductometrically.

(iii) Determination of the strength of strong and weak acids in a given mixture conductometrically.

(iv) To study the effect of solvent on the conductance of $AgNO_3$/acetic acid and to determine the degree of dissociation and equilibrium constant in different solvents and their mixtures (DMSO, DMF, dioxane, acetone, water) and to test the validity of Debye-Huckel-Onsager theory.

(v) Determination of the activity coefficient of zinc ions in the solution of 0.002 M zinc sulphate using Debye Huckel's limiting law.

Potentiometry/pH metry

(i) Determination of strength of halides in a mixture potentiometrically.

(ii) Determination of the valency of mercurous ions potentiometrically.

(iii) Determination of the strength of strong and weak acids in a given mixture using a Potentiometer/pH meter.

(iv) Determination of temperature dependence of EMF of a cell.

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(v) Determination of the formation constant of silver-ammonia complex and stoichiometry of the complex potentiometrically.
(vi) Acid-base titration in a non-aqueous media using a pH meter.
(vii) Determination of activity and activity coefficient of electrolytes.
(viii) Determination of the dissociation constant of acetic acid in DMSO, DMF, acetone and dioxane by titrating it with KOH.
(ix) Determination of the dissociation constant of monobasic/dibasic acid by Albert, Serjeant method.
(x) Determination of thermodynamic constants. ΔG, ΔS and ΔH for the reaction by e.m.f. method.
$Zn + H_2SO_4 \rightarrow ZnSO_4 + 2H$

Polarimetry

(i) Determination of rate constant for hydrolysis / inversion of sugar using a polarimeter.
(ii) Enzyme kinetics-inversion of sucrose.

Books Suggested

1. Vogel's Text book of Quantitative Analysis, revised. J. Bassett, R. C. Denney. G.H. Jeffery and J. Mendham ELBS.
2. Synthesis and Characterization of Inorganic compounds, W.L. Jolly, Prentice Hall.
3. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
4. Findley's Practical Physical Chemistry, B.P. Levitt, Longman.
5. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.

B021001T Organic Synthesis Semester-X

I Organometallic Reagents

Principle, preparations, properties and applications of the following in organic synthesis with mechanistic details.

Group I and II metal organic compounds
Li, Mg, and Zn compounds.

Transition metals
Cu, Pd, Ni and Fe compounds.

Other Elements
S, Si and B compounds.

II Oxidation

Introduction, different oxidative processes.

Hydrocarbons- alkenes, aromatic rings, saturated C-H groups (activated and unactivated). Alcohols, diols, aldehydes, ketones, ketals and carboxylic acids.

Amines, hydrazines and sulphides.

Oxidations with ruthenium tetraoxide, iodobenzenediacetate and thallium (III) nitrate.

III Reduction

Introduction. Different reductive processes.

Hydrocarbons- alkanes, alkenes, alkynes and aromatic rings.

Carbonyl compounds- aldehydes, ketones, acids and their derivatives. Epoxides, Nitro, nitroso, azo and oxine groups.

Hydrogenolysis.

IV Rearrangements

General mechanistie considerations- nature of migration, migratory aptitude, memory effects.

A detailed study of the following rearrangements-

Pinacol-pinacolone. Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Beckmann, Hofman, Curtius, Schmidt, Baeyer-Villiger.

Books Suggested:

1. Modern Synthetic Reactions, H.O. House, W.A. Benjamin.
2. Some Modern Methods of Organic Synthesis, W. Carruthers. Cambridge University Press.
3. Advanced Organic Chemistry, Reactions Mechanisms and Structure, J. March, John Wiley.
4. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
5. Advanced Organic Chemistry Part B. F. A. Carey and R.J. Sundberg, Plenum Press.
6. Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.

B021002T Heterocyclic Chemistry Semester-X

I Nomenclature of Heterocycles

Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic, fused and bridged heterocycles.

II Aromatic Heterocycles

General chemical behaviour of aromatic heterocycle, classification (structural type), criteria of aromaticity (bond lengths, ring current and chemical shifts in 1H NMR-spectra. empirical resonance energy, delocalization energy and Dewar resonance energy, diamagnetic susceptibility exaltations).

Heteroaromatic reactivity tautomerism in aromatic heterocycles.

III Non-aromatic Heterocycles

Strain- bond angle and torsional strains and their consequences in small ring heterocycles.

Conformation of six-membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion and 1,3,-diaxial interaction.

Stereo-electronic effects anomeric and related effects. Attractive interactions- hydrogen bonding and intermolecular nucleophilic- electrophilic interactions.

IV Heterocyclic Synthesis

Principle of heterocyclic synthesis involving cyclization reactions and cycloaddition reactions

V Small Ring Heterocycles

Three-membered and four-membered heterocycles-synthesis and reactions of aziridines, oxiranes, oxetanes and thietanes.

VI Six-membered Heterocycles with One Heteroatom

Synthesis and reactions of pyrylium salts and pyrones and their comparision with pyridinium&thiopyrylium salt and pyridones.

Synthesis and reactions of quinolizinium benzopyrylium salts, coumarins and chromones.

VII Six-Membered Heterocycles with Two or More Heteroatoms

Synthesis and reactions of diazines, triazines, tetrazines and thiazines.

VIII Seven-and Large Membered Heterocycles

Synthesis and reactions of azepines, oxepines, thiepines diazepines thiazepines, azocines, diazocines, dioxocines and dithiocines.

Books Suggested:

1. Heterocyclic Chemistry Vol. 1-3, R. R. Gupta, M. Kumar and V. Gupta. Springer Verlag.
2. The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.
3. Heterocyclic Chemistry, J.A. Joule, K. Mills and G. F. Smith, Chapman and Hall.

4. Heterocyclic Chemistry, T. L. Gilchrist, Longman Scientific Technical.
5. Contemporary Heterocyclic Chemistry, G.R. Newkome and W.W. Paudler, Wiley-Inter Science.
6. An Introduction to the Heterocyclic Compounds, R. M. Acheson, John Wiley.
7. Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C. W. Rees, eds. Pergamon Press.

B021003T Chemistry of Natural Products Semester-X

I Terpenoids and Carotenoids

Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, stereochemistry, biosynthesis and synthesis of the following representative molecules: Citral, Geraniol, α- Terpeneol, Menthol, Zingiberene, Abiatic acid and β-Carotene.

II Alkaloids

Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants.

Structure, stereochemistry, synthesis and biosynthesis of the following: Ephedrine, Nicotine, Atropine, Quinine and Morphine.

III Steroids

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation structure determination and synthesis of Cholesterol, Bile acids, Androsterone., Testosterone, Estrone, Progestrone, Aldosterone.
Biosynthesis of steroids.

IV Plant Pigments

Occurrence, nomenclature and general methods of structure determination, isolation and synthesis ofApigenin, Luteolin, Quercetin, Myrcetin Quercetin-3-glucoside, Vitexin, Cyanidin-7-arabinoside, Hirsutidin.

Biosynthesis of flavonoids: Acetate pathway and Shikimic acid pathway

V Porphyrins

Structure and synthesis of Hemoglobin and Chlorophyll.

VI Prostaglandins

Occurrence, nomenclature, classification, biogenesis and physiological effects.Synthesis of PGE_2, and PGF_2.

Pyrethroids and Rotenones

Synthesis and reactions of Pyrethroids and Retenones. (For structure elucidation, emphasis is to be placed on the use of spectral parameters wherever possible).

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. Stereoselective Synthesis: A Practical Approach M.Nogradi, VCH.
4. Rodd's Chemistry of Carbon Compounds, Ed, S. Coffe Elsevier.
5. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Ed. Kurt Hostettmann, M.P. Gupta and A. Marston, Harwood Academic Publishers.
6. Introduction to Flavonoids, B.A. Bohm, Harwood Academic Publishers.
7. New Trends in Natural Product Chemistry, Atta-Ur-Rahman and M.I. Choudhary, Harwood Academic Publishers.
8. Insecticides of Natural Origin, Sukh Dev, Harwood Academic Publishers

B021004T Medicinal Chemistry Semester-X

I Drug Design

Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrugs and soft drugs, structure-activity relationship (SAR), factors affecting bioactivity, resonance, inductive effect, isosterism, bio-isosterism, spatial considerations. Theories of drug activity: occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship. History and development of QSAR. Concepts of drug receptors, Elementary treatment of drug receptor interaction. Physico-chemical parameters: lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton and surface activity parameters and redox potentials. Free-Wilson analysis, Hansch analysis, relationships between Free-Wilson and Hansch analysis, LD-50, ED-50 (Mathematical derivations of equations excluded).

II Pharmacokinetics

Introduction to drug absorption, disposition, elimination using pharmacokinetics, important pharmacokinetic parameters in defining drug disposition and in the rapeutics. Mention of uses of pharmacokinetics in drug development process.

III Pharmacodynamics

Introduction, elementary treatment of enzyme stimulation, enzyme inhibition sulphonamides membrane active drugs, drug metabolism, xenobiotics biotransformation, significance of drug metabolism in medicinal chemistry.

IV Antineoplastic Agents

Introduction, cancer chemotherapy, special problems, role of alkylating agents and antimetabolites in treatment of cancer. Mention of carcinolytic antibiotics and mitotic inhibitors.

V Cardiovascular Drugs

Introduction, cardiovascular diseases, drug inhibitors of peripheral sympathetic function, central intervention of cardiovascular output. Direct acting arteriolar dilators.

Synthesis of amyl nitrate, sorbitrate.

VI Local Anti infective Drugs

Introduction and general mode of action. Synthesis of sulphonamides, furazolidone, acid ciprofloxacin, norfloxacin, dapsone, ethionamide, ethambutal and chloroquin.

VII. Psychoactive Drugs – The chemotherapy of Mind

Introduction neurotransmitters, CNS depressants, general anaesthetics, mode of action of hypnotics, sedatives, anti-anxiety drugs, benzodiazipines, buspirone, neurochemistry of mental diseases, antipsychotic drugs – the neuroleptics, antidepressants, butyrophenones, serendipity and drug development, stereochemical aspects of psychotropic drugs.

Synthesis of diazepam, oxazepam and chlorazepam.

VIII. Antibiotics

Cell wall biosynthesis, inhibitors – Lactam rings, antibiotics inhibiting, protein synthesis. Synthesis of penicillin G, penicillin V, ampicillin, amoxycillin, chloramphenicol, cephalosporin, tetracyclin and streptomycin.

Books Suggested:

1. Introduction to Medicinal Chemistry, A. Gringuage, Wiley-VCH
2. Wilson And Gisvold Es Text Rook of Organic Medicinal and Pharmaceutical Chemistry. Ed. Robert F.Dorge.
3. An Introduction to Drug Design, S.S. Pandeya and J.R. Dimmock, New Age International.
4. Burger's Medicinal Chemistry and Drug Discovery, Vol-1(Chapter-9 and Ch-14), Ed. M.E. Wolff, John Wiley.
5. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.
6. The Organic Chemistry of Drug Design and drug Action, R.B. Silverman, Academic Press.
7. Strategies for Organic Drug Synthesis and design. D. Leilnicer. John Wiley.

B021005T Polymers Semester-X

I. 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.

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. End-group, 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.

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 properties-crystalline 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.

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.

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.

B021006T Nuclear and Radio Chemistry Semester-X

I. Introduction

Some Historical Landmarks in Nuclear and Radiochemistry. Nuclear Structure and Stability (Nucleus shape, Isotopes. Isobars, lsotones, Nuclear lsomensm and Isomeric Transitions. Nuclear forces, Nuclear Mass & Binding Energy. Frequency distribution of stable Isotopes & Nuclear stability N/Z ratio), Nuclear Reactions, Notation Q-value of Nuclear reactions, Coulomb Barrier, Reaction Cross-section, Types of reactions. Scattering reactions (- Induced reactions, Neutrons induced, Proton induced, Deutmn, Photon, Heavy ion induced reactions), Natural Radioactivity, Artificial Radioactivity, Nuclear fission and Nuclear fusion; Radioactivity and Types of Nuclear decay - Types and Kinetics of Radioactive Decay.

II. Radiation detection and Measurements

Interaction of Radioactive with matter, Electromagnetic Interaction (Photoelectric Effect, Compton Scattering and Pair Production), Photo-tube and Photo-multiplier

A Saxena

tube, General Principles of Radioactivity Detection and Fundamental particles in Detectors and Nuclear Spectroscopy, Semiconductor Detector.

III. Nuclear Models

Nordhem rules and Magic numbers, Liquid- Drop Model, Fermi-Gas Model, Nuclear -Shell Model, The Optical Model and The collective Model. The Quantum Mechanical Nuclear Potentials- The square well potential, The Harmonic Oscillator potential, The Exponential potential, The Guassian potential and the Yukawa potential.

IV. Nuclear Reactor & Device

Fisson Chain Reaction- Radiations Decaying into channel width (Fission Cross Section, Control rods operated Neutron Flux and Nuclear chain reactions and MPDQ-92- Computer Program), Fission and Fertile isotopes. Nuclear Fuel, Fuel Cladding, Moderator, Coolant, Control Rods, Sensing elements, Conversion & Radioactivity; Nuclear Reactors- Boiler Water Reactor, Pressurised Water Reactor, Pressurised Heavy Water Reactor, Light- Water Gas Cooled Reactor, Advanced Gas Cooled Reactor, High Temperature Reactor, INDIAN REACTORS (Apsara, Cirus, Dhurva), Indian Kota Heavy Water Plant and Madras Atomic Power Station; Various Thermochemical Reactors, Laser Fusion Reactors, Lekka -8 (Japanese) Fusion, India's.Tokmann Aditya Toridal Reactor, Accelerates- Vande Graff Accelerator, Linear Accelerator. Cyclotron Reactor, Suchrocyclotron Accelerator; Nuclear Materials- **URANIUM -** Uranium Enrichment & Uranium as Fuel. Uranium Metal Ingot, Uranium di-oxide pellet. Freshly prepared Ammonium Diuraruite, Freshly prepared Magnesium diuranate, **PLUTONIUM -** Plutonium Based Fuels, Plutonium Metals, Plutonium Oxide Powder. Safety Aspects of Plutonium, **THORIUM -** Thorium Components, Thorium Breeders and Thorium Fuel Cycle, **HEAVY WATER -** Deuterium Enrichment Process and Radiolysis of Water, **ZIRCONIUM & ALLOYS, BERYLLIUM -** Use of Beryllium in Nuclear System and its application in other industries.

V. Applications of Isotopes

Production of Isotopes. Radiopharmaceuticlas and Radio-nuclide Therapy- NAME of the Pharmaceuticals and their application and Radioimmunoassay; Radiation, Sterilization of Medical Products. Food Preservation and Gamma Radiography, Age Determination (Carbon Dating, Diagnostic Radiopharmaceutical - Bone Density Measurements, Bone Imaging, Cardiovascular Studies. Central Nervous System, Environmental Radioactivity and Safety-Natural Radionuclides, Fall out from Nuclear Weapons Testing.

VI. Radioactive and Nuclear Techniques

Radioactive Analytical Techniques, Radiometric Titrations. Prompt Gamma Neutron Activation Analysis. Charged Particle Activation Analysis, Particle Induced X-ray emission analysis (PIGS).

Book Suggested:

1. Nuclear and Radioactivity- Friedlander G; Kennedy J.M Mamas E.S., Miller J.M., Wiley Inter Science N.Y. (1981).
2. Introduction to Nuclear Physics and Chemistry- Harvey B.G., Prentice Hall Engle-wood Cliffs (N.J.) 1963, EKE Edn (1965).

3. Source Book of Atomic Enemy, Glasstone S. Affiliated Ease-West Press, New Delhi 1969.
4. Environmental Chemistry P.S. Sindhu, New Age International. New Delhi.
5. Nuclear Reactions R. Singh & S. N. Mukherjee, New Age International. New Delhi.
6. Nuclear and Radiochemistry (Text book Arnikar, New Age International. New Delhi.

B021007T Computational Chemistry Semester-X

I. Fortran/C Programming and Numerical Methods

Advanced programming features of FORTRAN/C. Basic theory, discussion of algorithms and errors for the following numerical methods. Examples from chemistry should be selected for illustrating the methods. The teacher may select ANY THREE of the following subtopics considering the background of students, available time etc.

a. Solutions of Equations

Bisection. regular falsi, Newton-Raphson and related methods for solving polynomial and transcendental equations. Convergence, Errors and ill-conditioning.

b. Linear Simultaneous Equations

Gaussian elimination, Gauss - Seidel method, Gauss-Jordan method. Pivoting strategy. Errors and ill conditioning.

c. Eigen values and Matrix Diagonalization

Jacobi and Householder methods, analysis of errors.

d. Interpolation

Newton forward and backward difference, central difference formulae. Lagrange and Herrnite interpolation. Polynomial wiggle problem.

e. Numerical Differentiation

Solution of simple differential equations by Taylor series and Runge-Kutta methods.

f. Numerical Integration

Newton-Cotes formulae, Romberg integration. errors in integration formulae.

The students should develop computer programes for some of the above numerical methods.

i. Running of Advanced Scientific Package

The students are expected to get hands on experience of running a few selected advanced level scientific software packages after a brief introduction to the basic theory and methodology. ab initio quantum chemical packages such as GAUSSIAN/GAMES with carefully designed exercises for illustrating various features of the packages. Semi empirical/Dynamics/Simulation packages such as MOPAC. CHARM. AMBER. QUANTA etc. Basic ideas on structure activity relation, drug and catalysis design etc.

II Introduction to Networking and Search using Internet

Book Suggested:

1. Computational Chemistry, A. C. Norris, John Wiley.
2. Computer Programming in FORTRAN 77, R. Rajaraman, Prentice Hall.
3. Numerical Analysis. C.E. Frogberg, Macmillan.
4. Numerical Analysis, A Practical Approach, M. J. Maron, John Wiley.
5. Numerical Methods for Scientists and Engineers. H.M. Antia, Tata McGraw Hill.

B021008T Bioinorganic and Supramolecular Chemistry Semester-X

I Metal Storage Transport and Biomineralization

Ferritin, transferrin and siderophores

II Calcium in Biology

Calcium in living cells, transport and regulation, molecular aspects of Intramolecular processes, extracellular binding proteins.

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}.

IV Metal- Nucleic Acid Interactions

Metal ions and metal complex interactions, Metal complexes-nucleic acids.

V Metals in Medicine

Metal deficiency and disease, toxic effects of metals, metals used for diagnosis and chemotherapy with particular reference to anticancer drugs.

VI Supramolecular chemistry

Concepts and language.

(A) Molecular recognition : Molecular receptors for different types of molecules, design and synthesis of coreceptor molecules and multiple recognition.

(B) Supramolecular reactivity and catalysis.

(C) Transport processes and carrier design.

(D) Supramolecular devices. Supramolecular photochemistry, supramolecular electronic, ionic and switching devices.

(E) Host guest chemistry, cation, anion, neutral guest binding. Physicochemical method of investigation of supramolecular associates.

Some example of self-assembly in supramolecular chemistry.

Books Suggested:

1. Principle of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books
3. Inorganic Biochemistry Vol. I and II ed. G.L Eichhorn, Elsevier.
4. Progress in Inorganic Chemistry, Vols. 18 and 38 Ed. J.J. Lippard, Wiley.
5. Supramolecular Chemistry, J.M. Lehn, VCH.
6. Supramolecular Chemistry, Jonathan W. Steed, J.L.Atwood.
7. Supramolecular Chemistry, Jear-Merie Lehn.

B021009T Industrial Chemistry Semester-X

Unit 1: Cement, Ceramic and Glass
Composition of cement, mixing of cement clinker with Gypsum, Setting of cement. Composition, Physical and Chemical properties of Glass, Varieties of glass, Introduction to ceramics.

Unit 2: Composites
Introduction, constituents of composites, Types, of composites, Microscopic and Macroscopic Composites, Dispersion, Strength, Particle and Fiber- reinforced Composites.

Unit 3: Fertilizers
N - Ammonia, Ammonium nitrate and Urea; P - Phosphoric acid, Single and Triple superphosphate, DAP; K- Potassium Nitrate and Muriate of potash.

Unit 4: Petrochemicals and Lubricants
Introduction, Occurrence, Composition of Petroleum, Natural gas, cracking, refining, octane rating, cetane number, flash and fire point determination.
Lubricating oils and additives, Naphtha crackers and Profile of their products, Synthetic and Blended oils.

Unit 5: Paints
General characteristic, their function, Manufacture and Classification, Enamels, Emulsion paints, Water based paints. Formulation of paints: Function of vehicles, solvent, thinner, pigment, dyes, filler, resins, drier, insecticides, additives in paint formulation.

Books Suggested:

1. Oliver Kahn, Molecular Magnetism, VCH Publishers, UK,1993.
2. W. D. Callisters, Materials Science and Engineering: An Introduction, Wiley, 2006.
3. N. W. Aschcroft and N. D. Mermin Solid State Physics, Holt, Rinehart and Winston, New York, 1976.
4. J. C. Anderson, K. D. Leaver, J. M. Alexander and R. D. Rowlings Materials Science. ELBS, 2003.
5. Kelker and Hatz , Hand Book of Liquid Crystals, 2nd Ed. Wiley, 2014.
6. V.C. Malshe and Meenal Sikchi, Basics of Paint Technology, Part I & II, 2008,
7. G.P.A. Turner, Introduction to Paint Chemistry, Chapman& Hall, 1967.

B021010T Green Chemistry Semester-X

Unit 1: Introduction Principle and Concepts of green Chemistry

Need for green chemistry, Inception and evolution of green chemistry, Twelve principles of Green Chemistry with their explanation and examples, Designing a green synthesis using these principles, Green chemistry in day to day life.

Unit 2: Non Traditional Greener Alternative Approaches

Different approaches to green synthesis: Use of green reagents in organic synthesis-Dimethyl carbonate, Polymer supported reagents- Peracids and Chromic acids, Green Catalysis , role of catalysis in sustainable development , homogeneous and heterogeneous catalyst, Introduction , advantages and applications of Biocatalyst.

Unit 3: Application of Non-conventional Energy Sources

Introduction of microwave induce synthesis: Microwave activation, equipment, time and energy benefits, limitations, Organic transformations under microwaves- Fries rearrangement , Diels -Alder reaction, Decarboxylation, saponification of ester.
Introduction of ultrasound assisted green synthesis: Instrumentation, Physical aspects, application in organic transformations.

Unit 4 Environmentally Benign Solutions to organic solvents:

Ionic liquids as green Solvents: Introduction, properties and types of ionic liquids, Synthetic applications- Diels -Alder reaction.
Aqueous phase reactions: Synthesis applications- 1,3- Dipolar Cycloadditions, Carbon-Carbon bond-forming processes and bromination reactions. Role of supercritical Carbon dioxide in green chemistry, Ethyl lactate as a renewable green solvent: Properties and applications.

Unit 5: Synthesis of Nanomaterials:

Greener synthesis of Nanomaterials –Magnetic Nanoparticles, MW assisted nano catalysis in water, Synthesis of Nanoparticles using Bacteria , Yeast, Algae and Fungus.

Books Suggested:

1. P.A.G. Blackie, *Organic synthesis in water*, Springer (1998).
2. P.T. Anastas, *Green Chemistry: Theory and Practice*, Oxford University Press (2002).
3. M. Lancaster, *Green Chemistry: An Introductory Text*, Royal Society of Chemistry (2016).

B021011P Practical Semester-X

The Distribution of marks will be as follows.

(a) Organic Exercise (one)	25
(b) Physical Exercise (one)	25
(c) Viva-voce	10
(d) Record/Assessment	15

Organic Chemistry

Qualitative Analysis

Separation, purification and identification of the components of a mixture of three organic compounds (three solids or two liquids and one solid, two solids and one liquid), using TLC for checking the purity of the separated compounds, chemical analysis, IR, PMR and mass spectral data.

Multi-step Synthesis of Organic Compounds

The exercises should illustrate the use of organic reagents and may involve purification of the products by chromatographic techniques.

Photochemical reactions

Benzophenone ⟶ Benzpinacol ⟶ Benzpinacolone

Beckmann rearrangement: Benzanilide from benzene

Benzene ⟶ Benzophenone ⟶ Benzophenone oxime ⟶ Benzanilide

Benzilic acid rearrangement: Benzilic acid from benzoin

Benzoin ⟶ Benzil ⟶ Benzilic acid

Synthesis of heterocyclic compounds

Skraup synthesis: Preparation of quinoline from aniline Fisher- Indole synthesis:

Preparation of 2-phenylindole from phenylhydrazine.

Enzymatic synthesis

Enzymatic reduction: Reduction of ethyl acetoacetate using Baker's yeast to yield enantiomeric excess of S(+) ethyl-3-hydroxybutanoate and determine its optical purity.

Biosynthesis of ethanol from sucrose.

Synthesis using microwaves

Alkylation of diethyl malonate with benzyl chloride.

Synthesis using phase transfer catalyst

Alkylation of diethyl malonate or ethyl acetoacetate with an alkyl halide

Extraction of Organic Compounds from Natural Sources

1. Isolation of caffeine from, tea leaves.
2: Isolation of casein from milk (the students are required to try some typical colour reactions of proteins).
3. Isolation of lactose from milk (purity of sugar should be checked by TLC and PC and Rf value reported).
4. Isolation of nicotine dipicrate from tabacco.
5. Isolation of cinchonine from cinchona bark.
6. Isolation of piperine from black pepper.
7. Isolation of lycopene from tomatoes.
8. Isolation of β-carotene from carrots.
9. Isolation of oleic acid from olive oil (involving the preparation of complex with urea and separation of linoleic acid).
10. Isolation of eugenol from cloves.
11. Isolation of (+) limonine from citrus rinds.

Paper Chromatography

Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper, chromatography and determination of Rf values.

Spectroscopy

Identification of organic compounds by the analysis of their spectral data (UV, IR, PMR, CMR & MS).

Spectrophotometric (UV/VIS) Estimations

1. Amino acids
2. Proteins
3. Carbohydrates
4. Cholesterol
5. Ascorbic acid
6. Aspirin
7. Caffeine

Physical Chemistry

Number of hours for each experiment: 3-4 hours

A list of experiments under different headings are given below. Typical experiments are to be selected from each type.

Thermodynamics

(i) Determination of partial molar volume of solute (e.g., KC1) and solvent in a binary mixture.
(ii) Determination of the temperature dependence of the solubility of a compound in two solvents having similar intermolecular interactions (benzoic acid in water and in DMSO- water mixture) and calculate the partial molar heat of solution.

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-salicyclic acid) and organic (e.g. amine-iodine) complexes.
(iii) Characterization of the complexes by electronic and IR spectral data.

Polarography

(i) Estimation of Pb^{2+} and Cd^{2+}/Zn^{+} and Ni^{2+} ions in a mixture of Pb^{2+} and Cd^{2+}/Zn^{+} and Ni^{2+} by polarography.
(ii) Determination of dissolved oxygen in aqueous solution of organic solvents.

Electronics

This lab course will have theory as well as practicals and the lectures shall be delivered during lab hours.

Basic Electronics

Notations used in an electric circuit, study of electronic components and colour codes, conversion of chemical quantities into electrical quantities. Transducer illustration with electrodes, thermocouples and thermistors.

Passive components: Resistors, capacitors and inductors with some emphasis on solid state properties of materials. Net works of resistors. Thevenin's theorem, superposition theorem, loop analysis, R C circuits, L R circuits, LCR circuits. Illustration of the use of the circuits in NQR spectroscopy, Mossbauer spectroscopy, cyclic voltametry and in power supplies as filter circuits.

Active Components

Introduction to ordinary diodes and Zener diodes with some emphasis on p-n juction as a solid state property. Use of diodes as rectifiers, clipping and clamping circuits Power supplies.

Transistors: An extension of p-n juction to p-n-p and n-p-n transistors. Characteristics of transistors, hybrid parameters; transistor circuits as amplifiers, high impedance (preamplifier) circuits. Darlinction pairs differential amplifiers.

Operational Amplifiers

Ideal characteristics; inverter, summer integrator, differentiator, voltage follower, illustrative use of operational amplifiers.

Introduction to Fourier transform in instrumentation .

List of Experiments in Electronics

- Measurements of resistance with multimeter.
- To measure the resistance of the given ammeter
- Voltage measurement with CRO
- Familiarising with CRO
- Use of a Wheatstone Bridge for accurate measurement of resistance
- Capacitor as a charged storage device
- To study the behaviour of parallel charged capacitors in series charged capacitors placed in parallel
- The use of LCR Bridge
- Response characteristics of RC network
- Response characteristics of LR network
- Response characteristics of LCR network
- Verification of Kirchoff's laws
- To study the Lissajou's figures
- Measurement of e.m.f. with thermocouple
- To plot the characteristic curve of a diode.
- Half-wave and full-wave rectifier
- Clipping and clamping circuits
- Capacitors filter for full-wave rectifier
- Voltage doubler, Zener stabilized bipolar power supply
- Transistor characteristics
- Differential amplifier
- Transistor amplifier
- Introduction of an operational amplifier as a voltage follower
- Op-Amp as non-inverting and inverting amplifier
- Simple integration differentiation with Op-Amp. 741
- Op- Amp. as comparator
- Designing and fabrication of a printed circuit board
- Setting up of a thermostat: Constant temperature bath
- Four-probe method for resistivity measurement

Books Suggested:

1. The Systematic Identification of Organic Compounds, R.S. Shriner and D.Y. Curtin.
2. Semimicro Qualitative Organic Analysis, N.D. Cheronis, J.B. Entrikin and E.M. Hodnett
3. Experimental Organic Chemistry, M.P. Doyle and W.S. Mungall.
4. Small Scale Organic Preparations, P.J. Hill.
5. Organometallic Synthesis, J.J. Fisch and R.B. King Academic

6. Experimental Physical Chemistry, D.P. Shoemaker C.W. Garland and J.W. Niber, McGraw Hill Interscience.
7. Findlay's Practical Physical Chemistry, Revised B.P. Levitt, Longman.
8. Experiments in Physical Chemistry, J.C. Ghosh, Bharat Bhavan.