Department of Chemistry
MSc (Chemistry)
Syllabus (2018-19)
Course Structure under Choice Based Credit System (CBCS)

SEMESTER	COURSE CODE	COURSE NAME	L	T	P	Contact hours/ week	Credits	Max. Marks	Formative Assessment	Summative Assessment
I		**Core Courses**								
	09040107	Stereochemistry,Metal-Ligand Equilibria and Reaction Mechanism of Transition Metal Complexes	4	0	0	4	4	100	40	60
	09040108	Quantum Mechanics-I and Thermodynamics	4	0	0	4	4	100	40	60
	09040109	Stereo Chemistry and Organic Reaction Mechanism-I	4	0	0	4	4	100	40	60
	09040104	Inorganic Chemistry Practical-I	0	0	6	6	3	100	40	60
	09040105	Physical Chemistry Practical-I	0	0	6	6	3	100	40	60
	09040106	Organic Chemistry Practical-I	0	0	6	6	3	100	40	60
		Open Elective/Professional Ethics & Human Values	4	0	0	4	4	100	40	60
Total Credits			**16**	**0**	**18**	**34**	**25**	**700**	**280**	**420**
II		**Core Courses**								
	09040210	Coordination Chemistry and Clusters	4	0	0	4	4	100	40	60
	09040211	Chemical Kinetics and Electro Chemistry	4	0	0	4	4	100	40	60
	09040212	Organic Reaction Mechanism II	4	0	0	4	4	100	40	60
	09040204	Inorganic Chemistry Practical-II	0	0	6	6	3	100	40	60
	09040205	Physical Chemistry Practical-II	0	0	6	6	3	100	40	60
	09040206	Organic Chemistry Practical-II	0	0	6	6	3	100	40	60
		Skill Enhancement Compulsory Courses (Choose any one of the following papers)								
	09040207	General Spectroscopy	3	0	0	3	3	100	40	60
	09040208	Techniques in Chemistry	3	0	0	3	3	100	40	60
		Foundation Course (Compulsory)								
	09040209	Environmental Chemistry	3	0	0	3	3	50	20	30
Total Credits			**18**	**0**	**18**	**36**	**27**	**750**	**300**	**450**
III		**Discipline Specific Elective Courses (Choose any one of the following specialization)**								
		Specialization : Inorganic Chemistry								
	09040319	Advanced Inorganic Spectroscopy	4	0	0	4	4	100	40	60
	09040320	Nuclear Chemistry	4	0	0	4	4	100	40	60
	09040321	Bioinorganic Chemistry	4	0	0	4	4	100	40	60
	09040322	Inorganic Special Practical-I	0	0	6	6	3	100	40	60
	09040323	Inorganic Special Practical-II	0	0	6	6	3	100	40	60
	09040324	Inorganic Special Practical-III	0	0	6	6	3	100	40	60
		Specialization : Physical Chemistry								
	09040325	Chemical Dynamics and Surface Chemistry	4	0	0	4	4	100	40	60
	09040326	Statistical Thermodynamics and Quantum Mechanics-II	4	0	0	4	4	100	40	60
	09040327	Spectroscopy and Corrosion –I	4	0	0	4	4	100	40	60

	09040328	Physical Special practical-I	0	0	6	6	3	100	40	60
	09040329	Physical Special practical-II	0	0	6	6	3	100	40	60
	09040330	Physical Special practical-III	0	0	6	6	3	100	40	60
	Specialization : Organic Chemistry									
	09040331	Organic Spectroscopy	4	0	0	4	4	100	40	60
	09040332	Natural Products-I and Biochemistry	4	0	0	4	4	100	40	60
	09040333	Heterocyclic Chemistry and Organic Synthesis	4	0	0	4	4	100	40	60
	09040334	Organic Special Practical-I	0	0	6	6	3	100	40	60
	09040335	Organic Special Practical-II	0	0	6	6	3	100	40	60
	09040336	Organic Special Practical-III	0	0	6	6	3	100	40	60
Total Credits			**12**	**0**	**18**	**30**	**21**	**600**	**240**	**360**
	Discipline Specific Elective Courses (Choose any one of the following specialization)									
	Specialization : Inorganic Chemistry									
IV	09040419	Organometallic Chemistry	4	0	0	4	4	100	40	60
	09040420	Inorganic Materials and advanced analytical techniques	4	0	0	4	4	100	40	60
	09040421	Metals in Medicine	4	0	0	4	4	100	40	60
	09040422	Inorganic Special Practical-IV	0	0	6	6	3	100	40	60
	09040423	Project	0	0	12	12	6	200	80	120
	Specialization : Physical Chemistry									
	09040424	Solid State Chemistry and Polymers	4	0	0	4	4	100	40	60
	09040425	Statistical Thermodynamics and Quantum Mechanics-II	4	0	0	4	4	100	40	60
	09040426	Spectroscopy and Corrosion –II	4	0	0	4	4	100	40	60
	09040427	Physical Special Practical-IV	0	0	6	6	3	100	40	60
	09040423	Project	0	0	12	12	6	200	80	120
	Specialization : Organic Chemistry									
	09040428	Photo Chemistry and Pericyclic Reactions	4	0	0	4	4	100	40	60
	09040429	Natural Products-II	4	0	0	4	4	100	40	60
	09040430	Reagents and Rearrangements	4	0	0	4	4	100	40	60
	09040431	Organic Special Practical-IV	0	0	6	6	3	100	40	60
	09040423	Project	0	0	12	12	6	200	80	120
Total Credits			**12**	**0**	**18**	**30**	**21**	**600**	**240**	**360**
		Grand Total	**58**	**0**	**72**	**130**	**94**	**2650**	**1060**	**1590**

Scheme of Studies M.Sc. (Chemistry): 2018-19

Category	**Credits**	**%**
Core Course	42	44.68
Discipline Specific Elective Course	42	44.68
Skill Enhancement Compulsory Course (SECC)	3	3.19
University Open Elective	4	4.34
Foundation course (compulsory)	3	3.19
Total	**94**	**100%**

Semester – I

Core Courses

<table>
<tr><td colspan="7">1. Name of the Department: Chemistry</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="3">Stereochemistry,Metal-Ligand Equilibria and Reaction Mechanism of Transition Metal Complexes</td><td>L</td><td>T</td><td>P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="3">09040107</td><td>4</td><td>0</td><td>0</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td>Core (✓)</td><td>DSE ()</td><td>AEC ()</td><td>SEC ()</td><td>OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td colspan="2">B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practicals</td></tr>
<tr><td colspan="3">Lectures = 52</td><td colspan="2">Tutorials = Nil</td><td colspan="3">Practical = Nil</td></tr>
<tr><td colspan="8">8. Course Description:</td></tr>
<tr><td colspan="8">This core paper in Chemistry will enable postgraduate students to understand and rationalize bonding in main group compounds and predict their basic shapes and structures.
Concepts involved in explaining metal-ligand equilibria in solution will be explained. These include stepwise and overall formation constants and their interactions, factors affecting stability of metal complexes, and determination of binary formation constants by pH-metry and spectrophotometry.
Reaction mechanisms for ligand displacement in octahedral complexes via acid and base hydrolysis will be explained. Racemization of tris chelate complexes will be discussed.
Mechanism of ligand displacement reactions in square planar complexes will be explained along with Trans effect and its theories. Outer sphere and inner sphere electron transfer mechanisms will also be explained.
Structures of isopoly and heteropoly acids and salts of Mo and W will be explained. Finally, structures of selected binary and ternary compounds will be discussed.</td></tr>
<tr><td colspan="8">9. Course Objectives:</td></tr>
<tr><td colspan="8">The objectives of this course are to:
1. Introduce students to bonding theories in main group compounds
2. Explain to students shapes of main group compounds and their energetics of hybridization
3. Explain stepwise and overall formation constants; their interactions; and ways of determining them
4. Understand stability of metal complexes with respect to the metal ion and ligand
5. Explain mechanisms for ligand displacement reactions in octahedral and square planar complexes
6. Understand mechanism of electron transfer reactions
7. Explain isopoly and heteropoly acids and salts of Mo and W
8. Explain structures of selected binary and ternary compounds</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="8">Upon successful completion of this course, the student will be able to:
1. Explain bonding in main group compounds
2. Predict the shapes and determine the energetics of hybridization of main group compounds
3. Explain stepwise and overall formation constants and their interactions
4. Explain mechanisms of ligand displacement reactions in octahedral and square planar complexes
5. Understand the structures and properties of isopoly and heteropoly acids and salts
6. Explain crystal structures of selected binary and ternary compounds</td></tr>
</table>

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Metal-Ligand Equilibria in Solution**

VSEPR Theory, dπ -pπ bonds, Bent rule and determination of energetics of hybridization,Stepwise and overall formation constants and their interactions, Trends in stepwise constants, Factors affecting stability of metal complexes with reference to the nature of metal ion and ligand, Chelate effect and its thermodynamic origin, Determine binary formation constants by pH-metry and spectrophotometry

Unit – 2	**Number of lectures = 13**	**Title of the unit: Reaction Mechanism of Transition Metal Complexes-I**

Inert and labile complexes, Mechanisms for ligand replacement reactions, Formation of complexes of aquo ions, Ligand displacement reactions in octahedral complexes- acid hydrolysis, base hydrolysis, Racemization of tris chelate complexes, Electrophilic attack on ligands

Unit – 3	**Number of lectures = 13**	**Title of the unit: Reaction Mechanism of Transition Metal Complexes-II**

Mechanism of ligand displacement reactions in square planar complexes, Trans effect, Theories of trans effect, Mechanism of electron transfer reactions – types; Outer sphere electron transfer mechanism and inner sphere electron transfer mechanism, Electron exchange.

Unit – 4	**Number of lectures = 13**	**Title of the unit: Isopoly and heteropoly Acids and Salts and Crystal Structures**

Isopoly and Heteropoly acids and salts of Mo and W, Structures of isopoly and heteropoly anions,Structures of some binary and ternary compounds such as fluorite, antifluorite, rutile, antirutile, cristobalite, Layer lattices- CdI_2, BiI_3; ReO_3, Mn_2O_3, corundum, pervoskite, ilemnite and Calcite.

12. Brief Description of self learning / E-learning component

1. http://textofvideo.nptel.ac.in/104105033/lec39.pdf.
2. http://nptel.ac.in/courses/104101006/downloads/lecture-notes/mod10/lec3.pdf
3. https://ocw.mit.edu/courses/chemistry/5-111sc-principles-of-chemical-science-fall-2014/unit-ii-chemical-bonding-structure/lecture-12/
4. https://www.youtube.com/watch?v=1jRo5fTg0KY
5. http://www.macollege.in/app/webroot/uploads/department_materials/doc_560.doc.

13. Books Recommended

1. Concise Inorganic Chemistry by JD Lee
2. Selected Topics in Inorganic Chemistry by Malik, Tuli and Madan
3. Inorganic Chemistry by T. Moeller
4. Modern Aspects of Inorganic Chemistry by H.J. Emeleus and A.G. Sharpe
5. Chemical Binding by O.P. Agarwal
6. Inorganic Reaction Mechanism by Edberg
7. Inorganic Reaction Mechanism by Basolo Pearson
8. Structural Principles in Inorganic Compounds by W.E.A. Addison
9. Advanced Inorganic Chemistry by Cotton and Wilkinson
10. Concepts in Inorganic Chemistry, Vol. 2, Asim Das and Mahua Das
11. Inorganic Chemistry- Principles of Structure and Reactivity by James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi
12. Inorganic Chemistry by Shriver and Atkins
13. Polyoxometalate Molecular Science by Juan J. Borrás-Almenar, Eugenio Coronado, Achim Müller and Michael Pope

1. Name of the Department: Chemistry							
2. Course Name	Quantum Mechanics-I and Thermodynamics				**L**	**T**	**P**
3. Course Code	09040108				4	0	0
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**		**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**		Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals							
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**			

8. Course Description:

Quantum Mechanics, Schrodinger wave equation for a particle in a three dimensional box, Schrodinger wave equation for three dimensional Rigid rotator, Schrodinger wave equation for hydrogen atom, First and Second Law of thermodynamics, Free energy functions and their significance, Brief resume of first and second Law of thermodynamics, Phase Rule, Phase diagram for two completely miscible components systems.

9. Course Objectives:

1. To provide a firm foundation in the fundamentals and applications of quantum mechanics & thermodynamics.
2. To introduce importance & application of first & second law of thermodynamics
3. To introduce importance & application of Phase Rule, Phase diagram.

10. Course Outcomes (COs):

The students will acquire knowledge of :

1. Various concepts of quantum mechanics & wave mechanics
2. Detailed application & need of first & second law of thermodynamics
3. Describing systems of one component as well as multi-component systems.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Quantum Mechanics-I**

Postulates of Quantum Mechanics; derivation of Schrodinger wave equation; Max-Born interpretation of ψ and the Heisenberg's uncertainty principle; Linear and Hermitian Operators, (elementary ideas, quantum mechanical operator for linear momentum and angular momentum as Hermition operator). The average value of the square of Hermition operators; commuting operators and uncertainty principle (x & p; E &t); Schrodinger wave equation for a particle in one dimensional box; evaluation of average position, average momentum and determination of uncertainty in position and momentum and hence Heisenberg's uncertainty principle, pictorial representation of the wave equation of a particle in one dimensional box and its influence on the kinetic energy of the particle in each successive quantum level, lowest energy of the particle.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Quantum Mechanics-II**

Schrodinger wave equation for a particle in a three dimensional box. The concept of degeneracy among energy levels for a particle in three dimensional box. Schrodinger wave equation for a linear harmonic oscillator & its solution by polynomial method. Zero point energy of a particle possessing harmonic motion and its consequence. Schrodinger wave equation for three dimensional Rigid rotator, energy of rigid rotator, space

quantization; Schrodinger wave equation for hydrogen atom, separation of variable in polar spherical coordinates and its solution, principle, azimuthal and magnetic quantum numbers and the magnitude of their values, probability distribution function, radial distribution function and shape of atomic orbitals (s, p & d).

Unit – 3	**Number of lectures = 11**	**Title of the unit: Thermo Dynamics-I**

Brief resume of first and second Law of thermodynamics.Entropy changes in reversible and irreversible processes; variation of entropy with temperature , pressure and volume, entropy concept as a measure of unavailable energy and criteria for the spontaneity of reaction; free energy functions and their significance, criteria for spontaneity of a process; partial molar quantities (free energy, volume, heat concept), Gibb's-Duhem equation.

Unit – 4	**Number of lectures = 15**	**Title of the unit: Thermodynamics –II & Phase Rule**

Thermodynamics II: Brief resume of first and second Law of thermodynamics. Entropy changes in reversible and irreversible processes; variation of entropy with temperature, pressure and volume, entropy concept as a measure of unavailable thermodynamic derivation. Third law of thermodynamics (Nernest heat theorem, determination of absolute entropy, unattainability of absolute zero) and its limitation.

Phase Rule, Fugacity & Activity: Phase Rule, Phase diagram for two completely miscible components systems. Concepts of fugacity, fugacity of gases and its determination. Activity and activity coefficient, choice of standard states, determination of activity coefficient for solute and solvent.

12. Brief Description of self learning / E-learning component

1. http://epgp.inflibnet.ac.in.
2. https://youtu.be/lH9SNnQCs54
3. https://youtu.be/1OFlW8OXN64
4. http://nptel.ac.in/courses/103101004/5.

13. Books Recommended

1. Glasstone, S. Theoretical Chemistry
2. Glasstone, S. Thermodynamics for Chemists.
3. Barraw, G.M. Physical Chemistry.
4. Srivastava, R.C., S.K. Saha and A.K.Jain. Thermodynamics
5. Pauling, L. Introduction to Quantum Mechanics with Applications to Chemistry.

1. Name of the Department : Chemistry						
2. Course Name	Stereo Chemistry and Organic Reaction Mechanism-I		**L**	**T**		**P**
3. Course Code	09040109		4	0		0
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**	**Practical = Nil**			

8. Course Description:

Stereochemistry of molecules dictates isomerism, chemical and biochemical reactivity.These days, chiral drugs have become an integral part of pharmaceutical industry. A basic concept on 3D structures and conformations of molecules and asymmetric synthesis and other stereo chemical principles and attributes are essential. This course will lay the foundation on to which further advanced topics can be built up.

9. Course Objectives:

The objectives of this course are to:

a. Provide the students with knowledge and the basic understanding of stereo chemistry.
b. Understand different conformations and configurations of organic molecules
c. Study different types of reactions, their mechanisms and their stability.
d. Study the asymmetric synthesis ans its importance in organic synthesis.

10. Course Outcomes (COs):

1. Differentiate chiral and achiral molecules.
2. Recognize and draw structural isomers (constitutional isomers), stereoisomers including enantiomers and diastereomers, racemic mixture, and meso compounds.
3. Identify the stereocenters in a molecule and assign the configuration as R or S.
4. Know the relationship between enantiomers and their specific rotations.
5. Differentiate simple synthesis and asymmetric synthesis of oeganic molecules.
6. Deliver the importance of reaction mechanism.
7. Identify and differentiate the aromatic and aliphatic nucleophyllic substitution reactions.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 14**	**Title of the unit: Stereo Chemistry**

Elements of symmetry, Optical isomerism - optical activity - molecular dissymmetry and chirality. Molecular representations: Wedge, Fischer, Newman and Saw-horse formulae, their description and interconversions. Fisher's projection D,L. and R,S configurations - relative and absolute configurations, optical isomerism due to asymmetric carbon atoms, Threo and erythro isomers, optical isomerism in absence of chiral carbon(biphenyls, allenes and spirans) - optical isomerism of nitrogenous compounds, racemisation and resolution, methods of resolution, geometrical isomerism and E,Z configurations, properties of geometrical isomers.

Unit – 2	**Number of lectures = 12**	**Title of the unit: Asymmetric synthesis and Conformational Analysis**

Recapitulation of prochirality, homotopic and heterotopic ligands, stereoselectivity in cyclic compounds, enantioselectivity, diastereoselectivity, stereoselective aldol reactions. Cram's rule, Felkin Anh rule, Cram's chelate model. Asymmetric synthesis use of chiral auxiliaries, chiral reagents and catalysts, asymmetric hydrogenation, asymmetric epoxidation and asymmetric dihydroxylation. Conformational analysis of medium and large membered rings, effect of conformation on reactivity of acyclic and cyclic compounds.

Unit – 3	**Number of lectures = 13**	**Title of the unit: Structure and Reactivity (Reaction Mechanism)**

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determing mechanisms, isotope effects. Hard and soft acids and bases. Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. Effect of structure on reactivity. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft equation.

Unit – 4	**Number of lectures = 12**	**Title of the unit: Aliphatic and Aromatic Nucleophilic Substtitution (Reaction Mechanism)**

Aliphatic Nucleophilic Substitution: The SN2, SN1 and SNi mechanisms, mixed SN1 & SN2 mechanism SET mechanism. The neighbouring group mechanism (anchimeric assistance). Neighbouring group participation by pi and sigma bonds, Classical non classical & phenonium cations, Nucleophilic substitution at allylic, aliphatic trigonal and vinylic carbon. Effect on the reactivity due to – substrate structure, attacking nucleophile, leaving group and reaction medium. Ambident nucleophiles and substrates regioselectivity.

Aromatic Nucleophilic Substitution: SNAr, SN1, benzyne and SRN1 mechanisms. Reactivity effect of substrate structure, leaving group and nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.

12. Brief Description of self learning / E-learning component

1. http://www.colby.edu/chemistry/CH241F/Chapter%204.pdf
2. https://onlinecourses.nptel.ac.in/noc17_cy11/announcements
3. http://nptel.ac.in/courses/104105086/
4. http://ocw.uci.edu/courses/chem_201_organic_reactions_mechanisms_i.html
5. https://swayam.gov.in/courses/189-organic-chemistry-iii-reaction-mechanisms-2

13. Books Recommended

1. Stereochemistry of carbon compounds by Ernest L.Eliel and Samuel H. Wilen
2. Stereochemistry of organic compounds- Principles and Applications by D. Nasipuri
3. Stereochemistry by Eliel
4. Advanced Organic Chemistry by Jerry March.
5. Advanced Organic Chemistry, F. A. Carey, R. J. Sundberg, Volume I and II
6. Highlights of Organic Chemistry, W.J. L. Nobel; An Advanced Text Book.
7. Stereochemistry conformation and Mechanism – P. S. Kalsi

1. Name of the Department: Chemistry							
2. Course Name	Inorganic Chemistry Practical I			**L**	**T**	**P**	
3. Course Code	09040104			0	0	6	
4. Type of Course (use tick mark)	**Core (✓)**	**DSE ()**		**AEC ()**	**SEC ()**	**OE ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practicals							
Lectures = Nil	**Tutorials = Nil**	**Practical = 78**					

8. Course Description:

The lab work for this semester essentially focuses on various types of **volumetric analyses** and **green methods of syntheses** of selected metal acetylacetonato complexes. Volumetric analyses are under three categories- Potassium Iodide titrations, Potassium bromate titrations, and Ethylene Diamine Tetra Acetic Acid (EDTA) titrations.

9. Course Objectives:

1. Determination of iodide, Hydrazine and Antimony (III) using Potassium Iodide
2. Determination of Antimony (III), Aluminum, Magnesium and Zinc using Potassium bromate
3. Determination of Calcium, Copper and Barium using EDTA and their back titrations
4. Determination of strengths of metal ions in the presence of masking agents
5. Green syntheses of three acetylacetonato metal complexes.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Determine iodide, Hydrazine and Antimony (III) using Potassium Iodide
2. Determine Antimony (III), Aluminum, Magnesium and Zinc using Potassium bromate
3. Determine Calcium, Copper and Barium using EDTA (forward and back titrations)
4. Determine strengths of metal ions in the presence of masking agents
5. Synthesize selected metal acetylacetonato complexes employing green methods

11. List of Experiments

1. Determination of Iodide, Hydrazine and Antimony (III) with Potassium Iodide
2. Determination of Antimony (III) (by Direct Method) with Potassium bromate
3. Determination of Aluminum, Magnesium and Zinc (by Oxine method) with Potassium bromate
4. Determination of Calcium, Copper, Barium with Ethylene Diamine Tetraacetic Acid (EDTA) and Back titration
5. Titration of mixtures using masking agents
6. Green syntheses of
   i. Bis (acetylacetonato) Copper(II)
   ii. Tris (acetylacetonato) Iron (III)
   iii. Tris (acetylacetonato) Manganese (III)

12. Brief Description of self learning / E-learning component

1. https://www.youtube.com/watch?v=NH9BplLhKJk
2. https://www.youtube.com/watch?v=CWGmWkF2Mh4
3. https://www.youtube.com/watch?v=_wR0CMEpDJU
4. http://www.magritek.com/wp-content/uploads/2015/03/Lab-Manual-Metal-acetylacetonate-Complexes-web.pdf.

13. Books Recommended

1. Venkatesan, V, Veeraswamy, R and Kulandaivelu, A.R (1997): Basic Principles of Practical Chemistry", 2nd edition, Sultan Chand and Sons Publication, New Delhi.
2. Gurtur, J. N. and Kapoor, R (1987): Advanced Experimental Chemistry", Vol. I, S. Chand & Co., Ltd, New Delhi
3. Siddiqui, I.R., Singh, J., Shrivastava, J., Yadav, L.D.S., Singh, R.K.P., Singh, J. (2018): Advanced Practical Chemistry, 8th Edition, Pragati Prakashan.
4. Agarwal, S.K., Lal, K. Advanced Inorganic Analysis, Pragati Prakashan.
5. Mendham, J. (2009): Vogel's Textbook of Quantitative Inorganic Analysis, Pearson Education.
6. Svehla, G., Sivasankar, B. (2012); Vogel's Qualitative Inorganic Analysis, Pearson Education.

1. Name of the Department: Chemistry						
2. Course Name	Physical Chemistry Practical –I	**L**	**T**	**P**		
3. Course Code	09040105	0	0	6		
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = Nil		**Tutorials = Nil**	**Practical = 78**			

8. Course Description:

This Course will enable the students to learn various conductometric titrating techniques and concept of heat of neutralization. Students will also learn various properties of liquids such as refractometry, surface tension and adsorption. This course will also give a platform to develop methods of analysis of various properties of liquids.

9. Course Objectives:

1. To motivate the students to understand the principles of Thermochemistry, Refractometry and conductometric titrations.
2. To impart knowledge with respect to surface tension and adsorption of different systems.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Describe various conductometric titrations of Strong acid/Strong base, Weak acid /Weak base , Strong acid/Weak base and Weak acid/Strong base.
2. Describe application of thermochemistry in determination of heat of neutralization.
3. Know the handling of instruments such as refractometer.

11. List of Experiments

1. Conductometry

i. To determine cell constant of conductivity cell.
ii. NaOH vs. HCl titration.
iii. NaOH vs. Oxalic acid titration.
iv. NaOH vs CH_3 COOH titration.
v. Ba $(NO_3)_2$ vs. Na_2 SO_4 titration.

2. Thermochemistry

Determination of heat of neutralization of the followings:-

i. NaOH vs. HCl
ii. NaOH vs. CH_3COOH
iii. NaOH vs. Oxalic acid.

3. Refractometry

i. To determine molar refractivity of the given liquid.
ii. To determine percentage composition of liquids in the given binary mixture.
iii. To determine concentration of sugar in a solution.

4 Surface tension

To determine interfacial tension of two immiscible liquids.

5. Adsorption

To study the adsorption of Oxalic acid and Acetic acid on charcoal.

12. Books Recommended

1. Khosla,B.D., V.C. Garg and A. Khosla.Senior Practical Physical Chemistry.
2. Thawale,A. and P. Mathur. Experimental Physical Chemistry.
3. Vishwanatha,B. and P. S Raghav. Practical Physical Chemistry.
4. Sindhu, P.S. Practical in Physical Chemistry.

1. Name of the Department: Chemistry						
2. Course Name	Organic Chemistry Practical-I	**L**	**T**	**P**		
3. Course Code	09040106	0	0	6		
4. Type of Course (use tick mark)	**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals.						
Lectures = Nil	**Tutorials = Nil**	**Practical = 78**				

8. Course Description:

This Course will introduce the students to the basic principles of Separation, purification and identification of organic compounds in binary mixtures and will enable to develop and practice independent learning skills. This course will also give a platform to develop different methods to separate binary mixture.

9. Course Objectives:

The objectives of this course are to:

1. Understand the separation of organic compounds in a binary mixture
2. Learn the identification and purification of separated compounds from the binary mixture..
3. Have knowledge of key methods of separation
4. Learn the mechanism of chemical reactions of the derivatives of organic compounds.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Demonstrate knowledge of separation of organic compounds from binary mixture
2. Recognize different types of procedures for separation , identification and purification of organic compounds
3. Apply basic chemical concepts to write the mechanism of the derivatives.
4. Describe different methods for separation of mixtures.

11. List of Experiments

Separation, purification and identification of organic compounds in binary mixtures by chemical tests and preparation of their derivatives.

12. Books Recommended

1. Pasto, D.C. Johnson and M. Miller. Experiments and Techniques in Organic Chemistry. Prentice Hall.
2. Williamson, K. L. and D.D. Heath. Macroscale and Microscale Organic Experiments.
3. Middleton, H.and Adward Arnold. Systematic Qualitative Organic Analysis.
4. Clark, H. and Edward Arnold. Handbook of Organic Analysis-Qualitative and Quantitative.
5. Tatchell, A. R. Vogel's Textbook of Practical Organic Chemistry. John Wiley.

Semester – II

Core Courses

<table>
<tr><td colspan="8">1. Name of the Department: Chemistry</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Coordination Chemistry and Clusters</td><td colspan="2">L</td><td colspan="2">T</td><td>P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2">09040210</td><td colspan="2">4</td><td colspan="2">0</td><td>0</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td>Core (✓)</td><td>DSE ()</td><td>AEC ()</td><td>SEC ()</td><td>OE ()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td>B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practicals</td></tr>
<tr><td colspan="3">Lectures = 52</td><td colspan="2">Tutorials = Nil</td><td colspan="3">Practical = Nil</td></tr>
<tr><td colspan="8">8. Course Description:</td></tr>
<tr><td colspan="8">This core paper in Chemistry will enable postgraduate students to understand and rationalize bonding in transition metal complexes. The course will trace all theories of bonding in coordination complexes since its inception and will highlight to students how understanding of bonding in complexes evolved with time.

Derivation of Orgel and Tanabe-Sugano diagrams starting from spectroscopic terms will be explained. Important features of the electronic absorption spectra- calculation of Dq, B and β parameters, Jahn-Teller effect, Spectrochemical and nephelauxetic series, charge transfer spectra etc will be discussed. Basic principles of magneto-chemistry will be explained and will be applied in structure determination.

Students will also be made familiar with metal clusters. Principles governing structures and bonding in boranes, carboranes and metal carbonyl clusters will be explained. In addition, structure and bonding of selected transition metal-Pi complexes (metal carbonyls, phosphines, nitrosyls, dinitrogen, and dioxygen complexes) will also be discussed.</td></tr>
<tr><td colspan="8">9. Course Objectives:</td></tr>
<tr><td colspan="8">The objectives of this course are to:
1. Introduce students to important theories postulated to understand bonding in transition metal complexes (Werner’s theory, Sidgwick’s EAN Rule, Valence Bond Theory, Crystal Field Theory and Molecular Orbital Theory)
2. Demonstrate how spectroscopic states are derived from spectroscopic terms
3. Explain Orgel and Tanabe-Sugano diagrams for transition metal complexes
4. Explain important features of the electronic spectra of complexes- Jahn-Tellar effect, Spectrochemical and nephelauxetic series, charge transfer spectra
5. Explain basic principles of magnetochemistry and apply them in structure determination
6. Explain structure and bonding in metal clusters (boranes, carboranes and metal carbonyl clusters) and transition metal- complexes (metal carbonyls, phosphines, nitrosyls, dinitrogen, and dioxygen complexes)</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):</td></tr>
</table>

Upon successful completion of this course, the student will be able to:

1. Explain bonding in transition metal complexes
2. Derive spectroscopic states from spectroscopic terms
3. Interpret Orgel and Tanabe-Sugano diagrams
4. Explain electronic spectra of complexes
5. Apply fundamentals of magnetochemistry in structure determination
6. Explain structure and bonding in selected metal clusters and transition metal-□ complexes

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Metal-Ligand Bonding**

Crystal field theory - applications and its limitations, molecular orbital theory, octahedral, tetrahedral or square planar complexes, π-bonding and molecular orbital theory.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Electronic Spectra of Transition Metal Complexes**

Spectroscopic ground states, correlation and spin-orbit coupling in free ions for I series of transition metals, Orgel and Tanabe-Sugano diagrams for transition metal complexes ($d^1 - d^9$ states) calculation of Dq, B and β parameters, effect of distortion on the d-orbital energy levels. Structural evidence from electronic spectrum, Jahn-Tellar effect, Spectrochemical and nephelauxetic series, charge transfer spectra, electronic spectra of molecular addition compounds.

Unit – 3	**Number of lectures = 13**	**Title of the unit: Magnetic Properties of Transition Metal Complexes and Metal Clusters**

Elementary theory of magneto- chemistry, Gouy's method for determination of magnetic susceptibility, calculation of magnetic moments, magnetic properties of free ions, orbital contribution, effect of ligand-field, application of magneto-chemistry in structure determination, magnetic exchange coupling and spin state cross over.

Metal Clusters: Structure and bonding in higher boranes, Wade's rules, Carboranes, Metal Carbonyl clusters- Low Nuclearity Carbonyl clusters, total electron count (TEC).

Unit – 4	**Number of lectures = 13**	**Title of the unit: Metal- Pi Complexes**

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

12. Brief Description of self learning / E-learning component

1. http://nptel.ac.in/courses/104105033/
2. https://www.youtube.com/watch?v=g01r2YRH9ok
3. http://web.mit.edu/5.03/www/readings/polyhedral_boranes/006_cluster_bonding.pdf
4. http://nptel.ac.in/courses/104106064/lectures.pdf.

13. Books Recommended

1. Concise Inorganic Chemistry by JD Lee
2. Selected Topics in Inorganic Chemistry by Malik, Tuli and Madan
3. Concepts in Inorganic Chemistry, Vol. 3-7, Asim Das and Mahua Das
4. Advanced Inorganic Chemistry by Cotton and Wilkinson
5. Advances in inorganic Chemistry by SK Agarwal and Keemti Lal
6. Inorganic Chemistry- Principles of Structure and Reactivity by James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi

1. Name of the Department : Chemistry						
2. Course Name	Chemical Kinetics & Electrochemistry		**L**	**T**		**P**
3. Course Code	09040211		4	0		0
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 52	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

Effect of temperature on reaction rates, Collision theory of reaction rates and its limitations, Debye -Huckel theory of ion- ion interactions, Debye - Huckel limiting law of activity coefficients and its limitations, Huckel - Onsager treatment for aqueous solutions and its limitations Debye-Huckel-Onsager theory for non-aqueous solutions, Debye- Huckel - Bjerrum equation, Nernest heat theorem, Phase Rule, Chain reactions, Michaelis - Menton treatment, Stokes- Einstein relation, Walden's rule, Nernst - Planck Flux equation, Onsager phenomenological equations.

9. Course Objectives:

1. Students will be able to learn various areas of chemistry like chemical kinetics & electrochemistry.
2. Students will be able to learn various concepts of physical chemistry like Chain Reactions & Ion Transport in solutions.

10. Course Outcomes (COs):

The students will acquire knowledge of :

1. scientific theories of ion-ion interactions
2. various relationships such as relationship viz. equivalent conductivity (□) vs. concentration, effect of ion association upon conductivity
3. mechanism and further studies in chain reactions
4. ion transport in solutions

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Title of the unit: Chemical kinetics-I**

Effect of temperature on reaction rates, Rate law for opposing reactions of I^{st} order and II^{nd} order, Rate law for consecutive & parallel reactions of I^{st} order reactions, Collision theory of reaction rates and its limitations, steric factor, Activated complex theory, Ionic reactions: single and double sphere models, influence of solvent and ionic strength, the comparison of collision and activated complex theory.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Chemical Kinetics : Chain Reactions**

Chain reactions: hydrogen - bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane. Photochemical reactions (hydrogen - bromine & hydrogen -chlorine reactions). General treatment of chain reactions (ortho -para hydrogen conversion and hydrogen - bromine reactions), apparent activation energy of chain reactions, chain length, Rice- Herzfeld mechanism of organic molecules decomposition(acetaldehyde) Branching chain reactions and explosions (H_2 - O_2 reaction). Kinetics of (one intermediate) enzymatic reaction :

Michaelis - Menton treatment, evaluation of Michaelis 's constant for enzyme - substrate binding by Lineweaver - Burk plot and Eadie- Hofstae methods. Competitive and non-competitive inhibition.

Unit – 3	**Number of lectures = 15**	**Title of the unit: Electrochemistry: Ion - Ion Interactions**

The Debye -Huckel theory of ion- ion interactions: potential and excess charge density as a function of distance from the central ion, Debye Huckel reciprocal length, ionic cloud and its contribution to the total potential, Debye - Huckel limiting law of activity coefficients and its limitations, ion - size effect on potential, ion -size parameter and the theoretical mean - activity coefficient in the case of ionic clouds with finite - sized ions.

Debye-Huckel-Onsager treatment for aqueous solutions and its limitations Debye-Huckel-Onsager theory for non-aqueous solutions, the solvent effect on the mobility at infinite dilution, equivalent conductivity (□) vs. concentration $c^{1/2}$ as a function of the solvent, effect of ion association upon conductivity (Debye- Huckel - Bjerrum equation).

Unit – 4	**Number of lectures = 15**	**Title of the unit: Ion Transport in Solutions**

Ionic movement under the influence of an electric field , mobility of ions, ionic drift velocity and its relation with current density, Einstein relation between the absolute mobility and diffusion coefficient, the Stokes- Einstein relation , the Nernst -Einstein equation, Waldens rule, the Rate- Process approach to ionic migration , the Rate process equation for equivalent conductivity, total driving force for ionic transport, Nernst - Planck Flux equation, ionic drift and diffusion potential , the Onsager phenomenological equations. The basic equation for the diffusion, Planck- Henderson equation for the diffusion potential.

12. Brief Description of self learning / E-learning component

1. http://epgp.inflibnet.ac.in.
2. http://www.engr.uconn.edu/~jmfent/CHEG320_electrochemistry%20lectures.pdf
3. https://youtu.be/uTFtaslJ0LM
4. http://staff.uny.ac.id/sites/default/files/jas_ion_transport_in_solution.pdf

13. Books Recommended

1. Bockris, J.O.M. and A.K.N. Reddy. Modern Electrochemistry Vol.1
2. Laidler, K.J. Chemical Kinetics.
3. Frost, A. & G.Pearson. Kinetics & Mechanism of Reaction Rates.
4. Eyring, H. Modern Chemical Kinetics.
5. laidler, K.J., H.Eyring & S. Glasstone Theories of Reaction Rates.

1. Name of the Department: Chemistry						
2. Course Name	Organic Reaction Mechanism - II	**L**	**T**	**P**		
3. Course Code	09040212	4	0	0		
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem()	EverySem ()

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 52	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

This course covers the mechanism of free radical, elimination and addition reactions. It also cover metal hydride reduction of carbonyl compounds, mechanistic approach of all name reactions. It covers the reactions for the addition to carbon-carbon and carbon-hetero bond.

9. Course Objectives:

1. To make students able to understand free radical and elimination mechanism of reactions.
2. This course makes the students able to understand all these mechanisms and their application in organic synthesis.

10. Course Outcomes (COs):

On completion of this course, the students should

1. Be able understand all different kind of mechanisms given by different compounds
2. Know about the regio and chemoselectivity, and different type of elemination and addition reactions
3. Develop capacity to solve the organic reaction mechanism related problems.
4. Develop a clear understanding about the reactions for addition to the carbon-carbon and carbon-hetero bond.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Aliphatic and Aromatic Electrophillic Substtitution**

Aliphatic Electrophilic Substitution: Bimolecular mechanisms - SE2 and SEi. The SE1 mechanism, Electrophilic substitution accompained by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Aromatic Electrophilic Substitution: The arenium ion, mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeir reaction, Gattermann-Koch reaction. Pechmann reaction, Houben – Hoesch reaction, Fries rearangement.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Free Radical and Elimination Reactions**

Free Radical Reactions: Types of free radial reactions, free radical substitution mechanism. Mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. Effect of solvents on reactivity. Allylichalogenation (NBS), oxidation of aldehydes to acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction, Free radical rearrangement, Hunsdiecker reaction, Kolbe reaction, Hydroxylation of aromatics by Fenton's reagent.

Elimination Reactions: The E2, E1, E1cB mechanisms. Orientation of the double bond. Effects of substrate structure, attacking base, leaving group and medium on reactivity. Mechanism and orientation in pyrolytic eliminations.

Unit – 3	Number of lectures = 12	Title of the unit: Addition to Carbon – Carbon Multiple Bonds
Mechanistic and stereo chemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydroboration, Michael reaction. Sharpless asymmetric epoxidation, Hydrogenation of double and triple bonds. Hydrogenation of aromatic rings.		
Unit – 4	**Number of lectures = 15**	**Title of the unit: Formation of Carbon-Carbon Bond**
Mechanism of some name reactions: Aldol, Perkin, Benzoin, Cannizaro, Wittig, Reformatsky, - Hoffmann, Claisen and Favorsky rearrangements, openauer oxidation, clemmensen reduction, Meerwein - Pondorf verley and Birch reductions. Stork enamine reactions, Michael addition, Mannich Reaction, Diels - Alder reaction, Ene - reaction, Bayer - Villiger oxidation.		

12. Brief Description of self learning / E-learning component

1. https://www.masterorganicchemistry.com/2013/07/30/free-radical-reactions
2. https://chem.ucr.edu/documents/curricularmaterials/neumantextbook/Chapter11.pdf
3. https://chem.libretexts.org/LibreTexts/Athabasca_University/Chemistry_360%3A_Organic_Chemistry_II/Chapter_23%3A_Carbonyl_Condensation_Reactions.

13. Books Recommended

1. Advanced Organic Chemistry – Jerry March.
2. Advanced Organic Chemistry, F.A. Carey, R.J. Sunberg
3. Highlights of Organic Chemistry, W, J.L. Nobel.
4. Advanced Organic Chemistry Reactions, Mechanism and Structure, March, Jerry.
5. Advanced Organic Chemistry, Carey, F.A. and R.J. Sundberg.
6. A Guide Book to Mechanism in Organic Chemistry. Sykes, Peter.
7. Structure and Mechanism in Organic Chemistry, Ingold, C.K.

1. Name of the Department: Chemistry						
2. Course Name	Inorganic Chemistry Practical II	**L**	**T**	**P**		
3. Course Code	09040204	0	0	6		
4. Type of Course (use tick mark)	**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**	
5. Pre-requisite (if any)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = Nil	**Tutorials = Nil**	**Practical = 78**				

8. Course Description:

The lab work for this semester focuses **Quantitative Inorganic Analyses** and **Cerimetry**. In the former analyses, binary mixtures of metal complexes will be taken and strengths of individual metal ions in these mixtures will be determined by **gravimetric** and **volumetric** analyses.

Cerimetry (also called **cerimetric titration** or **cerate oximetry**) is a redox titration in which a Fe^{2+}-1,10-phenanthroline complex (ferroin) changes colour at the end point. Ferroin is reversibly discolored in its oxidized form upon titration with a Ce^{4+} solution.

9. Course Objectives:

1. Separation and determination of selected binary mixtures of metal ions employing volumetric and gravimetric methods
2. Determination of strengths of Ferrous, Oxalate and Nitrite ions using cerimetry.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Separate and determine binary mixtures of metal ions using gravimetric and volumetric methods
2. Determine strengths of Ferrous, Oxalate and Nitrite ions using Cerimetry.

11. List of Experiments

I. Separation and determination of the following two metal ions involving volumetric and gravimetric methods.

a. Silver-Copper
b. Copper-Nickel
c. Copper-Zinc
d. Nickel-Zinc
e. Copper-Iron

II. Determination by Cerimetry

a. Ferrous,
b. Oxalate
c. Nitrite

12. Brief Description of self learning / E-learning component

1. https://www.youtube.com/watch?v=tGHJ6LUUBIY
2. https://www.youtube.com/watch?v=0HZ7_muDE_8
3. https://www.youtube.com/watch?v=GI_o_34dVcM
4. https://www.youtube.com/watch?v=cptn5HCEK54.

13. Books Recommended

1. Venkatesan, V, Veeraswamy, R and Kulandaivelu, A.R (1997): Basic Principles of Practical Chemistry", 2nd edition, Sultan Chand and Sons Publication, New Delhi.
2. Gurtur, J. N. and Kapoor, R (1987): Advanced Experimental Chemistry", Vol. I, S. Chand & Co., Ltd, New Delhi
3. Siddiqui, I.R., Singh, J., Shrivastava, J., Yadav,L.D.S., Singh, R.K.P., Singh, J. (2018): Advanced Practical Chemistry, 8th Edition, Pragati Prakashan.
4. Agarwal, S.K., Lal, K. Advanced Inorganic Analysis, Pragati Prakashan
5. Mendham, J. (2009): Vogel's Textbook of Quantitative Inorganic Analysis, Pearson Education.
6. Svehla, G., Sivasankar, B. (2012); Vogel's Qualitative Inorganic Analysis, Pearson Education.

1. Name of the Department : Chemistry						
2. Course Name	Physical Chemistry practical-II		**L**	**T**		**P**
3. Course Code	09040205		0	0		6
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = Nil		**Tutorials = Nil**	**Practical = 78**			

8. Course Description:

This Course will enable the students to learn various potentiometric titrating techniques and hands on experience of using instruments such as pH meters. Students will also learn various experimental aspects of chemical kinetics This course will also give a platform to develop methods of analysis of various properties of liquids.

9. Course Objectives:

1. To motivate the students to understand the principles of chemical kinetics, potentiometric titrations, and pH of various systems.
2. To impart knowledge of the concepts like partition coefficient and equilibrium constant.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Describe various conductometricpotentiometric titrations of Strong acid/Strong base and Weak acid/Strong base etc.
2. Describe the concept of pH through working of instrument like pH meter.
3. Determine partition coefficient and equilibrium constant of various systems.

11. List of Experiments

1. Potentionmetry
   a. NaOH vs. HCl titration.
   b. NaOH vs. Oxalic acid titration.
   c. NaOH vs. CH_3 COOH titration.

2. pH metry
   a. NaOH Vs. HCl titration.
   b. NaOH vs Oxalic acid titration.
   c. NaOH vs. CH_3COOH titration.

3. Chemical Kinetics
   a. To study kinetics of hydrolysis of ester in the presence of acid.
   b. To compare the relative strength of acids (HCl and H_2SO_4).

4. Distribution Law
   a. To determine partition coefficient of benzoic acid between benzene and water.
   b. To determine partition coefficient of Iodine between Carbon tetrachloride and water.
   c. Determination of Equilibrium constant for $I_2 + I^- = I_3$

12. Books Recommended

1. Khosla,B.D., V.C. Garg and A. Khosla.Senior Practical Physical Chemistry.
2. Thawale,A. and P. Mathur. Experimental Physical Chemistry.
3. Vishwanatha,B. and P. S Raghav. Practical Physical Chemistry.
4. Sindhu, P.S. Practical in Physical Chemistry.

1. Name of the Department: Chemistry						
2. Course Name	Organic Chemistry Practical-II	**L**	**T**	**P**		
3. Course Code	09040206	0	0	6		
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = Nil		**Tutorials = Nil**	**Practical = 78**			

8. Course Description:

The course provides a core for future studies in Organic Synthesis. It includes introduction to basic practical skills including safe working practices (risk, hazard and control measures), laboratory report writing. It covers the multistep synthesis of some important organic compounds their separation and purification.

9. Course Objectives:

1. To make students able to perform the organic reactions safely and to understand the practical approach in chemistry.
2. To make students able to carry out organic reactions by following the reported procedure.
3. To learn the methods for their separation and purification.

10. Course Outcomes (COs):

By the end of this course, students should be able to:

1. Handle organic chemicals in a safe and competent manner.
2. Perform the standard techniques used in practical organic chemistry.
3. Carry out multistep synthesis of organic compounds following a prescribed procedure.
4. To develop skills to determine the mechanism of the performed practicals.
5. Characterize and purify the synthesized compounds.

11. List of Experiments

1. Synthesis of *p*-Nitroaniline from acetanilide.
2. Synthesis of *p*-Bromoaniline from acetanilide
3. Synthesis of anthranilic acid from phthalic anhydride.
4. Synthesis of methyl orange from aniline.
5. Synthesis of sym-tribromobenzene from aniline.
6. Synthesis of 2,4-dinitrophenyl hydrazine from chlorobenzene.
7. Synthesis of 2,5-dihydroxyacetophenone from hydroquinone.

12. Books Recommended

1. Prentice-Hall, 5th edition, Textbook of Practical Organic Chemistry, 1996.
2. Nicolas Bogliotti, Roba Moumné ,Multi step organic synthesis, A guide through experiments,.Dec 2017.
3. Brian S,Furniss ,Vogels text book of practical organic chemistry, 5th addition,.
4. Tatchell, A. R. Vogel's Textbook of Practical Organic Chemistry. John Wiley.

Skill Enhancement Compulsory Courses

1. Name of the Department: Chemistry						
2. Course Name	General Spectroscopy	**L**	**T**	**P**		
3. Course Code	09040207	3	0	0		
4. Type of Course (use tick mark)	**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52	**Tutorials = Nil**	**Practical = Nil**				

8. Course Description:

The structures in chemistry are symbols representing real existence of the compounds that form the substance of study in chemistry. This course offers the student the opportunity to learn and appraise the use of spectroscopic instruments in the determination of the structures of compounds. The student shall learn the theory of the various instruments and the interpretation of spectra such as electronics, Rotational, Vibrational-Rotational, and NMR.

9. Course Objectives:

The objectives of this course are to:

1. Introduce the theory of the various instruments and the signals produced when analysing compound.
2. Equip the student with enough information to be able to interpret signals from spectroscopic instruments for compound characterization.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Study the spectra of compounds and propose structures for compounds.
2. Determine functional groups and write structures

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Electromagnetic radiation and Electronic Spectra**

Electromagnetic radiation: Interaction of electromagnetic radiation with matter, regions of the Spectrum the width and intensity of spectral transitions. Applications of UV spectroscopy. Resolving power.

Electronics Spectra: Electronic spectra of diatomic molecules, vibrational course structure, and rotational fine structure of electronic band. The Frank- Condon principle, intensity of vibrational-electronic band, dissociation energy, the Fortrat diagram.

Unit - 2	**Number of lectures = 13**	**Title of the unit: Rotational and Vibrational Spectra**

Rotational spectra: The rotation of molecules, rotational spectra of diatomic molecules, the spectrum of non rigid rotator, the effect of isotopic substitutions rotational spectra of linear and symmetric top polyatomic molecules.

Vibrational and Vibrational-Rotational Spectra: The vibrating diatomic molecule; simple harmonic vibrations, anharmonicity of vibrations, the diatomic vibrating rotator, the interaction of rotations and vibrations the vibrations of polyatomic molecules, analysis by infrared technique. Application of infra-red spectroscopy to the determination of inorganic and Organic compounds.

Unit - 3	**Number of lectures = 13**	**Title of the unit: NMR Spectra**

Spin active nuclei, chemical shift, shielding and deshielding, internal standards, spin-spin coupling, equivalent and non- Equivalent Protons, effect of changing solvents and hydrogen bonding on chemical shifts, anisotropic effect. Applications of NMR Spectra in the structure elucidation of Organic Compounds.

12. Brief Description of self learning / E-learning component

1. http://nptel.ac.in/courses/104103071/26

2. http://nptel.ac.in/courses/104106063/Module%203/Lectures%201-3/Lectures%201-3.pdf
3. http://nptel.ac.in/courses/122101001/downloads/lec-13.pdf

13. Books Recommended

1. Nakamoto K. Infrared Spectra of Inorganic and Coordination Compound.
2. Banwel C.N. Fundamentals of Molecules Spectroscopy.
3. Sathyanarayana D.N. Introduction to Magnetic Resonance Spectroscopy ESR, NMR, NRR.
4. Williams D.H. and Fleming I. Spectrocopic methods in Organic Chemistry. 3rd edition. McGraw-Hill Book Company.
5. Williams D.A.R. Nuclear Magnetic Resonance Spectroscopy. John Wiley & Sons, N.Y.

1. Name of the Department : Chemistry						
2. Course Name	Techniques in Chemistry	**L**	**T**	**P**		
3. Course Code	09040208	3	0	0		
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical.						
Lectures = 52		**Tutorials = Nil**	**Practical = Nil**			

8. Course Description:

This course is designed for students to acquire quality knowledge in General Spectroscopic techniques and Nanotechnology.Its use varied, ranging from traditional device physics, to molecular self assembly, to improving new substances with dimensions on the nanoscale. The course also gives a theoretical as well as a practical introduction to principles and techniques of chromatography: adsorption and partition chromatography (normal and reversed-phase systems), thin layer chromatography (TLC), column liquid chromatography including HPLC, gas chromatography, ion exchange and size exclusion chromatography.

9. Course Objectives:

The objectives of this course are to:

1. Study the basic principle, instrumentation of Atomic Absorption Spectroscopy,Atomic Emission Spectroscopy and Flame Photometry.
2. Provide the students with knowledge and the basic understanding of nanomaterials.
3. Study different chromatographic techniques.
4. Study the concept of electrophoresis.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Deliver the importance of general spectroscopic techniques.
2. Understand the need to increase Nanotechnology awareness
3. Understand the basic need of Nanotechnology
4. Know the processing of some nanoprticles
5. Explain the principles of the most important liquid and gas chromatography.
6. Acquire some technical knowledge of gas and liquid chromatography, and in capillary electrophoresis.
7. Evaluate strengths and limitations of the most important chromatographic separation and detection methods in relation to the properties of the sample and of the analysis task.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Absorption and Emission Spectroscopy**

Atomic Absorption Spectroscopy - Principles, Instrumentation, Sensitivity and detection limits, Interferences in AAS and their elimination.

Atomic Emission Spectroscopy- Principles, Sources for excitation, Instrumentation, Qualitative and quantitative Analysis.

Flame Photometry- Principles, Interferences, Evaluation methods in Flame Photometry, Principle and Applications of TGA and DTA.

Unit – 2	**Number of lectures = 14**	**Title of the unit: Nanomaterials Technology**

Nanomaterials and their historical perspective. Applications of nanoscience and nanotechnology in various fields. Unique properties of nanomaterials due to their nanosize, Quantum dots, Techniques for their synthesis:- Hydrothermal, Solvothermal, Microwave irradiation, sol-gel, Precipitation, Reverse Micelle Synthesis, Physical Vapour deposition (PVD), Chemical Vapour Deposition (CVD), Electro deposition, Characterization of nanomaterials by X-ray diffraction (XRD), Scanning Electron Microscope (SEM), Energy

dispersive X-ray Analysis. Transmission Electron Microscope (TEM), Atomic Force microscopy (AFM) techniques. Properties of nanostructured materials: opticals, magnetic, chemical and photo catalytic properties.

Unit – 3	**Number of lectures = 13**	**Chromatographic Techniques**

Purification of organic compounds using chromatographic techniques: paper chromatography, Thin- Layer Chromatography, Column Chromatography, High Pressure Liquid Chromatography (HPLC), Gas Chromatography, Ion-Exchange Chromatography, Counter- Current distribution and Electrophoresis

12. Brief Description of self learning / E-learning component

1. https://en.wikipedia.org/wiki/Atomic_absorption_spectroscopy
2. http://www.liskeard.cornwall.sch.uk/images/Liskeard-Sixth-Form/Atomic-Absorption-Spectrometry.pdf
3. https://en.wikipedia.org/wiki/Atomic_emission_spectroscopy
4. https://en.wikipedia.org/wiki/Chromatography
5. https://www.khanacademy.org/test-prep/mcat/chemical-processes/separations-purifications/v/basics-of-chromatography.

13. Books Recommended

1. Poole, Charles P., Jr. Frank and J. Owens. Introduction to Nanotechnology. Wiley India
2. Sachdeva, Mamta. V. Basics of Nanochemistry.
3. Sergeev, G. B. and K. L. Klabunde.Nanochemistry. 2013. Elsevier.
4. Fahrner, W.R. Nano Technology and Nanoelectronics. Springer International.
5. Vantra, M. D., S. Evoy and J.R. Heflin-Introducation to Nanoscience and Technology. Edited Springer.
6. Lindsey, S. M. Introduction to Nanosciences. Oxford Press.
7. Muralidharan, V. S. and A. Subramania. Nano Science and Technolony.
8. Budhiraja, R.P. Basic Concepts of Analytical Chemistry by S.M. Khopkar, New age International Publishers.
9. Sharma,B.K. Instrumental Methods of Chemical Analysis. Goel Publishing House.

Foundation Course (Compulsory)

1. Name of the Department : Chemistry						
2. Course Name	Environmental Chemistry	**L**	**T**	**P**		
3. Course Code	09040209	3	0	0		
4. Type of Course (use tick mark)	**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52	**Tutorials = 0**	**Practical = 0**				

8. Course Description:

This Course will introduce you to the principles and factual basis of chemistry in an environmental context and will enable you to develop and practice independent learning skills. This course will also give you an appreciation of scientific methodology and enable you to develop those problem-solving and critical-thinking skills necessary to analyze and discuss chemical and physical phenomena in the environment.

9. Course Objectives:

The objectives of this course are to:

1. Understand and apply fundamental concepts of chemistry in the environment.
2. Have knowledge of key themes, theories and problems
3. Learn the important chemical reactions in the atmosphere

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Demonstrate knowledge of chemical and biochemical principles of fundamental environmental processes in air, water, and soil.
2. Recognize different types of toxic substances & responses and analyze toxicological information.
3. Apply basic chemical concepts to analyze chemical processes involved in different environmental problems (air, water & soil).
4. Describe causes and effects of environmental pollution by energy industry and discuss some mitigation strategies.
5. Explain energy crisis and different aspects of sustainability.
6. Discuss local and global environmental issues based on the knowledge gained throughout the course.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 15**	**Title of the unit: Environmental Pollution**

Types and major sources of air pollutants, effects of air pollutants on physico-chemical and biological properties surrounding atmosphere, air born diseases and their effects on health. Types and major sources of water pollutants, effects of water pollutants on physico-chemical and biological properties of water bodies, water born diseases with special reference to water pollution. Types and major sources of soil pollutants, effects of soil pollutants on physico-chemical and biological properties of soil. Air, drinking water and waste water quality standard. Major sources of noise pollution, effects of noise pollution on health, noise level standard in industrial, commercial, residential and silence zones. Radioactive and thermal pollution sources and their effects on surrounding environment. Solid waste disposal and its effects on surrounding environment.

Unit – 2	**Number of lectures = 12**	**Energy Resources and Conservation**

Renewable and non-renewable energy resources, growing energy need, sun as source of energy, solar radiation and its spectral characteristics, fossil fuels classification, composition. Physico-chemical characteristics and energy content of coal, petroleum and natural gas. Principle of generation and conservation of conventional and non-conventional energy. Energy from biomass and biogas, anaerobic digestion, energy use pattern and future need projection in different parts of the world, energy conservation policies.

Unit – 3	**Number of lectures = 15**	**Environmental Health Management**

Environmental health criteria, Scope of International Programme on Chemical Safety (IPCS). Effects of

mercury, lead, chromium, cadmium, arsenic and nitrate on human health. Water borne diseases; Prevention and protection of community health from water borne diseases. Air borne bio-allergents; present in the ambient air, seasonal changes, mode of dispersal, disease intensity and control. Effects of Physical Environment on Accidents, Crime, Suicide and Diseases of Man: Effects of temperature, humidity, ionization, ultra violet radiation and acidity of air on skin, lungs, throat, nose, eye, nervous system. Effects of weather and climate on diseases, mental processes, working efficiency, traffic and industrial accidents, behaviour, suicide and suicide attempts, effect of thermal stress and altitude on the action of drug.

12. Brief Description of self learning / E-learning component

1. https://www.youtube.com/watch?v=IIqFQkcHkCE
2. https://www.youtube.com/watch?v=51ixXCJ-Igo
3. https://en.wikipedia.org/wiki/Environmental_chemistry
4. https://www.nature.com/subjects/environmental-chemistry.

13. Books Recommended

1. De, A.K. Environmental Chemistry.
2. Manaham. Environmental Chemistry-.
3. Khopkar. Environmental Pollution Analysis.
4. Subramaniam, V. Environmental Chemistry.
5. Murray, J. Mc Ewan and Leon F. Philips. Chemistry of Atmosphere.
6. Heichlen, J. Atmospheric Chemistry.

Semester-III

Discipline Specific Elective Courses

Specialization: Inorganic Chemistry

1. Name of the Department : Chemistry						
2. Course Name	Advanced Inorganic spectroscopy	**L**	**T**	**P**		
3. Course Code	09040319	4	0	0		
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description:

Spectroscopic analysis is based on the interaction of an atom or a molecule with electromagnetic radiations of specific wavelength. This course will cover basic principles and detail understanding of different spectroscopic methods, which will include microwave , vibrational, electronic, NMR, mass and Mossbauer spectroscopy.

9. Course Objectives:

The objectives of this course are to:

1. Learn the basic principles of different spectroscopy.
2. Apply the techniques for pure samples as well as complex mixture.
3. Determine spectra and identify the unknown compounds, their shape and molecular composition.
4. Calculate the bond length of diatomic molecules.
5. Outline the selection rules for rotational and vibrational spectra and rationalize the role of dipole moment in the selection rules.
6. Identify the IR frequencies where simple functional group absorbs light.
7. Determine Spectra of Paramagnetic materials using NMR

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. Identify and characterize the molecule on the basis of spectroscopic study.
2. Apply vibrational spectroscopy to identify modes of bonding of ambidentate ligands.
3. Apply ESR in transitional metals with unpaired electrons.
4. Define Hyperfine coupling and splitting,
5. Discuss the active sites of metalloproteins with Raman spectra.
6. Find application of mass spectroscopy in various fields like finger print application, molecular weight determination, and evaluation of heat of sublimation of high melting solids.
7. Sketch qualitatively rotational-vibrational spectrum of diatomic molecule.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Vibrational Spectroscopy**

Symmetry and shapes of AB_2, AB_3,AB_4.AB_5 and AB_6, modes of bonding of ambidentate ligands,

ethylenediamine and diketonate complexes, application of resonance Raman Spectroscopy particularly for the study of active sites of metalloproteins as myoglobin and haemoglobin.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Electron Spin Resonance Spectroscopy**

Principle of ESR, Presentation of the spectrum, hyperfine coupling, hyperfine splitting in various structures, Factors affecting magnitude of g, zero field splitting and Kramer's degeneracy, Applications to transition metal

complexes having one and more than one unpaired electron, applications to inorganic free radicals, study of electron exchange reactions.

Unit – 3	**Number of lectures = 13**	**Title of the unit: Mossbauer Spectroscopy and Mass Spectrometry**

Mossbauer Spectroscopy: Basic Principles, spectral display, isomer shift, factors affecting the magnitude of isomer shift, quadrupole and magnetic hyperfine interaction, applications of technique to the study of bonding and structure of Fe^{2+}, Fe^{3+} ; Sn^{2+} and Sn^{4+} compounds; detection of oxidation states, nature of M-L bond,.

Mass Spectrometry: Principle, representation, interaction of molecule with high energy electrons, interpretation of mass spectrum, effect of isotopes on appearance of mass spectrum; applications- finger print application, molelcular weight determination, evaluation of heat of sublimation of high melting solids.

Unit – 4	**Number of lectures = 13**	**Title of the unit: Nuclear Magnetic Resonance Spectroscopy**

Nuclear Magnetic Resonance Spectroscopy: ^{19}F and ^{31}P NMR spectra – Chemical shifts, canpling constants, ^{19}F Spectra of fluoroacetone, 1-bromo-1-Fluoroethane, dimethyl phosphorus trifluoride and bromine pentafluoride ; ^{31}P spectra of HPF_2 $HPO(OH)_2$ H_2 $PO(OH)$, cis- $Pt(Pet_3)_2$ Cl_2, Application of 31p NMR for structural determination of Complexes with phosphorus ligands.

Spectra of Paramagnetic materials: Contact shift, its origin and application, Pseudo contact shift Diamagnetic complexes, Spectra of free radicals, Lanthanide shift Reagents, Magnetic susceptibility Measurement. Solid state NMR- Wide line NMR, Magnetic Angle spinning and Applications Magnetic Resonance Imaging.

12. Brief Description of self learning / E-learning component

1. https://www.slideshare.net/christophsontag/spectroscopic-methods-in-inorganic-chemistry-part1-uv-vis
2. https://www.slideshare.net/christophsontag/nmr-for-inorganic-chemistry

13. Books Recommended

1. Inorganic Spectroscopic Methods by Alan K. Brisdon
2. Spectroscopy in Inorganic Chemistry by C.N.R. Rao
3. NMR, NQR, EPR and Mössbauer spectroscopy in Inorganic Chemistry by R.V. Parish
4. NMR Spectroscopy in Inorganic chemistry by Jonathan A. Iggo
5. Structural Methods in Inorganic Chemistry by E.A.O. Ebsworth
6. Physical Methods in Chemistry by R.S. Drago
7. Introduction to Magnetic Resonance by A. Carrington & A.D. McLachlan.
8. Magnetism and Transition Metal Complexes by F.E. Mabbs & D.J. Machin

1. Name of the Department: Chemistry							
2. Course Name	Nuclear Chemistry		**L**		**T**		**P**
3. Course Code	09040320		4		0		0
4. Type of Course (use tick mark)	**Core ()**	**DSE (✓)**	**AEC ()**		**SEC ()**		**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practicals							
Lectures = 52	**Tutorials = Nil**	**Practical = Nil**					

8. Course Description:

This special paper in Chemistry will enable postgraduate students to understand how unstable nuclei decay and, in the process, release nuclear energy. Nuclear reactions can be of two types- fission and fusion. Their energetics and mechanism will be explained. Physical and chemical effects of radiation on matter, radiometric techniques to measure radiation and methods to detect radiation will also be discussed.

9. Course Objectives:

The objectives of this course are to:

1. Introduce students2 to decay of unstable nuclei and nuclear forces
2. Explain physical and chemical effects of radiation on matter
3. Understand radiochemical techniques
4. Explain various methods to detect nuclear radiation
5. Explain energetics, types and mechanism of nuclear reactions- fission and fusion

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Explain origin of nuclear energy and decay of unstable nuclei
2. Explain structure of the nucleus based on experimental evidence
3. Discuss the impact of radiation on matter
4. Describe various methods of detecting nuclear radiation
5. Explain types and mechanism of nuclear reactions

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Nuclear Binding Energy and Structure**

Nuclear Binding Energy: Justifications and applications; nuclear stability rules and decay of unstable nuclei.

Nuclear Structure: Nuclear forces; liquid drop model, Shell Model and collective model.

Unit - 2	**Number of lectures = 13**	**Title of the unit: Interaction of Radiation with matter and radiochemical techniques**

Interaction of Radiation with matter: Physical and chemical effects of radiation on matter (photoelectric

effect, Compton effect and pair production).

Radiochemical Techniques:

NAA - Principle, Application and Limitation

IDA - Principle, Application and Limitation

Radiometric titrations.

Unit - 3	**Number of lectures = 13**	**Title of the unit: Detection of Nuclear Radiation**

Various methods of detecting nuclear radiations, Gas-filled counters – Ionization chamber; Proportional counter and G.M. counters. Scintillation detectors; Solid state detectors.

Unit - 4	**Number of lectures = 13**	**Title of the unit: Nuclear reactions**

Nuclear Reactions: Energetics of nuclear reactions; various types of nuclear reactions including photonuclear, thermonuclear and spallation reactions; mechanism of nuclear reaction by compound nucleus model.

Nuclear fission: Fission probability; energy release; theories of fission.

Nuclear Fusion: Brief idea about breeder reactors; accelerators and cyclotron.

12. Brief Description of self learning / E-learning component

1. https://www.youtube.com/watch?v=H5eP-lgtjpY
2. https://www.youtube.com/watch?v=BnhX1aQlq7s
3. https://www.youtube.com/watch?v=3C7dmabYamc
4. https://www.youtube.com/watch?v=vPJidbP_oLM
5. https://www.youtube.com/watch?v=6vPQYYm2fO8.

13. Books Recommended

1. Essentials of Nuclear Chemistry by H.J. Arnikar
2. Radiochemistry and Nuclear Chemistry by G. Choppin, J.O. Liljenzin and J. Rydberg
3. Nuclear Chemistry by M. Sharon
4. Modern Nuclear Chemistry by W.D. Loveland, D.J. Morrisey and G.T. Seaborg
5. Handbook of Nuclear Chemistry: Instrumentation, Separation Techniques
6. Environmental issues by A. Vertes, S. Nagy and Z. Klencsar

1. Name of the Department: Chemistry							
2. Course Name	Bioinorganic Chemistry	**L**		**T**		**P**	
3. Course Code	09040321	4		0		0	
4. Type of Course (use tick mark)	**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**		**OE ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**		Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical							
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**			

8. Course Description:

This special paper in Inorganic chemistry will introduce students to vital essential and trace elements found in nature. Students will become familiar with the various functions of these elements. The role of metal ions in various biological systems, nucleotides, proteins and enzymes will be described.

The chemical composition of the atmosphere and the Earth's radiation balance will be discussed. In addition, the impact of introducing foreign substances (chemicals, heat, noise *etc*) into the environment will be described.

9. Course Objectives:

The objectives of this course are to:

1. Introduce students to essential and trace elements
2. Explain role of metal ions in biological systems and nucleotides
3. Understand role of metals in proteins (structure and function)
4. Understand role of metal ions in enzymes (structure and function)
5. Explain the chemical composition of the environment and the imbalances caused by release of foreign particles (chemicals, noise *etc*) in it

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Identify essential and trace elements found in nature and describe their function
2. Explain how metal ions contribute to functioning of vital biological systems
3. Explain the structure and function of vial metalloproteins
4. Explain the structure and function of vital metalloenzymes
5. Explain the composition of the atmosphere
6. Explain the impact of foreign particles (chemicals, noise *etc*) released into the atmosphere

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Metal Ions in Biological System**

Metal Ions in Biological Systems: General survey of essential and trace metals, Disturbing factors in metabolic process and causes of diseases, different classes of drugs.

Alkali and alkaline earth metals in biological systems: Ionophores, active transport of cations across membranes, sodium pump, Calcium pump, Calcium carriers, role of carriers in muscle contraction, blood clotting and hormones.

Interaction of metal ions with Nucleotides: metal ions in nucleotide systems, effect of metal ions on nuclei acids.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Metalloproteins**

Oxygen carriers: Porphyrins, metalloporphyrins, Hemoproteins, structure and functions of hemoglobin and myoglobin, synthetic oxygen carrier model systems

Nitrogen fixation: Biological nitrogen fixation, Nitrogenase, model for nitrogenase, metal-N_2 complexes, photosynthesis and chlorophyll.

Metal transport and storage: Transferrin, Ferritin, Siderophores

Unit – 3	**Number of lectures = 13**	**Title of the unit: Metalloenzymes**

Zinc Enzymes – Carboxypeptidase & Carbonic anhydrase

Iron Enzymes – Catalase, peroxidase & cytochrome P- 450

Copper Enzymes – Superoxide dismutase, blue copper- proteins

Coenzymes – Vitamins B_{12}

Unit – 4	**Number of lectures = 13**	**Title of the unit: Environmental Chemistry**

Atmosphere: Chemical composition of atmosphere, atmospheric structure, Earth's radiation balance; oxides of N, C, S and their effects, Greenhouse effect, acid rain, photochemical smog, air quality standards, depletion of ozone, particulate matter in atmosphere, mechanism of aerosol formation in air, Noise pollution and their health hazards.

12. Brief Description of self learning / E-learning component

1. https://www.youtube.com/watch?v=C_Kg0EMPEJ8
2. https://www.youtube.com/watch?v=n8IU53mS7M0
3. https://www.youtube.com/watch?v=dZE0TUTZtpQ
4. https://www.youtube.com/watch?v=s8jO6_8arCE
5. https://www.youtube.com/watch?v=7726rvJ6mNY.

13. Books Recommended

1. Inorganic Chemistry: Principles of Structure and Reactivity by J.E. Huheey
2. Environmental Chemistry by AK De
3. Environmental Pollution Analysis by Khopkar
4. Environmental Chemistry by V. Subramaniam
5. Metal Ions in Biochemistry by P.K. Bhattacharya
6. Bioorganic, Bioinorganic and Suprmolecular Chemistry by P.S. Kalsi and J.P.Kalsi

1. Name of the Department: Chemistry						
2. Course Name	Inorganic special practical-1	**L**		**T**		**P**
3. Course Code	09040322	0		0		6
4. Type of Course (use tick mark)	**Core ()**	**DSE (✓)**		**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = Nil	**Tutorials = Nil**	**Practical = 78**				

8. Course Description:

Practical work has had a central and distinct role in chemistry education (from school to university) for more than a century. Coordination complexes show diversity in structures depending on the metal ion, its coordination number and the dentcity of the ligands used. The module designed here for students is to understand the basic principles and learn the experimental part of complex preparation with transition elements.

9. Course Objectives:

The objectives of this course are to:

1. Make students understand the difference between double salts and coordination compounds.
2. Identify the chemicals and apparatus required for the synthesis of coordination complexes.
3. Discuss and compare the stability of different complexes.
4. Learn the formula and draw the structures of the complexes.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Synthesize different coordination complexes.
2. Observe the various colours associated with the particular complexes.
3. Compare the properties of these complexes by preparing similar complexes changing the metal
4. Analyze the samples and estimate their yield.

11. List of Experiments

Preparation of selected Inorganic Compounds complexes. Handling of air and moisture sensitive compounds:

1. Chromous Acetate
2. Hg $[Co(SCN)_4]$
3. $[Cu(NH_3)_4]\ SO_4.\ H_2O$
4. $[Mn(NH_3)_6]\ Cl_2$
5. $K_3\ [Fe(C_2O_4)_3]$
6. $VO\ (acac)_2$
7. Prussian blue
8. $[Co(NH_3)_5\ Cl]Cl_2$, $[Co(NH_3)_5\ NO_2]Cl_2$,$[Co(NH_3)_5ONO]Cl_2$
9. $K_3[Al\ (C_2O_4)_3]$
10. $[Ni\ (en)_3]\ S_2O_3$

12. Books Recommended

1. Siddiqui, I.R., Singh, J., Shrivastava, J., Yadav, L.D.S., Singh, R.K.P., Singh, J. (2018): Advanced Practical Chemistry, 8th Edition, Pragati Prakashan.

2. Agarwal, S.K., Lal, K. Advanced Inorganic Analysis, Pragati Prakashan.
3. Mendham, J. (2009): Vogel's Textbook of Quantitative Inorganic Analysis, Pearson Education.
4. Svehla, G., Sivasankar, B. (2012); Vogel's Qualitative Inorganic Analysis, Pearson Education.

1. Name of the Department: Chemistry						
2. Course Name	Inorganic Special Practical - II	**L**	**T**	**P**		
3. Course Code	09040323	0	0	6		
4. Type of Course (use tick mark)	**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**	
5. Pre requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = Nil	**Tutorials = Nil**	**Practical = 78**				

8. Course Description:

The emphasis of the lab work for this semester is on **spectrophotometry**. In the first two units, concentrations of selected cations (Fe, Ni, Mn, Cr, V, and Ti) and selected anions (Fluoride, Nitrate and Phosphate) will be determined. In the third unit, pK value of an indicator will be determined.

Finally, stoichiometry and stability constants of complexes will be determined Job's method ad slope ratio method. In Job's method, uv-absorbance is plotted against mole fraction. In the slope ratio method, absorbance is plotted against molar concentration of ions.

9. Course Objectives:

1. Spectrophotometric determination of selected cations and anions
2. Spectrophotometric determination of pK value of an indicator
3. Study of complexation (stoichiometry and stability constant) by Job's method/Slope ratio method

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Determine concentrations of selected cations and anions spectrophotometrically
2. Determine pK value of an indicator spectrophotometrically
3. Determine stoichiometry and stability constants of complexes by Job's method/Slope ratio method.

11. List of Experiments

1. Spectrophotometric determination of Fe, Ni, Mn, Cr, V, Ti and fluoride, Nitrate and phosphate.
2. Determination of pK value of an indicator spectrophotometrically.
3. Study of complexation (Stoichiometry and stability constant) between Fe-thiocynate, Fe-phenanthroline and Cu-ethylenediamine by Job's method/ Slope ratio method.

12. Brief Description of self learning / E-learning component

1. https://www.youtube.com/watch?v=98KYUaLe16U.
2. http://www.powershow.com/view1/f4f25-ZDc1Z/Spectrophotometric_determination_of_a_single_pKa_value_powerpoint_ppt_presentation
3. https://www.youtube.com/watch?v=Wn6PS-oTSyM.

13. Books Recommended

1. Chatwal,G.R and Anand, S.K (2000): Instrumental Methods of Chemical Analysis, Himalaya Publishing House, Delhi
2. Kamalesh Bansal, (2009): Analytical Spectroscopy, Campus Book International.
3. Spectrometry and Spectrofluorimetry: A Practical Approach by Michael G. Gore

1. Name of the Department: Chemistry						
2. Course Name		Inorganic Special Practical – III		**L**	**T**	**P**
3. Course Code		09040324		0	0	6
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = Nil		**Tutorials = Nil**		**Practical = 78**		

8. Course Description:

The emphasis of the lab work for this semester is on **instrumental analysis**. Students will be trained in **polarography** and **amperometry**. Students will be given hands-on training on **Atomic Absorption Spectrophotometer and Flame Photometer.**

Finally, students will be trained to interpret graphs generated by **Differential Thermal Analysis / Thermogravimetric Analysis (DTA/TGA)** instrument

9. Course Objectives:

1. Polarographic determination of selected metal ions and mixtures
2. Amperometric titration
3. Estimation of metal ions by Atomic Absorption Spectrophotometry and Flame Photometry.
4. Interpretation of DTA/TGA graphs of a given sample

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Determine selected metal ions and mixtures polarographically
2. Conduct amperometric titrations
3. Estimate metal ions by Atomic Absorption Spectrophotometry and Flame Photometry.
4. Interpret graphs of DTA/TGA for a given sample

11. List of Experiments

Interpretation of IR spectrum and determination of structure/bonding in some simple inorganic compounds and coordination compounds, such as: (60 marks)

a. Ammonium salts [NH4Cl, (NH4)2 SO4, NH4 SCN, NH4 NO3]
b. Sulphate ions in different bonding mode: ionic – K2 SO4 , CaSO4 etc., unidentate, bidentate, bridged etc.

c. Thiocynate and Isothiocynate complexes.
d. Oxalato complexes
e. Cyano complexes – K4 Fe(CN)6 , Na2 [Fe(CN)5 NO]
f. Ammine complexes
g. Spectra of isomers – Nitro – and Nitrito.

12. Brief Description of self learning / E-learning component

1. https://www.youtube.com/watch?v=3olOk_xNq8g
2. https://www.youtube.com/watch?v=3olOk_xNq8g
3. https://www.slideshare.net/nareshbabu7792/thermal-analysis-tga-dta
4. https://www.chemie-biologie.uni-siegen.de/ac/be/lehre/.../summary_of_tg_and_dta.pd
5. https://www.perkinelmer.com/CMSResources/.../44-74556GDE_TGABeginnersGuide

13. Books Recommended

1. Chatwal, G.R and Anand, S.K (2000): Instrumental Methods of Chemical Analysis, Himalaya Publishing House, Delhi

Semester-III

Specialization: Physical Chemistry

1. Name of the Department: Chemistry						
2. **Course Name**	Chemical Dynamics & Surface Chemistry		**L**		**T**	**P**
3. Course Code	09040325		4		0	0
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**		
8. Course Description:						
Thermodynamics of electrified interfaces, Helmholtz-Perrin model, Gouy- Chapman model and Stern model of electrified interfaces, fundamental problems in the study of pure liquid electrolytes, Butler-Volmer equation, Polarizable and non-polarizable interfaces, Gibb's adsorption equation and its applications, thermodynamics of micellization, Theories of unimolecular reactions, , London-Eyring-Polanyi method for the calculation of energy of activation.						
9. Course Objectives:						
1. Students will be able to learn various areas of chemistry like thermodynamics of electrified interfaces & rate of reactions. 2. To study the physical and chemical (experimental) methods for determining the concentrations of the species participating in chemical reactions. 3. To introduce advanced topics related to surface chemistry.						
10. Course Outcomes (COs):						
The students will acquire knowledge of : 1. Thermodynamics of electrified interfaces 2. Models of simple ionic liquids & lattice oriented models 3. Gibb's adsorption equation and its applications 4. method for the calculation of energy of activation						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 11**	**Title of the unit: Electrified Interfaces**				
Thermodynamics of electrified interfaces: electrocapillary thermodynamics, non-polarizable interface and thermodynamic equilibrium, fundamental thermodynamic equation of polarizable interfaces, determination of excess charge density on the electrode, electrical capacitance and surface excess of the interface, potential of zero charge, Helmholtz-Perrin model, Gouy - Chapman model and Stern model of electrified interfaces.						
Unit – 2	**Number of lectures = 17**	**Title of the unit: Ionic Liquids & Electrodics**				
Ionic Liquids: The thermal dismantling of an ionic lattice, characteristics of ionic liquids, the fundamental problems in the study of pure liquid electrolytes, models of simple ionic liquids: lattice						

oriented models (the vacancy model, the hole model), quantification of the hole model, the Furth approach to the work of hole formation, distribution function for the sizes of the holes and the average size of a hole.
Electrodics: Rate of charge- transfer reactions under zero fields, under the influence of an electric field, the equilibrium exchange current density, the non-equilibrium drift-current density (Butler-Volmer) equation. Some general and special cases of Butler-Volmer equation, the high-field and low-field approximations, physical meaning of the symmetry factor ( ), a preliminary to a second theory of , a simple picture of the symmetry factor and its dependence on overpotential. Polarizable and non-polarizable interfaces.

Unit – 3	**Number of lectures = 13**	**Title of the unit: Adsorption**

Surface tension, capillary action, pressure difference across curved surface (Leplace equation), Gibb's adsorption equation and its applications, determination of BET equation and its application for the determination of surface area; surface active agents and their classification, concept of micelles, critical micelle concentration (cmc), determination of cmc by conductivity and surface tension methods; factors affecting cmc, counter - ion binding to micelles, thermodynamics of micellization.

Unit – 4	**Number of lectures = 11**	**Title of the unit: Chemical Dynamics**

Study of fast reactions, Flow methods, Relaxation method, Flash photolysis and shocktube method. Theories of unimolecular reactions: Lindemann's theory, Hinshelwoods treatment, R.R.K. and R.R.K.M. theories, The theory of absolute reaction rates, potential energy surfaces, activation energies, London-Eyring-Polanyi method for the calculation of energy of activation.

12. Brief Description of self learning / E-learning component

1. http://epgp.inflibnet.ac.in/
2. http://nptel.ac.in/courses/122101001/27
3. http://www.engr.uconn.edu/~jmfent/CHEG320_electrode%20kinetics%20lectures.pdf
4. https://chem.libretexts.org. 29: Chemical Kinetics II: Reaction Mechanism

13. Books Recommended

1. Bockris, J.O.M. and A.K.N. Reddy. Modern Electrochemistry Vol.1& 2.
2. Laidler, K.J. Chemical Kinetics.
3. Frost, A. and G.Pearson. Kinetics and Mechanism of Reaction Rates.
4. Laidler, K.J., H.Eyring and S. Glasstone. Theories of Reaction Rates.
5. Glasstone, S. Electrochemistry.

1. Name of the Department: Chemistry						
2. Course Name		Statistical Thermodynamics & Quantum Mechanics-II	**L**	**T**	**P**	
3. Course Code		09040326	4	0	0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description:

Maxwell - Boltzmann statistics, Partition function and its factorization, Derivation of equation of state for a mono atomic ideal gas, Derivation of expressions for transitional, vibrational, rotational, electronic energy; expressions for entropy, Gibbs free energy, work function due to transitional, vibrational and rotational motion of a molecule, Chemical equilibrium and equilibrium constant in terms of partition functions, Free energy function, Applicability of perturbation theory to an electron in a one dimensional box under the influence of electric field, LCAO-MO approximation.

9. Course Objectives:

1. To introduce the student to today's understanding of statistical physics and statistical mechanics.
2. Students will be able to learn various areas of chemistry like Statistical Thermodynamics & Quantum Mechanics.
3. To introduce advanced topics related to Quantum Statistical Mechanics.

10. Course Outcomes (COs):

The students will acquire knowledge of :

1. computing entropy by counting the number of allowed states for simple systems such as the ideal gas.
2. identifying the relationship and correct usage of infinitesinal work, work, energy, heat capacity, specific heat, latent heat, and enthalpy.
3. using some empirical equations of state to compute the final state of thermodynamical systems such as the ideal gas.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Statistical Thermodynamics I**

Concept of distribution, thermodynamic probability and most probable distribution; canonical, grand canonical and micro canonical ensembles. Maxwell - Boltzmann statistics, Statistical thermodynamic formulation of Maxwell - Boltzmann distribution law, Maxwell - Boltzmann law of distribution of energy and evaluation of average velocity, root mean square velocity; law of equipartition of energy; Partition function and its factorization, relationship of atomic and molar partition function to thermodynamic properties(I) internal energy (ii) entropy (iii) Gibb's free energy (iv) heat contant (v) work function (vi)

pressure (vii) heat capacity at constant volume. Derivation of equation of state for a mono atomic ideal gas.

Unit – 2	**Number of lectures = 14**	**Title of the unit: Statistical Thermodynamics II**

Translational partition function, calculation of absolute entropy of an ideal monoatomic gas, Seckure - Tetrode equation, Vibrational , Rotational, & electronic partition function of diatomic molecules, Derivation of expressions for transitional ,vibrational, rotational, electronic energy; expressions for entropy, Gibbs free energy, work function due to transitional, vibrational and rotational motion of a molecule. Effect of change of zero point energy on partition function and also on thermodynamic properties like internal energy, Gibbs free energy, enthalpy, work function & entropy. Chemical equilibrium and equilibrium constant in terms of partition functions, Free energy function.

Unit – 3	**Number of lectures = 13**	**Title of the unit: Quantum Mechanics I**

Quantum mechanical treatment of Helium atom and the failure of rigorous quantum mechanical method. Need of approximate methods, first order perturbation theory (excluding time dependent), variation principle. Application of first order perturbation and variation principle to evaluate ground state of helium atom. Applicability of perturbation theory to an electron in a one dimensional box under the influence of electric field.

Unit – 4	**Number of lectures = 13**	**Title of the unit: Quantum Mechanics II**

Valance bond method, valance bond method to hydrogen, hydrogen molecule ion (their symmetric and anti symmetric solution without actual valuation of various integrals, energy of molecular hydrogen system, LCAO-MO approximation, refined treatment of hydrogen molecules Concept of resonance and its role in the stability of hydrogen molecule ion, electron spin, Pauli's exclusion principle, hybridization.

12. Brief Description of self learning / E-learning component

1. http://epgp.inflibnet.ac.in/
2. https://youtu.be/bE7Z6Zkst1I
3. https://youtu.be/CBrsWPCp_rs
4. https://youtu.be/7ItAyG_m7jA
5. http://chemistry.umeche.maine.edu/Modeling/lcao.html.

13. Books Recommended

1. Glasstone, S. Theoretical Chemistry.
2. Levinine.Quantum Chemistry.
3. Pauling, Eyring and Wilson. Quantum Chemistry
4. Nash, L.K. Introduction to Statistical Mechanics.

1. Name of the Department: Chemistry						
2. Course Name	Spectroscopy & Corrosion-I		**L**	**T**	**P**	
3. Course Code	09040327		4	0	0	
4. Type of Course (use tick mark)	**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52	**Tutorials = Nil**	**Practical = Nil**				

8. Course Description:

Nuclear Magnetic Resonance Spectroscopy, simplification of complex spectra, Theory & application of Electron spin resonance spectroscopy, Theory & application of Moss Bauer Spectroscopy, Electrode reactions, Electrochemical techniques to study corrosion – Galvanostatic and potentiostatic techniques, theories of passivity, Protection methods against corrosion, classification, mechanism, selection of corrosion inhibitors.

9. Course Objectives:

1. To enable students to learn the principle & application of behind different spectroscopic techniques such as NMR, Moss Bauer , ESR spectroscopy.
2. To illustrate the use of different spectroscopic methods in the structure elucidation of some simple compounds.
3. To explore the basic nature of corrosion and its many processes.
4. To provide fundamental understanding of aspects of electrochemistry and materials science relevant to corrosion phenomena

10. Course Outcomes (COs):

The students will acquire knowledge of :

1. Various techniques studying metal complexes or organic radicals and determining structure of molecules
2. Methodologies for predicting, measuring, and analyzing corrosion performance of materials.
3. Identifying practices for the prevention and remediation of corrosion.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Spin Resonance Spectroscopy**

Spin and an applied field; the nature of spinning particles, interaction between spin and magnetic field, Larmor precession, population of energy levels. Nuclear Magnetic Resonance Spectroscopy; Hydrogen Nuclei, the chemical shift, the coupling constant, coupling between several nuclei, analysis by NMR technique, exchange phenomena, simplication of complex spectra.

Unit - 2	**Number of lectures = 12**	**Title of the unit: Electron spin resonance spectroscopy & Moss Bauer Spectroscopy**

Electron spin resonance spectroscopy; the theory of E.S.R. the position of E.S.R. absorption, the g factor, the fine and hyperfine structures of E.S.R. absorption. Applications of E.S.R. spectroscopy.

Moss Bauer Spectroscopy: The theory of Moss-Bauer spectroscopy, the chemical shift quadrupole effects, the effect of magnetic field, application of Moss-Bauer spectroscopy.

Unit - 3	**Number of lectures = 14**	**Title of the unit: Corrosion I**

Introduction: Definition of corrosion, importance and cost of corrosion classification of corrosion

Electrochemistry of Corrosion: Electrode reactions, electrode potentials, electrochemical cell formation, Nernst equation, exchange current density, polarization of electrode (resistance, concentration and activation), mixed potential theory, polarization diagrams, pourbaix diagrams, corrosion rate expression and weight loss method for corrosion rate, galvanic series. Electrochemical techniques to study corrosion – Galvanostatic and potentiostatic techniques, Stern –Geary equation, Tafel slopes, measurement of corrosion potential and corrosion current density, Tafel extrapolation and Linear polarization resistance methods, recording and interpretation of anodic and cathodic polarization curves.

Unit - 4	**Number of lectures = 14**	**Title of the unit: Corrosion II**

Kinetics of Passivity: Introduction , electrochemical behaviour of active/passive metals, Flade potential, criteria for selecting a metal exhibiting passivity, factors influencing electrochemical passivity and corrosion rate, theories of passivity.

Protection Methods against Corrosion: Change of metal, designimprovement, change of environment, anodic protection, cathodic protection and protective coatings.

Corrosion inhibitors: classification, mechanism, selection of corrosion inhibitors, inhibition efficiency and factors influencing inhibition efficiency, measurement of inhibition efficiency.

12. Brief Description of self learning / E-learning component

1. staff.mbi-berlin.de/schultz/biomed/script4.pdf
2. https://www.slideshare.net/solairajananant/nmr-spectroscopy-13887430
3. https://youtu.be/Q2Fo5BAReGo
4. www.npl.co.uk/upload/pdf/the_electrochemistry_of_corrosion.pdf
5. http://epgp.inflibnet.ac.in.

13. Books Recommended

1. Barrow, G.M. Introduction of Molecular Spectroscopy.
2. Banwell, C.N. Fundamentals of Molecular Spectroscopy.
3. Sastri, V.S. Corrosion Inhibitors: Principle and Applications.
4. Trephewey, K.R. and J. Chamberlain. Corrosion.
5. Narain, Raj. Introduction to Metallic Corrosion and its Prevention.
6. Mukherjee, S.N. Introduction to the Science of Corrosion and its Inhibition.
7. Fontana, M.G. Corrosion Engineering.

1. Name of the Department: Chemistry						
2. Course Name	Physical Special Practical -1	**L**	**T**	**P**		
3. Course Code	09040328	0	0	6		
4. Type of Course (use tick mark)	**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = Nil	**Tutorials = Nil**	**Practical = 78**				

8. Course Description:

This Course will enable the students to learn various potentiometric titrating techniques and concept of characterizing an acid without indicators. Students will also learn various concepts of electrochemistry, pH metry and dipole metry. It will also give a platform to develop various skills of laboratory experimentation to quality control methods of analysis.

9. Course Objectives:

1. To motivate the students to understand the principles of Potentiometry, pH metry and Dipole metry.
2. To impart knowledge with respect to surface tension and adsorption of different systems.
3. To give hands on experience of working of pH meter & Dipole meter.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Determine dielectric constant of non aqueous liquid at different concentration and hence determination of Dipole Moment.
2. Describe various potentiometric titrations.
3. Describe application and functioning of pH meter & Dipole meter.

11. List of Experiments

I. Potentiometry

a. $KMnO_4$vs. Mohr's salt or $FeSO_4$ titration
b. $K_2Cr_2O_7$ vs. Mohr's salt or $FeSO_4$ titration.
c. $AgNO_3$ vs. KCl or KI titration
d. $AgNO_3$ vs. (KCl + KI) mixture titration
e. $AgNO_3$ vs. (KCl + KBr +KI) mixture titration
f. Fe^{2+} vs Ce^{+4} titration.

II. pH metry

a. NaOH vs Succinic Acid titration
b. NaOH vs Citric Acid titration
c. To predict composition of Copper amine complex from CuSO4 vs.
i. NH_4OH titration.
d. To determine dissociation constant of weak acid
e. To determine dissociation constant of acetic acids in acetone by titrating with
i. Potassium hydroxide.
f. To determine degree of hydrolysis of aniline hydro chloride.

III. Dipole metry

a. To determine the dielectric constant of various organic liquids.

12. Books Recommended

1. Khosla,B.D., V.C. Garg and A. Khosla.Senior Practical Physical Chemistry.
2. Thawale,A. and P. Mathur. Experimental Physical Chemistry.
3. Vishwanatha,B. and P. S Raghav. Practical Physical Chemistry.
4. Sindhu, P.S. Practical in Physical Chemistry.

1. Name of the Department: Chemistry						
2. Course Name	Physical special practical-II	**L**	**T**	**P**		
3. Course Code	09040329	0	0	6		
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite .	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = Nil	**Tutorials = Nil**	**Practical = 78**

8. Course Description:

This lab course provides the use of very important instruments like conductometer, polarimeter and flame photometer. Students can apply the principle behind acid base titrations and can find the strength of unknown solutions by measuring the mobility of ions using conductometer. Polarimeter will help the students to find out specific rotation of various optically active substances. Flame photometry is a process where in emission of radiation by neutral atom is measured.

9. Course Objectives:

The objectives of this course are to:.

1. Understand the theory behind conductivity of ions .
2. Use conductometric titrations for detecting sharp equivalence point.
3. Find out specific rotations of optically active substances.
4. Perform experiments on alkali and alkali earth metals by thermally dissociating in flame.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. Perform titrations of strong acid-strong base, weak acid- strong base and strong acid-weak base, conductometrically.
2. Perform titration of combination of acids with alkali and find their respective strength conductometrically.
3. Identify dextro and laevo rotatory substances and measure their specific rotation using polarimeter.
4. Determine the concentration of ions of alkali and alkali earth metals using flame,

11. List of Experiments

I. Conductometric titrations

a. NaOH vs. Citric acid
b. NaOH vs. Succinic Acid
c. NH_4OH vs CH_3COOH
d. CH_3COONa vs HCl
e. NaOH vs. (HCl + CH_3COOH) mixture
f. NaOH vs. (HCl + CH_3COOH + $CuSO_4$) mixture.
g. To study the conductometry titration of hydrochloric acid with sodium carbonate. Also determine the concentration of sodium carbonate in a commercial sample of soda ash.
h. $AgNO_3$ vs KCl or KI
i. To determine solubility and solubility product of sparingly soluble salts (AgCl, PbSO4, $BaSO_4$)
j. Verification of D.H.O. equation for strong electrolytes.

II. Polarimetry

1. To determine specific rotation for various optically active substances.
2. To determine concentration of glucose or fructose or sucrose or tartaric acid in solution.
3. To determine the percentage composition of optical substances in the binary mixture (components comprise of Glucose or Fructose or sucrose or Tartaric acid)

III. Flame Photometry

1. To determine the concentration of Na+ or Li+ or Ca++ ions in solution.

12. Books Recommended

1. Khosla,B.D., V.C. Garg and A. Khosla.Senior Practical Physical Chemistry.
2. Thawale,A. and P. Mathur. Experimental Physical Chemistry.
3. Vishwanatha,B. and P. S Raghav. Practical Physical Chemistry.
4. Sindhu, P.S. Practical in Physical Chemistry.

1. Name of the Department: Chemistry						
2. Course Name	Physical special practical-III	**L**	**T**	**P**		
3. Course Code	09040330	0	0	6		
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = Nil		**Tutorials = Nil**	**Practical = 78**			

8. Course Description:

This course provides practical training with the use of special instruments like ultrasonic interferometry and spectrocolorimetry. This lab course also enables the students to have practical knowledge about the kinetics of different reactions and the factors it depends upon.

9. Course Objectives:

The objectives of this course are to:

1. Have clear concepts about kinetics of a reaction.
2. Understand terms like rate law, order of reaction, molecularity and chemistry behind iodine clock reaction.
3. Enable students to apply the basic principles of UV-visible spectrophotometer and determine concentration of unknown solution from their λmax values.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. Able to measure the sound for various liquids.
2. Verify lambert-Beer's law with different coloured solutions and
3. Find the unknown concentration of any coloured solution.
4. Determine the activation energy for hydrolysis of an ester.
5. Study reaction kinetics of iodine clock reaction.

11. List of Experiments

I. Ultrasonic Interferrometry

a. To measure speed of sound for various liquids.
b. To determine the isentropic compressibility of liquids.

II. Spectrocolorimetry

a. To test the validity of Lambert Beer's Law for KMnO4 and K2Cr2O7
b. To determine the concentration of copper sulphate, potassium permanganate and potassium dichromate in the given solution.
c. To study complex formation between ferric and thiocyanate ions.

III. Chemical Kinetics

a. To determination the activation energy for the hydrolysis of ethyl or methyl acetate.
b. To determine the temperature coefficient for the hydrolysis of ethyl or methyl acetate.
c. To study the kinetics of reaction between potassium iodide and potassium persulphate solution.
d. To study the kinetics of acid catalyzed inversion of cane sugar.
e. To study of kinetics of bromination of Gallic acid by bromide-bromate mixture in acid medium. (Clock reaction).

12. Books Recommonded

1. Khosla,B.D., V.C. Garg and A. Khosla.Senior Practical Physical Chemistry.
2. Thawale,A. and P. Mathur. Experimental Physical Chemistry.
3. Vishwanatha,B. and P. S Raghav. Practical Physical Chemistry.
4. Sindhu, P.S. Practical in Physical Chemistry.

Semester-III

Specialization: Organic Chemistry

<table>
<tr><td colspan="8">1. Name of the Department : Chemistry</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Organic Spectroscopy</td><td>L</td><td colspan="2">T</td><td>P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2">09040331</td><td>4</td><td colspan="2">0</td><td>0</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td>Core ()</td><td>DSE (✓)</td><td>AEC ()</td><td>SEC ()</td><td>OE ()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td>B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practicals</td></tr>
<tr><td colspan="3">Lectures = 52</td><td>Tutorials = Nil</td><td colspan="4">Practical = Nil</td></tr>
<tr><td colspan="8">8. Course Description:</td></tr>
<tr><td colspan="8">The structures in chemistry are symbols representing real existence of the compounds that form the substance of study in organic chemistry. The student had in the course of the study of organic chemistry written many structures without asking how the structures had come to be. The course introduces the key spectroscopic methods used by chemists and biochemists to analyze the molecular structure of organic compounds and provides opportunity to learn and appraise the use of spectroscopic instruments in the determination of the structures of organic compounds.</td></tr>
<tr><td colspan="8">9. Course Objectives:</td></tr>
<tr><td colspan="8">The objectives of this course are to:
1. Discuss similarities and differences between spectroscopy and spectrometry.
2. Identify the basic components of spectroscopic instrumentation.
3. Introduce the theory of the various instruments and the signals produced when analyzing compounds.
4. Demonstrate a working knowledge of ultraviolet-visible (UV-Vis) spectroscopy, infrared (IR) spectroscopy, nuclear magnetic resonance (NMR) spectroscopy and mass spectrometry (MS).</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="8">Upon successful completion of this course, the student will be able to:
1. Determine functional groups and write structures.
2. Study the spectra of compounds and propose structures for compounds.
3. Elucidate the structures of organic molecules from spectral data.</td></tr>
<tr><td colspan="8">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td colspan="2">Number of lectures = 10</td><td colspan="5">Title of the unit: Ultraviolet and Visible Spectroscopy</td></tr>
<tr><td colspan="8">Introduction – Electronic energy levels, electronic transitions and selection rules. The origin, general appearance and designation of UV bands, absorption laws and measurement of absorption intensity, chromophores, auxochromes, bathochromic shift, hypsocromic shift, hypochromic effect, hyperchromic effect. The ultraviolet spectrometer,Wood-Ward and Fieser’s rules for calculating ultraviolet absorption maxima for conjugated dienes, unsaturated carbonyl compounds and aromatic carbonyl compounds. Application of UV spectroscopy to problems in organic chemistry.</td></tr>
<tr><td>Unit – 2</td><td colspan="2">Number of lectures = 12</td><td colspan="5">Title of the unit: Infrared Spectroscopy</td></tr>
<tr><td colspan="8">Introduction – Basic theory and instrumentation including FT IR infrared spectrum. Units of frequency wave length and wave number, Molecular vibrations. Functional group and finger print regions.Fundamental vibrations, overtones, Fermi resonance. Frequency of vibrations of a diatomic molecule, factors influencing vibrational frequencies, sampling techniques, characteristic frequencies of organic molecules and interpretation of spectra.</td></tr>
<tr><td>Unit – 3</td><td colspan="2">Number of lectures = 15</td><td colspan="5">Title of the unit: Nuclear Magnetic Resonance Spectroscopy (^{1}H and ^{13}C NMR)</td></tr>
<tr><td colspan="8">Introduction – The Nuclear spin, Larmor frequency, population of nuclear spin level, spin - spin relaxation and</td></tr>
</table>

spin - lattice relaxation. Principles of NMR, Measurement techniques (CW & FT NMR).equivalent and non equivalent protons, enantiotopic and diastereotopic protons, Chemical shift, reference compounds, factors affecting the chemical shift, spin - spin coupling, multiplicity of splitting and relative intensity of lines in a multiplet, integration, vicinal, germinal and long range couplings, Coupling constants and factors affecting coupling constants. Techniques for simplification of complex spectra: solvent effects, Lanthanide shift reagents, spin decoupling (double resonance), Nuclear Overhauser effect (NOE). Effect of sensitivity of ^{13}C NMR compared to ^{1}H NMR, comparison of ^{13}C NMR and ^{1}H NMR, chemical shifts of ^{13}C NMR. Simplification of ^{13}C NMR spectra by process of Broad Band decoupling, Selective decoupling and off resonance decoupling.

Unit – 4	**Number of lectures = 15**	**Title of the unit: Mass Spectrometry & (ORD and CD)**

Mass Spectrometry : Introduction – Elementary theory , instrumentation, Measurement techniques (EI, CI, FD, FAB), Mass spectrum, base peak, molecular ions, isotope ions, rearrangement ions, fragment ions, even electron rule, nitrogen rule, matastable ions. Salient features of fragmentation pattern of organic compounds including β-cleavage, Mclafferty rearrangement, retro Diels – Alder fragmentation and ortho effect.

Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD): Definition, haloketo rule, octant rule for ketones. Cotton effect and Cotton curves, deduction of absolute configuration.

12. Brief Description of self learning / E-learning component

1. https://swayam.gov.in/courses/252-organic-spectroscopy.
2. http://nptel.ac.in/courses/102103044/4
3. http://ocw.uci.edu/courses/chem_203_organic_spectroscopy.html

13. Books Recommended

1. R.M. Silverstein & G.C. Bassler, Spectrometric Identification of Organic Compounds.
2. W. Kemp. Organic Spectroscopy.
3. D.H. Williams and I. Fleming. Spectroscopic Methods in Organic Chemistry.
4. Jag Mohan. Organic Spectroscopy.
5. Dyer, J.R. Application of Spectroscopy of Organic Compounds.
6. Pavia. Organic Spectroscopy.
7. Williams, D.H. and I. Fleming Spectroscopic Methods in Organic Chemistry.

1. Name of the Department: Chemistry						
2. Course Name	Natural products-I and Biochemistry		**L**	**T**		**P**
3. Course Code	09040332		4	0		0
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = Nil**	**Practical = Nil**			

8. Course Description:

This course covers the structure elucidation and synthesis various biologically important natural compounds e.g. vitamins, nicotinic acid and biotin. It also includes importance and classification of enzymes and coenzymes.

9. Course Objectives:

1. To make students able to determine the structure and synthesis of given vitamins, carotene and porphyrins.
2. Students should know the structure and synthesis of flavaniods.
3. This course makes the students able to understand biological activity and catalytic property of enzyme and chemistry of co-enzyme

10. Course Outcomes (COs):

On completion of this course, the students should

1. Able to know the determine of structure and synthesis of given vitamins.
2. Know the importance and route for the synthesis of given carotene and porphyrins.
3. Have a clear understanding about the biological importance and types of enzymes and coenzymes.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: Vitamins**

Classification, Occurrence Chemistry of Vitamins, Structure elucidation and synthesis of vitamins A, C, D and E

Unit – 2	**Number of lectures = 12**	**Title of the unit: Carotenoids & Porphyrins**

Carotenoids: General methods of structure elucidation and synthesis of α, β & ɤ- carotene, and lycopene

Porphyrins: Structural determination and synthesis of porphyrins and Haemin. .

Unit – 3	**Number of lectures = 15**	**Title of the unit: Plant pigments**

Occurance, general chemical methods for structure determination of plant pigments. Structure elucidation and synthesis of Flavone, Quercetin, Xanthone and Cyanidin chloride.

Unit – 4	**Number of lectures = 10**	**Title of the unit: Enzymes and Co-enzymes**

Enzymes and co-enzymes: Introduction to biological catalysis, nomenclature, classification and specificity.

Kind of reaction catalysed by enzymes: Oxidation – reduction, isomerisation, epimerisation, hydrolysis, phosphorylation, acylation, methylation, decarboxylation, dehydration.

Co-enzymes: Chemistry of Co-enzymes; Co-I, Co-II, Co-A, Co-carboxylase, FMN, FAD and Pyridoxal phosphate.

12. Brief Description of self learning / E-learning component

1. https://chem.libretexts.org/LibreTexts/Athabasca_University/Chemistry_360%3A_Organic_Chemistry_II/Chapter_26%3A_Biomolecules%3A_Amino_Acids%2C_Peptides%2C_and_Proteins/26.10_Enzymes_and_Coenzymes
2. http://courses.washington.edu/medch562/pdf/562P_RettieVitaminA.pdf
3. http**:**//www-oc.chemie.uni-regensburg.de/OCP/ch/chv/oc21/lcns_04k03aw.pdf

13. Books Recommended

1. Duags, Herman. and C. Penny. Bioinorganic chemistry: A Chemical Approach to Enzyme Action. Springer-Verlag.
2. Palmer, Trevor. Understanding Enzymes.
3. Suckling, E. and J. Collin. Enzyme Chemistry: Impact and Applications. Chapman and Hall.
4. Page, M.I. and A. Willians. Enzyme Mechanisms.
5. Price, N.C. and L. Stevens. Fundamentals of Enzymology.
6. Kalsi, P.S. The Chemistry of Natural Products.

1. Name of the Department : Chemistry						
2. Course Name	Heterocyclic Chemistry and Organic Synthesis		**L**	**T**	**P**	
3. Course Code	09040333		4	0	0	
4. Type of Course (use tick mark)		**Core ( )**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**	**Practical = Nil**			

8. Course Description:

Classification of heterocycles. Synthesis and reactions of Imidazole, Thiazole and Oxazole, Pyrimidines and Purines. Structural elucidation of uric acid and caffeine, Nucleosides and Nucleotides. General methods of formation, General study of Nitrogen, Phosphorous and Sulphur ylides and their applications. Antimalarials, antipyretics, analgesics, sulphadrugs, anticancer drugs.

9. Course Objectives:

1. To introduce synthesis and reaction mechanisms of heterocyclic compounds and ylides.
2. To describe the structure elucidation of Nucleosides and Nucleotides
3. To discussed the physiological action and the chemical constitution of drugs.

10. Course Outcomes (COs):

The students will acquire knowledge of

1. Nomenclature, synthesis and reactivity of different heterocyclic compounds.
2. Nucleosides and Nucleotides
3. General methods of formation and reaction mechanisms of Ylides
4. Relationship between physiological action and the chemical constitution of different type of drugs

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Three, Four and Five-membered Heterocycles**

Three membered and four membered hetero cycles - synthesis and reactions of aziridines,Oxiranes,Oxetanes and Thietanes

Five-membered Heterocycles: Synthesis and reactions of 1, 3-Azoles: Imidazole, Thiazole and Oxazole.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Six membered Heterocycles**

Six membered Heterocyclics with one heteroatom: Synthesis and reactions of Coumarines,Chromones and quinolizinium salts.

Six membered Heterocyclics with two heteroatoms: Synthesis and reactions of Pyrimidines and Purines.

Structural elucidation of uric acid and caffeine.

Unit – 3	**Number of lectures = 12**	**Title of the unit: Ylides**

General methods of formation, General study of reactions with their mechanisms of Nitrogen (Ammonium, Immonium, Diazonium and Nitrile), Phosphorous and Sulphur ylides and their applications.

Unit – 4	**Number of lectures = 15**	**Title of the unit: Disconnection Approach**

An introduction to synthons and synthetic equivalents, disconnection approach, functional group inter-conversions, the importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclisation reactions,amine synthesis.

One group C-C Disconnections: Alcohols and carbonyl compounds, regioselectiviity. Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis.

Two group C-C Disconnections: "Diels-Alder reaction, 1,3-difunctionalised compounds, α ,β-unsaturated carbonyl compounds,Michael addition and Robinson annelation."

12. Brief Description of self learning / E-learning component
1. http://nptel.ac.in/syllabus/104105034/ 2. http://bhavanscollegedakor.org/images/pdf/sci/disconnetcion.pdf. 3. https://onlinecourses.nptel.ac.in/noc18_cy03/preview.
13. Books Recommended
1. Gupta, R.R., M. Kumar and V. Gupta. Heterocyclic Chemistry. 2. Ahluwalia, V.K. Heterocyclic Chemistry 3. Finar, I.L. Organic Chemistry, Volume 2 4. Sturant Warren, John Wiley and sons,Organic synthesis : The Disconnection Approach. 5. Warren.S, Willey. Designing Organic Synthesis.

1. Name of the Department: Chemistry						
2. Course Name	Organic Special Practical-I		**L**	**T**		**P**
3. Course Code	09040334		0	0		6
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = Nil		**Tutorials = Nil**	**Practical = 78**			

8. Course Description:

This Course will introduce the students to determine the structure of organic compounds through spectroscopic methods and chemical methods and will enable to develop and practice independent learning skills. This course will also give a platform to develop different methods to determine the structure of organic compounds..

9. Course Objectives:

The objectives of this course are to:

1. Perform the standard techniques used in practical organic chemistry.
2. Plan and carry out identification using a prescribed procedure.
3. Identify and report relevant structures of compounds.
4. Handle organic chemicals safely and describe their potential dangers.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Describe various techniques used for the structural determination of organic compounds.
2. Describe disposal techniques and laboratory emergency procedures.
3. Know the handling of instruments.
4. Apply identification techniques for the structural determinationof organic compounds

11. List of Experiments

Structural determination of organic compound using spectroscopic methods (IR, UV, NMR & Mass) followed by chemical methods.

Note: Students need to analyze at least ten compounds.

12. Books Recommended

1. R.M. Silverstein & G.C. Bassler, Spectrometric Identification of Organic Compounds.
2. W. Kemp. Organic Spectroscopy.
3. D.H. Williams and I. Fleming. Spectroscopic Methods in Organic Chemistry.
4. Jag Mohan. Organic Spectroscopy.
5. Dyer, J.R. Application of Spectroscopy of Organic Compounds.
6. Williams, D.H. and I. Fleming Spectroscopic Methods in Organic Chemistry.
7. Nicolas Bogliotti, Roba Moumné ,Multi step organic synthesis,A guide through experiments, 2017.
8. Brian S,Furniss ,Vogels text book of practical organic chemistry, 5th addition,.
9. Tatchell, A. R. Vogel's Textbook of Practical Organic Chemistry. John Wiley.

1. Name of the Department : Chemistry						
2. Course Name	Organic Special Practical-II		**L**	**T**		**P**
3. Course Code	09040335		0	0		6
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = Nil		**Tutorials = Nil**	**Practical = 78**			

8. Course Description:

This course provides students with practical experience of the techniques of analysis of quantitative data. Using examples of research in chemical science and other fields. It is addressed to students who have little or no experience of using quantitative data and it aims to enable students to develop an understanding of basic and intermediate quantitative methods and the ability to use these methods.

9. Course Objectives:

1. To develop quantitative technique skills in students.
2. To isolate the organic compounds from the natural resources.

10. Course Outcomes (COs):

Students will gain an understanding of:

1. the application of analytical methods based on titrations, isolation, separations, etc
2. the design and application of an analysis related to a question of relevance based on experience in the laboratory and research of the scientific literature
3. Solving most important problems of quantitative analysis.

11. List of Experiments

I. Quantitative Analysis

a. Determination of percentage or number of hydroxyl groups in organic compound by acetylation method.
b. Estimation of Amines and phenols using bromate-bromide solution or acetylation method.
c. Determination of iodine and saponification values of oil samples.
d. Determination of concentration of Glucose and Sucrose in the given solution.

II. Isolation

a. Caffeine from tea leaves
b. Lactose from milk
c. Nicotine dipicrae from tobacco
d. Limonine from lemon peel
e. Cystine from human hair

12. Books Recommended

1. Pasto, D., C. Johnson and M. Miller. Experiments and Techniques in Organic Chemistry. Prentice-Hall.
2. Williamson, K. L. and D.D. Heath. Macroscale and Microscale Organic Experiments.
3. Middleton, H. and Adward Arnold. Systematic Qualitative Organic Analysis.
4. Clark, H .and Adward Arnold. Handbook of Organic Analysis: Qualitative and Quantitative.
5. Tatchell, A. R. Vogel \'s Textbook of Practical Organic chemistry. John Wiley.

1. Name of the Department: Chemistry						
2. Course Name	Organic Special Practical -III		**L**	**T**		**P**
3. Course Code	09040336		0	0		6
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical = 78**			

8. Course Description:

This Course will introduce the students to synthesize the organic compounds through multi step process.and will enable to develop and practice independent learning skills. This course will also give a platform to develop different methods to synthesize organic compounds..

9. Course Objectives:

The objectives of this course are to:

1. Perform the standard techniques used in practical organic chemistry.
2. Plan and carry out a multi-step synthesis using a prescribed procedure.
3. Measure and report relevant physical properties of prepared compounds.
4. Handle organic chemicals safely and describe their potential dangers.
5. Use the reference material found in the laboratory.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Describe various techniques used for synthesis of organic compounds.
2. Describe disposal techniques and laboratory emergency procedures.
3. Know the handling of instruments.
4. Apply purification techniques for the purification of organic compounds

11. List of Experiments

Multistep synthesis

1. Benzanilide from benzene
2. Benzilic acid from benzoin.
3. Benzopinacolone from benzophenone.
4. Acridone from anthranilic acid
5. m-Nitroaniline from benzene.
6. p-nitrobenzanilide from benzophenone.

12. Books Recommended

1. Prentice-Hall, 5th edition, Textbook of Practical Organic Chemistry, 1996.
2. Nicolas Bogliotti, Roba Moumné ,Multi step organic synthesis, A guide through experiments,.Dec 2017.
3. Brian S,Furniss ,Vogels text book of practical organic chemistry, 5th addition,.
4. Tatchell, A. R. Vogel's Textbook of Practical Organic Chemistry. John Wiley.

Semester-IV
Discipline Specific Elective Courses

Specialization: Inorganic Chemistry

<table>
<tr><td colspan="8">1. Name of the Department: Department of Chemistry</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Organometallic Chemistry</td><td>L</td><td>T</td><td colspan="2">P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2">09040419</td><td>4</td><td>0</td><td colspan="2">0</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td>Core ()</td><td>DSE (✓)</td><td>AEC ()</td><td>SEC ()</td><td>OE ()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td>B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practicals</td></tr>
<tr><td colspan="3">Lectures = 52</td><td colspan="2">Tutorials = Nil</td><td colspan="3">Practical = Nil</td></tr>
<tr><td colspan="8">8. Course Description:</td></tr>
<tr><td colspan="8">This course provides detailed knowledge about organometallic compounds, their classification, synthesis properties and applications in different fields.</td></tr>
<tr><td colspan="8">9. Course Objectives:</td></tr>
<tr><td colspan="8">The objectives of this course are to:
1. Enable the students to get an idea about organometallic compounds and their chemistry.
2. Help them classify these compounds on the basis of bonding.
3. Have an idea about their synthesis and reaction mechanisms
4. Know their diverse applications in industries.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="8">Upon successful completion of this course, the student will be able to
1. Define and identify an organometallic compound
2. Write their structure, synthesis and reaction mechanism.
3. Apply their properties for different applications like polymerization, catalytic hydrogenation etc
4. Comment on their kinetics and stability.</td></tr>
<tr><td colspan="8">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td colspan="2">Number of lectures = 13</td><td colspan="5">Title of the unit: Introduction of organometallic compounds</td></tr>
<tr><td colspan="8">Introduction and Classification of organometallic compounds by bond types viz. covalent, ionic, electron deficient and cluster compounds.
Alkyls and Aryls of Transition Metals: Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis.</td></tr>
<tr><td>Unit – 2</td><td colspan="2">Number of lectures = 13</td><td colspan="5">Title of the unit: Transition Metal π–Complexes</td></tr>
<tr><td colspan="8">Transition metal π–complexes with unsaturated molecules- alkenes, alkynes, allyl, & dienyl(metallocene) complexes, preparation, properties and nature of bonding and structural features, important reactions related to nucleophilic and electrophilic attack on ligands and to organic synthesis</td></tr>
<tr><td>Unit – 3</td><td colspan="2">Number of lectures = 12</td><td colspan="5">Title of the unit: Compounds of Transition Metal-Carbon Multiple Bonds</td></tr>
<tr><td colspan="8">Transition metal- carbene complexes: Fischer type and Schrock type carbene complexes, their synthesis, reactions and structures & bonding; Transition metal-carbyne complexes: their synthesis, reactions and structural features.</td></tr>
<tr><td>Unit – 4</td><td colspan="2">Number of lectures = 14</td><td colspan="5">Title of the unit: Fluxional Organometallic Compounds and role of organometallics as catalysts</td></tr>
</table>

Fluxionality & dynamic equilibria in compounds such as acyclic alkenes,σ-bonded and π–bonded cyclic alkenes, rotation of ligands on metals, ligand scrambling on metals.

Applications of Transition metal Organometallics as Catalysts: Zeigler-Natta polymerization ; homogeneous catalytic hydrogenation; alkene hydrogenation-Wilkinson Catalyst; Oxidation of olefins-Wacker's process; hydroformylation of olefins – the oxo process.

12. Brief Description of self learning / E-learning component

1. https://onlinecourses.nptel.ac.in/noc18_cy09/preview.
2. https://ocw.mit.edu/courses/chemistry/5-44-organometallic-chemistry-fall-2004/

13. Books Recommended

1. Organometallic Compounds by M.L.H. Green
2. Principles of Organometallic Chemistry by G.E. Coates, M.L.H. Green and P. Power.
3. Organometallic Chemistry by R.C. Mehrotra
4. Basic Organometallic Chemistry: Concepts, Syntheses and Applications by Anil J. Elias and B.D. Gupta

1. Name of the Department : Chemistry						
2. Course Name	Inorganic Materials and advanced analytical techniques			**L**	**T**	**P**
3. Course Code	09040420			4	0	0
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 52	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

Many aspects of modern life are dependent upon the availability of functional solids .Hence Chemists are in a strong position to contribute to their syntheses. This course provides an overview of the synthesis of inorganic materials their properties, characterization and applications. The course also introduces the fundamental principles needed to understand the behavior of materials at the nanometer length scale and the different classes of nanomaterials with applications ranging from information technology to biotechnology. The last two sections deal with advanced analytical techniques and their applications in various fields.

9. Course Objectives:

The objectives of this course are to:

1. Provide an introduction to the concepts underlying solid state chemistry.
2. Understand an overview of the synthesis and applications of inorganic materials
3. To recognize the structure and compound identification in the solid state.
4. Develop and characterize nanomaterials, including x-ray techniques, scanning probe microscopy and electron microscopy; and to identify the electronic, magnetic, optical and mechanical properties of nanomaterials.
5. Apply a variety of spectroscopic and advanced analytical techniques to identify and characterize the inorganic materials.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. Display an appreciation of the techniques available for the study of structures and mechanisms in solid state inorganic chemistry.
2. Demonstrate knowledge of crystal structures and their defects, nonstoichiometry and physical properties.
3. Compare the advantages and/or disadvantages of electrogravimetry and coulometry.
4. Describe how a coulometric titration is performed and discuss the advantages of a coulometric titration over a conventional redox titration,
5. Describe the process of performing an amperometric titration.
6. Determine the size of nanoparticles using TEM and SEM
7. Use the techniques of solvent extraction, ion exchangers including liquid ion exchangers and chromatographic methods for identification and estimation of multicomponent systems (such as TLC, GC, HPLC, etc)

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: Inorganic Materials**

Introduction to solid state, metallic bond, band theory(Zone model, Brillouin Zones, Limitations of the zone Model); Defects in solids, p-type, n- type, inorganic semiconductors(used in transistors, IC, Etc) electrical, optical , magnetic and thermal properties of inorganic materials, superconductors with special emphasis on the synthesis and structure of high temperature superconductors.

Solid state Lasers (Ruby, YAG and Tunable Lasers): Inorganic Phosphor materials, Synthesis and advantages

of optical fibres over conducting fibres, diffusion in solids, catalysis and zone refining of metals.		
Unit – 2	**Number of lectures 13**	**Title of the unit: Nano Materials**
Preparation of nanomaterials, and their characteristic differences over bulk materials. Principles of Electron microscopy, Dynamic Light Scattering, Atomic Force Microscopy and characterization of nanomaterials.		
Unit – 3	**Number of lectures = 15**	**Title of the unit: Analytical techniques**
Electroanalytical methods-polarography (DC, AC and pulse), cyclic voltammetry, coulometry and anode stripping voltammetry. Optical methods: UV/Visible, X-ray photoelectron spectroscopy(XPS), Auger Electron Spectroscopy (AES), ESCA, Atomic absorption and emission spectroscopy. Imaging Techniques: Electron Microscopy (SEM, TEM) Infrared spectroscopy, Dispersive and Fourier Transformed Raman, Resonance Raman and Surface Enhanced Raman spectroscopy- Dispersive and Fourier Transformed. Hifanated Techniques: GC –IR, TG-IR Spectroscopy, GC Mass Spectroscopy and any other.		
Unit – 4	**Number of lectures = 15**	**Title of the unit: Advanced Analytical Techniques**
Diffraction Methods: single crystal and powder X-Ray Diffraction and their applications for inorganic Compounds, Neutron Diffraction and Electron Diffraction. Separation Methods: Theory and applications of separation methods in analytical chemistry:solvent extraction, ion exchangers including liquid ion exchangers and chromatographic methods for identification and estimation of multicomponent systems (such as TLC, GC, HPLC, etc)		

12. Brief Description of self learning / E-learning component

1. http://www.tricliniclabs.com/directory/solid-state-development-services/physical-and-analytical-chemistry/inorganic-materials-analysis-phase-identification-quantification.html.
2. http://www.extra.research.philips.com/hera/people/aarts/_Philips%20Bound%20Archive/PJR/PJR-47-1992_93-147.pdf.
3. https://www.youtube.com/watch?v=X6caYRvVOyg&list=PLKyB9RYzaFRj5Mvxv3cqLAOK9Ee5sqJ5k

13. Books Recommended

1. Keer,H.V Principles of the solid state ,Wiley Eastern Ltd: New Delhi(1993).
2. West, A.R. Solid state chemistry and its Applications, John Wiley&Sons (1987).
3. Hannay, N.Treatise on Solid State Chemistry Plenum (1976).
4. Timp. G; Ed.Nanotechnology Springer-Verlag:N.Y(1999).
5. Cheetham, AK.&Day, P; Eds. Solid state Chemistry Techniques Clarindon Press, Ixford (1987).
6. Christian,G.D; Analytical Chemistry : 6th Ed, John Wiley&Sons, Inc (2004).
7. Skoog D A; West, D.M; Holler, R.J.& Nieman, T.A Principles of Instrumental Analysis, Saunders Golden Sunburst Series(1997).
8. Willard, H.H; Merritt L.L; Dean, J.A.& Settle, F.A.(Eds).
9. Instrumental Methods Of Analysis.7th Ed; Wadsworth Publishing (1988) ISBN 0534081428
10. Khopkar, S.M. Concepts in Analytical Chemistry Halsted(1984).

1. Name of the Department: Chemistry						
2. Course Name	Metals in Medicine	**L**	**T**	**P**		
3. Course Code	09040421	4	0	0		
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 52	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

This course gives diverse knowledge about the role of metals in medicines .Students come to know about metal deficiency diseases ,toxicity of metals in biological systems and their therapies and remedies.The course also highlights the role of ligands and the pros and cons of ligand chelation in biological systems.

9. Course Objectives:

The objectives of this course are to:

1. Enable the students to know about the role of metals in biological systems.
2. Study various diseases due to metal deficiencies and their therapies.
3. Discuss metal toxicity and their detoxification methods.
4. Understand the vital role of vitamins in our body.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. Identify the metal deficiency diseases and treat them with proper therapy.
2. Become familiar with carcinogens, tumor growth and role of various metals in anticancer activity.
3. Discuss role of ligands and their beneficial effects as chelating agents in anti-cancer drugs, antiviral activity etc.
4. Apply knowledge of nuclear medicine as they study about radioiodine -1 31, technetium – 99m, gallium and indium.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Metals in Medicine**

Biochemical bases of essential metal deficient diseases; Iron, copper and zinc deficiencies and their therapies, carcinogens and carcinostatic agents, zinc in tumour growth and inhibition, anticancer activity and mechanism of platinum complexes, anticancer activity of Rhodium, copper and Gold complexes, anti cancer activity of Selenium, antibacterial and antiviral properties of metal complexes, polyamino carboxylic acids and polyethylene amines as chelating drugs.

Unit – 2	**Number of lectures 13**	**Title of the unit: Heavy metals in Biological systems**

Drugs in hypo and hyper activity of thyroids, Inorganic drugs in dental carries, clinical disorders of alkali and alkaline earth metals and their remedies, lithium drugs in psychiatry.

Toxicity of heavy metals – and their detoxification, role of Selenium in Biological systems with reference to its essentiality and toxicity, mechanism of metal ion induced toxicity, interaction between orally administered drugs and metal ions in gut.

Unit – 3	**Number of lectures = 13**	**Title of the unit: Ligand Therapy**:

Ligand induced toxicity, interfererence with haemoglobin in oxygen transport system, intefererence with metallo-enzymes, beneficial effects of ligand chelation; carcinogenic ligands, carcinostatic ligands, alkylating agents as anticancer drugs, Thiosemicarbazones as anticancer drugs, macrocyclic antibiotic ligands and prodable mechanism of the drug, antiviral activity of chelating agents, aspirin chelation, drugs where chelation

and therapeutic activity are unrelated.		
Unit – 4	**Number of lectures = 13**	**Title of the unit: Vitamins and their functions**
Vitamins, recommended dietary allowances , deficiencies and supplementations, dietary miners, calcium and vitamin D, antioxidants and their health effects, biomineralisation. Radiopharmacology, nuclear medicines, radioiodine -1 31, technetium – 99m, gallium and indium scan.		
12. Brief Description of self learning / E-learning component		
1. https://www.slideshare.net/mohdsakharkar/metal-ion. 2. https://authors.library.caltech.edu/25052/10/BioinCh_chapter9.pdf		
13. Books Recommended		
1. Metals in Medicine by James C. Dabrowiak 2. Metallotherapeutic Drugs & Metal-Based Diagnostic Agents by Marcel Gielen		

1. Name of the Department: Chemistry						
2. Course Name	Inorganic Special Practical – IV	**L**	**T**	**P**		
3. Course Code	09040422	0	0	6		
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (If any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = Nil		**Tutorials = Nil**	**Practical = 78**			

8. Course Description:

Practical work has had a central and distinct role in chemistry education (from school to university) for more than a century. The aim of this special inorganic lab is to increase our understanding of the composition, properties and structure of coordination complexes and identify those using IR spectra.

9. Course Objectives:

The objectives of this course are to:

1. Identify the inorganic compounds from their characteristic spectra.
2. Synthesize different coordination complexes.
3. Get knowledge about the denticity f the ligands used in the synthesis of the compounds.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Synthesize the inorganic and coordination compounds.
2. Interprete their structure and bonding from IR spectra.
3. Differentiate the isomers from spectra.

11.List of Experiments

1 Conductometrically- Composition of mixture of weak and strong acide, Precipitation and displacement titrations.

2 pH-metry-Composition of mixture of strong and weak acide pK value of organic acids.

3 Potentiometry- redox titrations, Precipitations, Simultaneous determination of Halide ions.

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Semester-IV

Specialization: Physical Chemistry

1. Name of the Department : Department of Chemistry						
2. Course Name	Solid State Chemistry and Polymers	**L**	**T**	**P**		
3. Course Code	09040424	4	0	0		
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**	**Practical = Nil**			

8. Course Description:

This course highlights the use of electrochemistry in different applications like fuel cells, lead batteries, dry cells etc and in amperometric titrations .Another unit deals with solid state chemistry. The students will obtain required knowledge for understanding material science problems .They will study the structure of solids and get introduced with the importance of chemical and physical bonds, crystal disorders and defects for material properties. The third unit includes detail study of polymers. Here the students will learn about polymers, their types , their preparations ,mechanisms involved in polymerization and molecular mass determination. The course also outlines a brief idea about biopolymer solutions and their thermodynamics.

9. Course Objectives:

The objectives of this course are to

1. Provide an introduction of the concepts underlying solid state chemistry.
2. Illustrate the wide range of materials and physical properties currently available.
3. Enable students identify different types of polymers in our surroundings.
4. Introduce students to the practical application of polymers
5. Explain polymerization methods and understand polymerization kinetics.
6. Understand thermodynamics of biopolymers.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Apply the principles of electrochemistry in various electrochemical energy converters.
2. Perform Amperometric titrations determination of activation energy for an irreversible electrode process.
3. Classify types of solids and calculate lattice energy.
4. Identify the structure and packing in solids and different defects in crystals.
5. Identify polymerization reactions and their kinetics.
6. Calculate the molecular weight of polymers by osmometry, viscometry, light scattering and sedimentation method.
7. Evaluate the size, shape, molecular weight and extent of hydration of biopolymers by various experimental techniques.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Electrochemistry and its applications.**

Applications of Electrochemistry: The maximum intrinsic efficiency, actual efficiency and current - potential relation in an electrochemical energy converter, factors influencing the electrochemical energy conversion, the power output of an electrochemical energy converter. Electrochemical electricity generators (fuel cells), brief idea about H_2- O_2, hydrocarbon - air, and natural gas & CO -air fuel cells. Electricity storage: some important quantities in electricity storage (electricity storage density, energy density, power),

desirable conditions for an ideal strorer , storage of electricity using the lead-Acid battery, dry cell, silver-zinc cell and Sodium- Sulfur cell, Amperometric titrations determination of activation energy for an irreversible electrode process.

Unit – 2	Number of lectures = 13	Title of the unit: Solid State Chemistry

Solid State Chemistry: Thermal decomposition reactions, Nucleation, Free energy of nucleation: Laws, Classification, Functions and growth of nuclei. Kinetic expressions for diffusion controlled, phase boundary controlled and nucleation and growth controlled reactions. Perfect and imperfect crystals, Intrinsic and extrinsic defects, Point defects, Line and plane defects, Vacancies: Schottky and Frenkel defects, Thermodynamics of Schottky and Frenkel defect formation, Colour centres, non-stoichiometry defects.
Classification of solids, Lattice energy, Evaluation of Madelung constant (NaCl), Calculation of repulsive potential exponent: Lattice heat capacity. Einstein and Debye model of lattice heat capacity, Debye T^3 law.

Unit – 3	Number of lectures = 13	Title of the unit: Polymers.

Polymers: Classification of polymers and polymerisation, condensation and addition polymers, kinetics of condensation (step-wise) polymerisation, size distribution in linear condensation polymers, molecular size control, degree of polymerization; mechanism of vinyl radical polymerisation, molecular weight and its determination, effect of temperature and pressure on chain polymerisation, stereochemistry of polymer chain & stereo regular polymerisation, Ionic polymerisation (similarities and contrast), kinetics of cationic, anionic polymerisation, kinetics of copolymerisation, criteria for polymer solubility; Mass number and Mass average molecular weight, determination of molecular weight of polymers by osmometry, viscometry, light scattering and sedimentation method.

Unit – 4	Number of lectures = 13	Title of the unit: Biopolymers and their thermodynamics.

Thermodynamics of biopolymer solutions: Thermodynamics of biopolymer solutions: Entropy of mixing & liquid state model along with limitation, Free volume theory, Heat and free energy of mixing. Osmotic pressure membrane equilibrium, Muscular contraction and energy generation in mechanochemical system.

Biopolymers and their molecular weights: Evaluation of size, shape, molecular weight and extent of hydration of biopolymers by various experimental techniques. Sedimentation equilibrium, Hydrodynamic methods, Diffusion, Sedimentation velocity, Viscosity, Electrophoresis and rotational motions

11.Brief Description of self learning / E-learning component

1. http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-50532002000100004.
2. https://www.chem.uci.edu/~lawm/Basic%20West%20Ch%201.pdf
3. https://leseprobe.buch.de/images-adb/36/0c/360cdf9a-dc74-4828-b88e-3d807e0b79b8.pdf
4. http://iopscience.iop.org/article/10.1088/0953-8984/18/14/E01/meta

12. Books Recommended

1. Billmeyer, F.W. and Jr. Wiley. Textbook of Polymer Science.
2. Alcock, H.R. and F.W. Lambe. Contemporary Polymer Chemistry.
3. Cowie, J.M.C. Physics and Chemistry of Polymer.
4. Flory, P.J. Polymer Chemistry.
5. Bockris, J.O.M. and A.K.N. Reddy. Modern Electrochemistry. Vol.1 & 2.
6. Glasstone, S. Electrochemistry.
7. Reiger, P.H. Electrochemistry.
8. Heyrovsky. Polarography.
9. Kannala, Zutshi. Introduction to Polarography and Allied Techniques.

1. Name of the Department : Chemistry						
2. Course Name	Statistical Thermodynamics and Quantum Mechanics-II	**L**	**T**		**P**	
3. Course Code	09040425	4	0		0	
4. Type of Course (use tick mark)	**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52	**Tutorials = Nil**	**Practical = Nil**				

8. Course Description:

The objective of statistical thermodynamics is to give a molecular basis for thermodynamics. Thermodynamics is built on the concept of equilibrium. This course will give the students an excellent command on concepts of thermodynamics at the molecular level and non-equilibrium thermodynamics. Non-equilibrium thermodynamics is concerned with transport processes and with the rates of chemical reactions. It relies on what may be thought of as more or less nearness to thermodynamic equilibrium.

This course also highlights the detail study of angular momentum under the quantum mechanics concept. Another interesting area is explored under the unit of molecular orbital theory where the students will learn the Hückel method or Hückel molecular orbital method (HMO). It deals with simple linear combination of atomic orbitals molecular orbitals method for the determination of energies of molecular orbitals of π electrons in conjugated hydrocarbon systems, such as ethylene, benzene and butadiene ...

9. Course Objectives:

The objectives of this course are to:

1. Create a bridge between theory of the micro world (theory of individual molecules and their interactions) and theory of macroscopic phenomena.
2. Explain (quantitative) the properties of macroscopic systems (e.g. thermodynamic functions) using the knowledge of the properties of individual molecules (obtained from molecular spectroscopy or quantum chemistry).
3. Learn the principles of non-equilibrium thermodynamics and theory of fluctuations.
4. Understand the use of angular momentum operator for calculating eigen values.
5. Introduce the theory of LCAO which uses the combination of atomic orbitals to yield molecular orbitals that are delocalized over the entire molecule rather than being localized on its constituent atoms.

10. Course Outcomes (COs):

1. Upon successful completion of this course, the student will be able to:
2. learn to recognize, define, and solve problems in equilibrium thermodynamics and statistical physics.
3. Understand the fundamentals and thermodynamic criteria for non-equilibrium states, entropy production and entropy flow .
4. Apply the theory of fluctuations and calculate equilibrium fluctuations of extensive parameters, intensive parameters and densities in systems.
5. Use the Hamiltonian operator to derive the quantization rules and also use the method of ladder operators
6. Apply Huckels method for the determination of energies of conjugated hydrocarbon systems like ethylene, benzene, butadiene.

11. Unit wise detailed content

Unit-1	**Number of lectures = 20**	**Title of the unit: Statistical Thermodynamics:**

Free energy functions and the partition functions, calculation of equilibrium constant using partition function, Bose - Einstein statistics, statistics of photon gas, gas degeneration, Fermi-Dirac statistics, extreme gas

degeneration, energy of Bosons & Fermi particles, specific heat of electron gas, , Thermionic emission, comparison of Maxwell-Boltzmann, Bose –Einstein and Fermi-Dirac statistics.

Unit – 2	**Number of lectures = 17**	**Title of the unit: Non –Equilibrium Thermodynamics:**

General theory of non-equilibrium processes, entropy production and entropy flow; thermodynamic criteria for non-equilibrium states, entropy production in heat flow, mass flow, electric current, chemical reactions, Saxen's relation, Onsager's reciprocity relation, , Electro kinetic phenomenon.

Theory of fluctuation, energy fluctuations in the canonical ensemble, distribution function and fluctuations, fluctuations of density and energy.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Angular Momentum**

Angular momentum, angular momentum operators in cartesian coordinates, eigen function & eigen values, commutation relation between angular momentum operators (Lx,Ly , Lz , L2), total orbital angular momentum and spin angular momentum, commutation relation between components of total orbital angular momentum and spin angular momentum, ladder operators, commutators of [L2 , L+] and [L2 ,L-] , application of ladder operators to an eigen function of Lz.

Unit – 4	**Number of lectures = 5**	**Title of the unit: Molecular Orbital Theory**

Huckel molecular orbital (HMO) theory of llinear and cyclic conjugated systems, Applications of HMO theory to (i) set up and solve Huckel determent equation; (ii) calculate resonance energy; (iii) wave functions for molecular orbitals and molecular diagrams for the following :

(a)Ethylene molecule (b) Allyl system (Allyl radical and the related cation and anion) (c) Butadiene; (d) Cyclobutadiene (e) Cyclopropenyl system (cyclopropenyl radical and the related cation and anion

11.Brief Description of self learning / E-learning component

1. http://trl.lab.uic.edu/1.OnlineMaterials/BasicPrinciplesByTWLeland.pdf
2. https://www.pdfdrive.net/statistical-thermodynamics-e19748342.html
3. https://video.search.yahoo.com/search/video;_ylt=Awr9DtNleMxa25oAgvFXNyoA;_ylu=X3o
4. DMTByNWU4cGh1BGNvbG8DZ3ExBHBvcwMxBHZ0aWQDBHNlYwNzYw--?p=statistical+thermodynamics&fr=tightropetb

12. Books Recommended

1. Prigogine, I. Non-Equilibrium Thermodynamics.
2. Kalidas, C. Non-Equilibrium Thermodynamics.
3. Leonard K. Nash :Elements of Statistical Thermodynamics

1. Name of the Department : Chemistry						
2. Course Name	Spectroscopy and Corrosion –II		**L**	**T**		**P**
3. Course Code	09040426		4	0		0
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals		
Lectures = 52	**Tutorials = Nil**	**Practical = NIl**

8. Course Description:

This is an advance course in chemistry that exposes students to the principles and chemical applications of symmetry and group theory. The major topics include basic concepts of symmetry elements and symmetry operations, point groups of molecules and fundamental principles of group theory. Another unit deals with the electronic spectra of polyatomic molecules, Raman spectra and its applications. Two units have been devoted to corrosion chemistry and industrial corrosion problems. Corrosion has a huge economic and environmental impact on all facets of national infrastructure from highways bridges, buildings, oil and gas, chemical processing and virtually on all metallic objects in use.These units deal with various types of corrosions, their causes, effects and preventions.

9. Course Objectives:

The objectives of this course are to

1. Illustrate symmetry concepts and to demonstrate the scope of symmetry and group theory.
2. Classify the atomic and molecular orbitals according to symmetry.
3. Determine the point group of a molecule in a systematic method.
4. Apply electronic spectroscopy and Raman spectroscopy in group theory to find the
5. Learn about different types of corrosions.
6. Understand and discuss various techniques for corrosion prevention like coating, plating, cathodic protection etc.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. Identify symmetry elements and recognize symmetry operations generated by each symmetry element for a given molecule.
2. Combine symmetry operations and set up multiplication table for simple point groups.
3. Perform vector transformation and generate reducible representation of common molecules.
4. Classify the irreducible representations into translational, rotational and vibrational modes.
5. Find the number of infrared and Raman active vibrations in a molecule.
6. Identify the causes and conditions of corrosions and
7. Apply technologies to limit corrosion and methods to prevent corrosion ,

11. Unit wise detailed content

Unit-1	**Number of lectures = 20**	**Title of the unit: Symmetry and Group Theory**

Symmetry and Group Theory in Chemistry: Symmetry elements and symmetry operationgroup and its properties, Multiplication table, point symmetry groups. Schonflies symbol, representations of groups by matrices (representation for the Cn, Cnv, Cnh, Dnh etc. groups to be worked out explicity) Irreduceable representation of groups, the great orthogonality theorem (without proof) and its importance, character tables and their use in spectroscopy.

Unit – 2	**Number of lectures =15**	**Title of the unit: Electronic Spectroscopy**

Electronic Spectroscopy of Polyatomic Molecules :Free electron model, spectra of carbonyl group, spectra of

ethene, n-II and II-II transitions, spectra of benzene , spectra of transition metals, charge-transfer transition, fluorescence phosphorescence.

Raman Spectroscopy : Quantum theory of Raman effect, Classical theory of Raman effect, Pure rotational Raman spectra, Raman activity of vibrations, vibrational Raman spectra, polarization of light and Raman effect, applications.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Forms of corrosion.**

Forms of Corrosion: Uniform corrosion, galvanic corrosion, pitting corrosion, crevice corrosion, intergranular corrosion, stress corrosion cracking, corrosion Dfatigue, fretting corrosion, dealloying, hydrogen embrittlement, erosion corrosion, microbial induced corrosion, filliform corrosion and exfoliation.

Unit – 4	**Number of lectures = 7**	**Title of the unit: Industrial Corrosion Problems**

Industrial Corrosion Problems: Atmospheric corrosion and high temperature oxidation. Corrosion in industrial cooling water system, corrosion in boilers and condensate pipe lines, corrosion due to acids, corrosion during metal surface cleaning and descaling, corrosion during storage and transportation of metallic articles, corrosion in various industries.

11.Brief Description of self learning / E-learning component

1. https://en.wikipedia.org/wiki/Symmetry_group
2. http://chemistry.rutgers.edu/undergrad/chem207/SymmetryGroupTheory.html
3. https://corrosion.ksc.nasa.gov/corr_forms.htm

12. Books Recommended

1. Vincent, A. Molecular Symmetry and Group theory.
2. Bauim, A. Nass. Applied Group Theory.
3. Swarnlakshmi, S., T. Saroja and R.M. Ezhilarasi. Group Theory in Chemistry.
4. Barrow, G.M. Introduction of Molecular Spectroscopy.
5. Banwell, C.N. Fundamental of Molecular Spectroscopy.
6. Sastri, V.S. Corrosion Inhibitors: Principles & Applications.
7. Trephewey, K.R. and J. Chamberlain. Corrosion.
8. Narain, Raj. Introduction to Metallic Corrosion and its Prevention.
9. Mukherjee, S.N. Introduction to the Science of Corrosion and its Inhibition.
10. Fontana, M.G. Corrosion Engineering.

1. Name of the Department: Chemistry						
2. Course Name	Physical Special Practical-IV	**L**	**T**	**P**		
3. Course Code	09040427	0	0	6		
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite .	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = Nil		**Tutorials = Nil**	**Practical = 78**			

8. Course Description:

Analytical chemistry is a discipline which provides valuable information in various branches of science and technology. Among the various analytical techniques titrimetry is the mostly widely used method. Titrations include acid-base titration, redox titrations, precipitation titrations etc. This course will help the students to perform different titrations using potentiometer and estimate the strength of unknown acid. No indicator is used; .instead the potential is measured across the analyte. This course also includes the use of pH meter to estimate the mixture of acids by titration with a base. A new technique Dipolemetry is introduced in this course to find the dipole moment of various liquids.

9. Course Objectives:

The objectives of this course are to:

1. Find the strength of unknown acid
2. Find the equivalence point of acid base titrations
3. Find the strength of mixture of acids
4. Perform precipitation titrations potentiometrically where end point is not sharp using external indicator.
5. Perform iodometric and other redox titrations potentiometrically.
6. Find the dipole moment of organic liquids.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. Estimate the strength of individual acids in a mixture
2. Plot the graphs of base added vs the pH and determine the equivalence point.
3. Find the dissociation constant of weak acid.
4. Compare the strength of different acids by titating them with base potentiometrically and pHmetrically.
5. Find the basicity of an acid from the titration curves.

11. List of Experiments

I. Potentiometry

a. NaOH vs. H3PO4 titration.
b. NaOH vs. (HCl + CH3COOH) mixture
c. NaOH vs. Boric Acid
d. ZnSO4 vs K4[Fe(CN)6]
e. $Na_2S_2O_3$ vs Iodine
f. To determine solubility and solubility product of sparingly soluble salts $BaSO_4$, AgCl and $PbSO_4$
g. To determine degree of hydrolysis of aniline hydro chloride
h. To determine dissociation constant of weak acid.

II. pH metry Titrations

a. NaOH vs. H_3PO_4
b. NaOH vs. (HCl + CH_3COOH) mixture

c. NH_4OH vs. HCl
d. NH_4OH vs. CH_3COOH
e. NaOH vs. Boric Acid

III. Dipole metry

a. To determine dipole moment of various organic liquids.

12. Books Recommended

1. Khosla,B.D., V.C. Garg and A. Khosla.Senior Practical Physical Chemistry.
2. Thawale,A. and P. Mathur. Experimental Physical Chemistry.
3. Vishwanatha,B. and P. S Raghav. Practical Physical Chemistry.

Sindhu, P.S. Practical in Physical Chemistry.

Semester-IV

Specialization: Organic Chemistry

1. Name of the Department: Chemistry						
2. Course Name	Photochemistry and Pericyclic Reactions	**L**	**T**	**P**		
3. Course Code	09040428	4	0	0		
4. Type of Course (use tick mark)	**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem()	EverySem ()

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 52	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

To cover the types of EMR, electronic excitation, what is quantum yield and photochemistry of intramolecular reaction of carbonyl compounds. To cover the intermolecular photochemical reaction of carbonyl compounds, along with aromatic and alkenes. Free radical reactions. To cover the complete, PMO, FMO and HMO approach and its utilisation to understand electrocyclic, cycloaddition and sigmatropicrearrangements.

9. Course Objectives:

1. Students should understand the effect of EMR on matter and how chemical reaction procced by the action of EMR
2. Student should understand the photochemical raection of alkene, and photorearrangment
3. To understand pericyclic reaction, types of it and how MOS change during different types of photochemical reaction.

10. Course Outcomes (COs):

On completion of this course, the students will

1. Be able to understand and deal Phenomenon of photochemistry.
2. Be able to understand the photochemical reactions of Alkenes, Carbonyl and Aromatic compounds.
3. Be able to understand and be able to apply the Woodward–Hoffmann rules governing pericyclic reactions.

11. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: Photochemistry**

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

Photochemistry of Alkenes: Intramolecular reactions of the olefinic bond- geometrical isomerism, cyclisation, rearrangement of 1,4 and 1,5 – dienes.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Photochemistry of Carbonyl and Aromatic compounds**

Photochemistry of Carbonyl Compounds: Intramolecular reactions of carbonyl compounds–saturated, cyclic and acyclic,β,γ-unsaturated andα,β-unsaturated compounds, Cyclohexadienones.Intermolecular cycloaddition reactions–dimerisations and oxetane formation.

Photochemistry of Aromatic Compounds: Isomerisations, additions and substitutions.

Miscellaneous Photochemical Reactions: Photo-Fries reactions of anilides. Photo-Fries rearrangement. Barton

reaction. Singlet molecular oxygen reactions. Photochemical formation of smog. Photodegradation of polymers.

Unit – 3	**Number of lectures = 8**	**Title of the unit: Pericyclic Reactions**

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions, Woodward – Hoffmann correlation diagrams, FMO and PMO approach Electrocyclic reactions – conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems.

Cycloadditions – antarafacial and suprafacial additions, 4n and 4n+2 systems with a greater emphasis on (2+2) and (4+2) cycloaddition-stereochemical effects and effects of substituents on the rates of cycloadditions, 1,3-dipolar cyclo-additions and cheleotropic reactions.

Unit – 4	**Number of lectures = 8**	**Title of the unit: Sigmatropic Rearrangements**

Sigmatropic Rearrangements-suprafacial and antrafacial shifts [1,2]- sigmatropic shifts involving carbon moieties retention and invertion of configuration, (3,3) and (5,5) sigma-tropic rearrangements, detailed treatment of Claisen and Cope rearrangements, fluxional tautomerism, aza-cope rearrangements, introductions to Ene reactions, simple problems on pericyclic reactions. Elecrocyclic rearrangement of cyclobutenes and 1,3 cyclohexadienes.

12. Brief Description of self learning / E-learning component

1. http://nptel.ac.in/courses/104105038/
2. http://assets.vmou.ac.in/MSCCH06.pdf**.**

13. Books Recommended

1. Organic Photochemistry – Chapman and Depuy.
2. Organic Photochemistry – W.H. Horsepool.
3. Photochemistry of Excited States – J.D.Goyle.
4. Organic Photochemistry. Coxon,J. and B. Halton.
5. Organic Photochemistry. Kan, Robert O.
6. Pericyclic Reactions, Mukherji, S.M.

1. Name of the Department: Chemistry						
2. Course Name	Natural Product II		**L**	**T**		**P**
3. Course Code	09040429		4	0		0
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals		
Lectures = 52	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

Classification, occurrence, Structure determination and synthesis of Citral, Zingibrene, Santonin, α- Cadinene, Camphor, Nicotine, Quinine, morphine, Cholesterol, Testosterone, Progesterone, Esterone and synthetic non-steroidal estrogens, oestrogens. Pencillin, chloramphenicol, Streptomycin and Tetracyclins, PGE_2 and PGF2 α.

9. Course Objectives:

Objectives of this course are to:

1. make the students aware of the many pharmaceutically active products of natural origin.
2. give students an awareness of the richness and diversity of plants and animal around them.
3. give students the skills to make meaningful changes to these substances.

10. Course Outcomes (COs):

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

1. identify and characterize various classes of natural products by their structures.
2. have some knowledge of some of the plants around them and their pharmaceutical importance.
3. have some knowledge of bacteria and other life forms from which useful pharmaceuticals are derived.
4. have acquired the skills to isolate, purify and characterize simple products that are derived from plants and some animals.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Terpenoids**

Classification , nomenclature, occurrence and general method of structural determination, Isoprene rule, stereochemistry and synthesis of Citral, Zingibrene, α- Cadinene, and Camphor .

Unit – 2	**Number of lectures = 13**	**Title of the unit: Alkaloids**

Classification, occurrence, general methods of isolation and structure elucidation, Stereochemistry, and synthesis of following: Nicotine, Quinine, morphine, and Reserpine

Unit – 3	**Number of lectures = 13**	**Title of the unit: Steroids and Harmons**

Occurrence, General method of isolation, Diel's Hydrocarbon, Structure elucidation and synthesis of Cholesterol, Progesterone, Esterone and synthetic non-steroidal estrogens.

Unit – 4	**Number of lectures = 13**	**Title of the unit: Antibiotics and Prostaglandins**

Antibiotics: Structure elucidation of Pencillin, Streptomycin and Tetracyclins.

Prostaglandins: Classification, Physiological effects and synthesis of PGE_2 and PGF2 α.

12. Brief Description of self learning / E-learning component

1. http://semmelweis.hu/farmakognozia/files/2015/11/Terpenoids-2015-11.pdf
2. http://www.people.uniurb.it/GiovanniPiersanti/organica2/Lectures/02Lipids2.pdf
3. http://semmelweis.hu/mikrobiologia/files/2014/09/FoD_03.pdf
4. http://faculty.smu.edu/jbuynak/medicinal_outline_11_4_04.pdf

13. Books Recommended

1. Finar, I.L. Organic Chemistry.
2. Nogradi, M. Stereoselective Synthesis: A Practical Approach.
3. Rehman, Atta-Ur. and M.I. Choudhary. New Trends in Natural Products Chemistry.
4. Hostettmann, Kurt., M.P. Gupta and A. Marston. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas.
5. Mann, J., R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne. Natural Products: Chemistry and Biological Significance.

1. Name of the Department : Chemistry						
2. Course Name	Reagents and Rearrangements		**L**	**T**		**P**
3. Course Code	09040430		4	0		0
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 52	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

This course is designed for students to acquire knowledge in organic transformations using different reagents. It provides sound knowledge of different molecular rearrangements in the synthesis of organic compounds. .

9. Course Objectives:

The objectives of this course are to:

1. Study the preparation ,properties and applications of organo metallic reagents
2. Study the preparation ,properties and applications of oxidizing agents
3. Study the preparation ,properties and applications of reducing agents
4. Discuss different molecular rearrangements.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Apply different reagents in the organic transformations.
2. Understand the need to study molecular rearrangements.
3. Construct efficient, simple mechanistic pathways for the synthesis of a given compound

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Organo Metallic Reagents**

Preparation, properties and applications of following reagents in organic synthesis with mechanistic details. Organo magnesium reagents, Organo copper reagents, Organo zinc reagents, Organo lithium reagents, Organo boron reagents, , Organo tin reagents and Organo silicon reagents.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Oxidation**

Preparation, properties and applications of following reagents in organic synthesis with mechanistic details. DDQ, Selinium dioxide, Peracids, Prevost Oxidations, Osmium teraoxide, Potassium permanganate, Cr(VI) oxidants, DMSO oxidants, Manganese dioxide, Silver Carbonate, Periodic acid, Lead tetra acetate and thallium (III) nitrate.

Unit – 3	**Number of lectures = 20**	**Title of the unit: Reduction**

Preparation, properties and applications of following reagents in organic synthesis with mechanistic details Catalytic hydrogenations, Lithium aluminiumhydride, sodium borohydride, DIBAL-H, Sodium cyano borohydride, Alanes and Boranes, Metal basic medium reductions, Metal acedic medium reductions and Diimide reductions.

Unit – 4	**Number of lectures = 15**	**Title of the unit: Molecular rearrangements**

Definition and classification. Molecular rearrangements involving 1) electron deficient carbon: Wagner-Meerwein, Pinacol-Pinacolone, Allylic and Wolf rearrangement. 2) electron deficient Nitrogen: Hofmann, Lossen, Curtius, Schmidt and Beckmann rearrangements 3) electron deficient Oxygen: Baeyer-Villiger oxidation. 4) Base catalysed rearrangements: Benzilic acid, Favourski, Transannular, Sommlett-Hauser and Smiles rearrangement

12. Brief Description of self learning / E-learning component

1. http://nptel.ac.in/course.php.
2. http://www.chem.iitb.ac.in/~kpk/ra.pdf
3. https://nptel.ac.in/courses/104101005/downloads/LectureNotes/chapter%2011.pdf

13. Books Recommended

1. Warren, S. Designing Organic Synthesis.
2. Fuhrhop, J. and G. Penzilin. Organic Synthesis Concepts, Methods and Starting Materials.
3. Carruthers, W. Some Modern Methods of Organic Synthesis.
4. House, H.O. and W.A. Benjamin. Modern Synthesis Reactions.
5. March, J. Advanced Organic Chemistry Reactions Mechanism and Structure.
6. Norman, R. and J.M. Coxon. Principles of Organic Synthesis.
7. Carey, F.A. and R.J. Sundburg. Advanced Organic Chemistry Part-B.
8. Mehrotra, R.C. and A. Singh. Organometallic Cchemistry: A Unified approach.
9. Sondhi, G.S., R. Gopalan. and V. Ramalingam. Organometallic Chemistry: Concise Coordination Chemistry.

1. Name of the Department: Chemistry						
2. Course Name	Organic Special Practical-IV		**L**	**T**		**P**
3. Course Code	09040431		0	0		6
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**AEC ()**	**SEC ()**	**OE ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals.						
Lectures = Nil		**Tutorials = Nil**	**Practical = 78**			

8. Course Description:

This Course will introduce the students to the basic principles of spectrophotometric estimations and isolation of organic compounds and will enable to develop and practice independent learning skills. This course will also give a platform to develop different methods to isolate organic compounds.

9. Course Objectives:

The objectives of this course are to:

1. Understand basic principle of spectrophotometer
2. Learn the isolate of organic compounds.
3. Have knowledge of key methods of isolation and estimations.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Demonstrate knowledge of isolation of organic compounds.
2. Recognize different types of isolation methods.
3. Apply basic chemical concepts to estimate different types of organic compounds.
4. Describe different methods for isolation.

11. List of Experiments

I. Spectrophotometric (UV/VIS) Estimations:

a. Amino acids
b. Carbohydrates
c. Ascorbic acid
d. Aspirin
e. Cholesterol

2. **Isolation**

a. Casein from milk
b. β-Carotene from carrots
c. Lycopene from tomatoes
d. Piperine from black pepper
e. Oleic acid from olive oil

12. Books Recommended

1. Pasto,D., C. Johnson and M. Miller. Experiments and Techniques in Organic Chemistry. Prentice-Hall.
2. Williamson, K. L. and D.D. Heath. Macroscale and Microscale Organic Experiments.
3. Middleton, H.and Adward Arnold. Systematic Qualitative Organic Analysis.
4. Clark, H. and Adward Arnold. Handbook of Organic Analysis: Qualitative and Quantitative.
5. Tatchell, A. R. Vogel's Textbook of Practical Organic Chemistry. John Wiley.