Name of the Faculty : Faculty of Science

Name of the Program : MSc (Chemistry)

Scheme of Study/ Scheme of Examination (2020 onwards)

										Theory		Theory (Internal)					Practical				Practical (Internal)								Oral				
Sr.No.	Semester/ Year	Course Code	Nomenclature	Theory/ Practical	Core/ AECC/ SEC/ DSE/ GE	L	T	P	Credits	Max	Pass	Midterm	Assignment	Professional Activities	Max	Pass	Demonstration/Conduct/Presentation	Viva-voce	Max	Pass	Attendance & Regularity in Lab Work	Project/Laboratory Work Report	Midterm Oral Examination/Assessment	Conduct/Demonstration	Max	Pass	Max	Pass	Overall Pass Marks	Whether to be offered under CBCS (Yes/No)	Scheme of Examinations (Theory+Internal+Practical +Oral/Theory +Internal+Practical/ Theory+Practical
				ASSIGNED MARKS						60	24	20	10	10	40	16	20	20	40	16	10	10	10	30	60	24	100	40			
1	I/I	17060101	Transition Metal Chemistry	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal
2		17060102	Quantum Chemistry and Thermodynamics	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal
3		17060103	Stereo Chemistry and Organic Reaction Mechanism	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal
4		17060104	Inorganic Chemistry Practical-I	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	40	No	Practical +Internal
5		17060105	Physical Chemistry Practical-I	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	40	No	Practical +Internal
6		17060106	Organic Chemistry Practical-I	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	40	No	Practical +Internal
7		17060107	Professional Ethics and Human Values	Theory	AECC	2	0	0	2	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal
8		17060108	Analytical Chemistry	Theory	SEC	2	0	0	2	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal
9	II/I	17060201	Bioinorganic Chemistry and Metal Clusters	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal
10		17060202	Chemical Kinetics and Electro Chemistry	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal
11		17060203	Organic Spectroscopy	Theory	Core	3	0	0	3	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal
12		17060204	Inorganic Chemistry Practical-II	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	40	No	Practical +Internal
13		17060205	Physical Chemistry Practical-II	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	40	No	Practical +Internal
14		17060206	Organic Chemistry Practical-II	Practical	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	40	No	Practical +Internal
15		17060207	Research Methodology and Technical Writing	Theory	AECC	2	0	0	2	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal
16		17060208	Material Chemistry	Theory	SEC	2	0	0	2	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal
17	III/II	17060301	Advanced Inorganic Spectroscopy	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal
18		17060302	Coordination Chemistry	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal
19		17060303	Organometallic Chemistry	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal
20		17060304	Inorganic Special Practical-I	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	40	No	Practical +Internal
21		17060305	Inorganic Special Practical-II	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	40	No	Practical +Internal
22		17060306	Inorganic Special Practical-III	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	40	No	Practical +Internal
23		17060307	Chemical Dynamics and Surface Chemistry	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal
24		17060308	Advance Quantum Chemistry and Statistical Thermodynamics	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal
25		17060309	Solid State and Biophysical Chemistry	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal
26		17060310	Physical Special Practical-I	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	40	No	Practical +Internal
27		17060311	Physical Special Practical-II	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	40	No	Practical +Internal
28		17060312	Physical Special Practical-III	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	40	No	Practical +Internal
29		17060313	Photo Chemistry and Pericyclic Reactions	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal
30		17060314	Heterocyclic Chemistry and Organic Synthesis	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16											100	40	40	No	Theory+Internal

31		17060315	Reagents and Rearrangements	Theory	DSEC	3	0	0	3	60	24	20	10	10	40	16										100	40	40	No	Theory+Internal
32		17060316	Organic Special Practical-I	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	40	No	Practical +Internal
33		17060317	Organic Special Practical-II	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	40	No	Practical +Internal
34		17060318	Organic Special Practical-III	Practical	DSEC	0	0	4	2								20	20	40	16	10	10	10	30	60	24	100	40	40	No	Practical +Internal
35		17060319	Drug Design and Development	Theory	SEC	2	0	0	2	60	24	20	10	10	40	16										100	40	40	No	Theory+Internal
36			Open Elective Course (From University Basket)	Theory	OEC	3	0	0	3	60	24	20	10	10	40	16										100	40	40	No	Theory+Internal
37		17060321	Summer Training	Practical		0	0	0	4								40	40	80	32	20	20	20	60	120	48	200	80	40	No	Practical +Internal
38	IV/II	17060401	Project Work	Practical		0	0	0	20								80	80	160	64	40	40	40	120	240	96	400	160	40	No	Theory+Internal
39			**Online Courses during 1st, 2nd and 3rd semesters***						**9**																						

***4 week course- 1 credit, 8 week course- 2 credits, 12 weeks course- 3 credits**
Every semester a student may opt for either:
One, 12 week course or
One, 4 week course & One, 8 week course or
Three, 4 week courses

Department of Chemistry
MSc (Chemistry)
Syllabus and Curriculum (2020 onwards)
Program Structure under Choice Based Credit System (CBCS)

Semester - I

1. Name of the Department: Chemistry							
2. Course Name	Transition Metal Chemistry			**L**	**T**	**P**	
3. Course Code	17060101			3	0	0	
4. Type of Course (use tick mark)		**Core (✓)**		**DSE ()**		**SEC ()**	
5.Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practicals							
Lectures = 40		**Tutorials = Nil**		**Practical = Nil**			

8. Course Description:

This course will enable the postgraduate students to understand and rationalize the conceptsinvolved in transition metal chemistry. It covers the inorganic reaction mechanisms withstepwise and overall formation constants and their interactions as well as factors affectingstability of metal complexes. Students will also be made familiar with metal clusters.

9. Course Objectives:

The objectives of this course are:

1. To provide a firm foundation in transition metal chemistry.
2. To introduce the concept of stepwise and overall formation constants and their uses in theformation of inorganic complexes.
3. To explain the concept of different mechanisms for the formation of inorganic complexes
4. To introduce importance & applications of isopoly and heteropoly acids and metal clusters.

10. Course Outcomes (COs):

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

1. Demonstrate the knowledge of transition metal chemistry.
2. Identify and solve the problems related to the formation of inorganic complexes.
3. Apply the analytical reasoning for explaining the mechanisms of ligand displacement reactions.
4. Explain the structures and properties of different metal clusters and transition metal-complexes

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Metal-Ligand Equilibria in Solution**

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.

Unit – 2	**Number of lectures = 8**	**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.

Unit – 3	**Number of lectures = 12**	**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 = 8**	**Title of the unit: :Isopoly and heteropoly Acids and metal clusters**

Isopoly and Heteropoly acids and salts of Mo and W, Structures of isopoly and heteropoly anions.
Metal Clusters: Structure and bonding in higher boranes, Wade's rules, Carboranes.

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://web.mit.edu/5.03/www/readings/polyhedral_boranes/006_cluster_bonding.pdf
6. http://www.macollege.in/app/webroot/uploads/department_materials/doc_560.doc.

13. Books Recommended

1. Selected Topics in Inorganic Chemistry, Malik, Tuli and Madan, New Delhi : S. Chand & Company Ltd, **ISBN**-13: 978-8121906005
2. Inorganic Chemistry, T. Moeller, Wiley; 2nd edition, **ISBN-13:** 978-0471612155
3. Modern Aspects of Inorganic Chemistry, H.J. Emeleus and A.G. Sharpe, Routledge & Kegan Paul PLC; Revised ed edition, Routledge and kegan paul PLC **ISBN-13:** 978-0710075215
4. Chemical Binding by O.P. Agarwal, Disha Publication; Second edition **ISBN**: 9788188476039, 818847603X.
5. Inorganic Reaction Mechanism by Edberg, vol. 70 , 1st edition, **ISBN:** 9780128128343
6. Mechanism of Inorganic reaction by F. Basolo R.G. Pearson, John Wiley & Sons Inc, **ISBN**-13: 978-0471055457
7. Structural Principles in Inorganic Compound, W.E.A. Addison,Longmans, **ISBN-13:** 978-0582442016
8. Advanced Inorganic Chemistry by Cotton and Wilkinson, A Wiley-Interscience **publication**, 5th Edition **ISBN-13:** 978-0471199571
9. Fundamental Concepts in Inorganic Chemistry, Vol. 2, Asim Das and Mahua Das, CBS Publishers & Distributors Pvt Ltd, India; 1st edition**ISBN-13:** 978-8123923512
10. Inorganic Chemistry- Principles of Structure and Reactivity by James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, Prentice Hall; 4 edition, **ISBN-13:** 978-0060429959
11. Inorganic Chemistry by Shriver and Atkins,Oxford; 5 edition **ISBN-13:** 978-0199236176
12. Polyoxometalate Molecular Science by Juan J. Borrás-Almenar, Eugenio Coronado, Achim Müller and Michael Pope,NATO Science Series, (NAII, volume 98), **ISBN** 978-1402012426

1. Name of the Department: Chemistry						
2. Course Name	Quantum Mechanics and Thermodynamics			**L**	**T**	**P**
3. Course Code	17060102			3	0	0
4. Type of Course (use tick mark)		**Core (✔)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 40	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

This course will enable the post graduate students to understand and rationalize the basics and advancement of quantum chemistry, includes the Schrodinger wave equation for 1-D, 2-D and 3-D along with the operators and other important aspects of quantum chemistry. Students will also focuses on the interesting concepts of thermodynamics such as theirs laws, phase rule, fugacity.

9. Course Objectives:

The objectives of this course are:

1. To provide a firm foundation in the fundamentals and applications of quantum mechanics
2. To learn degeneracy in 3-D box , simple harmonic oscillator and rigid rotator
3. To introduce the importance & application of first & second law of thermodynamics
4. To explain the importance & application of Phase Rule, Phase diagram.

10. Course Outcomes (COs):

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

1. Understand the various concepts of quantum mechanics & wave mechanics
2. Explain the degeneracy in 3-D box, simple harmonic oscillator and rigid rotator
3. Solve the problems related to first & second law of thermodynamics
4. Describe systems of one component as well as multi-component systems.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Quantum Mechanics-I**

Postulates of Quantum Mechanics; Schrodinger wave equation; Max-Born interpretation of Ψ and the Heisenberg's uncertainty principle; Operators and their algebra, Linear and Hermitian Operators (linear momentum and angular momentum operators as Hermitian operators), commuting operators.

Schrodinger wave equation for a particle in one-, two- and three-dimensional box; evaluation of average position, average momentum and determination of uncertainty in position and momentum, 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, concept of zero-point energy.

Unit – 2	**Number of lectures = 8**	**Title of the Unit: Quantum Mechanics-II**

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 variables in spherical polar coordinates.		
Unit – 3	**Number of lectures = 12**	**Title of the Unit: Thermodynamics**
Brief resumé 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), Gibbs-Duhem equation, variation of chemical potential with temperature and pressure.		
Unit – 4	**Number of lectures = 8**	**Title of the Unit: Classical Thermodynamics**
Thermodynamics II: Third law of thermodynamics (Nernst 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
5. https://chemistry.mit.edu/classes/
6. https://www.edx.org/course/quantum-world-harvardx-chem160x#!

13. Books Recommended

1. Glasstone, S. Theoretical Chemistry **ISBN**978-0716735397
2. Glasstone, S. Thermodynamics for Chemists **ISBN**1406773220, 9781406773224
3. A. Chandra - Introductory Quantum Chemistry Paperback – 2017 **ISBN** 9780074620540
4. Donald A. McQuarrie - Quantum Chemistry Paperback – 2016 **ISBN** 9788130918945
5. Barrow, G.M. Physical Chemistry. **ISBN**9780071140485
6. Srivastava, R.C., S.K. Saha and A.K.Jain. Thermodynamics **ISBN**81-203-2498-6
7. Pauling, L. Introduction to Quantum Mechanics with Applications to Chemistry **ISBN** 9780486648712

1. Name of the Department :Chemistry						
2. Course Name	Stereo Chemistry and Organic Reaction Mechanism		**L**		**T**	**P**
3. Course Code	17060103		3		0	0
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical /Medical)	**6.Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 40		**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 the pharmaceutical industry. This course also covers the mechanisms of different chemical reactions and will lay the foundation on to which further advanced topics can be built up.

9. Course Objectives:

The objectives of this course are to:

1. Provide the students with knowledge and the basic understanding of stereochemistry.
2. Understand different conformations and configurations of organic molecules
3. Study different types of reactions, their mechanisms and their stability.
4. Study the asymmetric synthesis and its importance in organic synthesis.

10. Course Outcomes (COs):

Students will be able to:

1. Identify the stereocenters in a molecule and assign the configuration as R or S
2. Know the relationship between enantiomers and their specific rotations.
3. Develop capacity to solve the organic reaction mechanisms related problems.
4. Know about the regio and chemoselectivity, and different types of elimination reactions.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 11**	**Title of the unit: Stereochemistry**

Stereoisomerism: Classification, Optical isomerism due to asymmetric carbon atoms: molecules with one, two or more chiral centers.

Configuration nomenclature: D, L and R,S configurations. Optical isomerism in absence of chiral carbon(biphenyls, allenes, spiranes), Optical isomerism of nitrogenous compounds, geometrical isomerism and E, Z configurations, properties of geometrical isomers.Axial and planar chirality and helicity.

Cyclostereoisomerism: Configurations, conformations and stability of cyclohexanes (mono & di), cyclohexenes, cyclohexanones, halocyclohexanones, decalins, decalols and decalones.

Asymmetric Induction: Cram's, Prelog's and Felkin-Ahn model

Unit – 2	**Number of lectures = 9**	**Title of the unit: Aliphatic and Aromatic Nucleophilic Substitution (Reaction Mechanisms)**

Aliphatic Nucleophilic Substitution: The S_N2, S_N1 and S_Ni mechanisms, mixed S_N1 & S_N2 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 NucleophilicSubstitution: S_NAr, S_N1, benzyne and $S_{RN}1$ mechanisms. Reactivity effect of substrate structure, leaving group and nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.

Unit – 3	**Number of lectures = 9**	**Title of the unit: Aliphatic and Aromatic Electrophilic Substitution**

Aliphatic Electrophilic Substitution: Bimolecular mechanisms - S_E2 and S_Ei.The S_E1 mechanism, Electrophilic substitution accompanied 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 rearrangement.

Unit – 4	**Number of lectures = 11**	**Title of the unit: Free Radical Substitution and Elimination Reactions**

Free Radical Reactions: Types of free radical reactions, free radical substitution mechanisms. Mechanisms 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 E_2, E_1, E_{1cB} mechanisms. Orientation of the double bond. Effects of substrate structure, attacking base, leaving group and medium on reactivity. Mechanism and orientation in pyrolytic eliminations.

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
6. https://faculty.chemistry.harvard.edu/myers/pages/chem-115-handouts
7. http://www.cureffi.org/tag/chem-20/
8. https://archive.org/details/EvansD.A.HarvardsAdvancedOrganicChemistry2003/page/n51
9. https://www.masterorganicchemistry.com/2013/07/30/free-radical-reactions

13. Books Recommended

1. Stereochemistry of carbon compounds, E.L.Eliel and S.H. Wilen, Wiley, **ISBN: 9788126515707**
2. Stereochemistry of organic compounds- Principles and Applications, D. Nasipuri, NEW AGE; Third edition (2018), **ISBN-13:** 978-8122430295
3. Advanced Organic Chemistry – Jerry March, John Wiley & Sons Inc; 3rd edition, **ISBN:**978-0471854722.
4. Advanced Organic Chemistry, Part A: Structure and Mechanisms, F.A. Carey, R.J. Sunberg, Publisher: Springer; 5th edition (2008), **ISBN-13:** 978-0387683461
5. Highlights of Organic Chemistry, W.J. L. Nobel; An Advanced Text Book, CRC Press; 1 edition (1974), **ISBN-13:** 978-0824762100
6. Stereochemistry conformation and Mechanism – P. S. Kalsi, New Age Publishers; Tenth edition

(1 January 2019), **ISBN-13:** 978-9387788329
7. A Guide Book to Mechanism in Organic Chemistry, P.Sykes, BH Kishan, earson Education; 1 edition (2013), **ISBN-13:** 978-8131793558
8. Structure and Mechanism in Organic Chemistry, C. K. Ingold, CBS; 2 edition (2000),**ISBN-13:** 978-8123909752
9. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall; 6th edition (January 27, 1992), **ISBN-13:** 978-0136436690
10. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Trinity, Macmillan Publishers India (1984), **ISBN-13:** 978-0333904619

1. Name of the Department: Chemistry						
2. Course Name	Inorganic Chemistry Practical I		**L**	**T**	**P**	
3. Course Code	17060104		0	0	4	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals

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

8. Course Description:

The lab work for this semester focuses on Quantitative Inorganic Analysis by gravimetric, volumetric method 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.

9. Course Objectives:

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

1. To separate and determine the selected binary mixtures of metal ions employing volumetric methods
2. To separate and determine the selected binary mixtures of metal ions employing gravimetric methods
3. To do determination of strengths of Ferrous, Oxalate and Nitrite ions using cerimetry.
4. To learn qualitative analysis of inorganic compounds.

10. Course Outcomes (COs):

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

1. Demonstrate the knowledge of separation and determination of the ions in binary mixtures of metal ions using various methods.
2. Identify and solve the problems related to the binary mixtures of metal ions.
3. Apply the analytical reasoning for determination strengths of anions of inorganic compounds
4. Perform the qualitative analysis of inorganic compounds which leads to a safe laboratory environment.

11. List of Experiments(At least seven experiments to be performed by the student)

I. Estimate the following metal ions gravimetrically.

1. Copper as copper thiocyanate

2. Nickel as nickel-dmg complex

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

a. Silver-Copper
b. Copper-Nickel
c. Copper-Zinc
d. Copper-Magnesium
e. Copper-Barium
f. Copper-Nickel-Zinc
g. Copper-Nickel-Magnesium

III. 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. Basic Principles of Practical Chemistry",Venkatesan, V, Veeraswamy, R and Kulandaivelu, A.R, 2nd edition, Sultan Chand and Sons Publication, New Delhi. **ISBN**: 9788180547768
2. Advanced Experimental Chemistry",Gurtur, J. N. and Kapoor, R ., Vol. I, S. Chand & Co., Ltd, New Delhi **ISBN**: 9788192959887.
3. Advanced Practical Chemistry, 8th Edition, Pragati Prakashan, Siddiqui, I.R., Singh, J., Shrivastava, J., Yadav,L.D.S., Singh, R.K.P., Singh, J., ISBN:: 978-93-86633-50-7
4. Advanced Inorganic Analysis, Agarwal, S.K., Lal, K. Pragati Prakashan ISBN: 978-93-87151-38-3
5. Vogel's Textbook of Quantitative Inorganic Analysis, Pearson Education,Mendham, J., **ISBN-13:** 978-8131723258
6. Vogel's Qualitative Inorganic Analysis, Pearson Education, Svehla, G., Sivasankar, B., **ISBN**:9788131773710;

1. Name of the Department: Chemistry						
2. Course Name	Physical Chemistry Practical –I		**L**	**T**	**P**	
3. Course Code	17060105		0	0	4	
4. Type of Course (use tick mark)		**Core (↔)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (↔)	Either Sem ()	Every Sem ()

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

8. Course Description:

This Course will enable the master students to learn various conductometric titration techniques and the concept of heat of neutralization. It also helps the students to learn the various properties of liquids such as refractive index, surface tension and adsorption. This course will also give a platform to develop methods of analysis of various properties of liquids.

9. Course Objectives:

The objectives of this course are:

1. To impart knowledge of concept of various conductometric titrations of Strong acid/Strong base, Weak acid /Weak base , Strong acid/Weak base and Weak acid/Strong base
2. To introduce the concepts of partition coefficient and equilibrium constant
3. To understand the surface tension and adsorption of different systems
4. To explain knowledge of concept of pH meter

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 the concept of pH through working of instruments like pH meter.
3. Determine partition coefficient and equilibrium constant of various systems
4. Predict surface tension of liquids and adsorption of solids

11. List of Experiments(At least seven experiments to be performed by the student)

1. Conductometry

i. HCl vsNaOH titration.
ii. Oxalic acid vs NaOH titration.
iii. CH_3COOH vs NaOH titration.
iv. Mixture of CH_3COOH+HCl vs NaOH

2. Surface tension

termine interfacial tension of two immiscible liquids.

3. Adsorption

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

4. pH metric

1. HCl vs NaOH titration.
2. Oxalic acid vs NaOH titration.
3. CH_3COOH vs NaOH titration.

5. Distribution Law

1. To determine partition coefficient of benzoic acid between benzene and water.
2. To determine the partition coefficient of Iodine between Carbon tetrachloride and water.

3. Determination of Equilibrium constant for $I_2 + I^- = I_3^-$

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

1. https://youtu.be/E0oYzyJrKGg
2. https://www.britannica.com/science/surface-tension
3. https://youtu.be/vMOa7wrP3w0
4. https://nptel.ac.in/courses/108105063/pdf/L-08(SS)(IA&C)%20((EE)NPTEL).pdf
5. https://www.thefreedictionary.com/distribution+law

13. Books Recommended

1. Khosla,B.D., V.C. Garg and A. Gulati.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	17060106		0	0		6
4. Type of Course (use tick mark)		**Core (✓)**		**DSE ()**		**SEC ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/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 synthesize the organic compounds and enable them to develop and practice independent experimental skills. Students will learn stereochemical aspects (geometrical isomers and stereoisomers) and different reactive intermediates formation during the synthesis.This course will also give a platform to develop different methods to synthesize organic compounds.

9. Course Objectives:

The objectives of this course are:

1. To introduce the standard techniques used for organic synthesis
2. To learn Condensation reaction and carbene addition
3. To explain Nucleophilic aromatic/aliphatic substitution reaction
4. To understand Rearrangement reactions involving carbocations and carbanions
5. To learn the handling of organic chemicals safely and describe their potential dangers

10. Course Outcomes (COs):

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

1. Perform various organic synthesis by utilizing various synthetic techniques
2. Design organic synthetic methods
3. Describe disposal techniques and laboratory emergency procedures
4. Know the handling of instruments used for organic synthesis
5. Apply purification techniques for the purification of organic compounds

11. List of Experiments (At least seven experiments to be performed by the student)

Preparations involving stereochemical aspects (geometrical isomers and stereoisomers) and different reactive intermediates:

(a) Condensation reaction,
(b) Carbene addition,
(c) Nucleophilic aromatic/aliphatic substitution reaction
(d) Rearrangement reactions involving carbocations and carbanions

Note: Overall at least 10 experiments should be performed including one from each category.

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

1. https://www.youtube.com/watch?v=fbNf_guvK_0
2. https://www.youtube.com/watch?v=6MDPAimsHF4
3. https://www.youtube.com/watch?v=Wucp2wiu3-U

13. Books Recommended

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

1. Name of the Department : Chemistry						
2. Course Name	Professional Ethics and Human Values	**L**		**T**	**P**	
3. Course Code	17060107	2		0	0	
4. Type of Course (use tick mark)	**Core ()**	**DSE ()**	**AEC (✔)**	**SEC ()**	**OE ()**	
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical

Lectures = 26	**Tutorials = 0**	**Practical = 0**

8. Course Description:

This course provides students with the knowledge of ethics in professional and social life. Some of the examples from history and day to day life will make the students more responsible towards their profession, society and family.

9. Course Objectives:

The objectives of this course are:

1. To understand Ethics and Universal Declaration on Bioethics and its need.
2. To give due regard to nature and other forms of life by protecting the environment and become socially responsible citizens
3. To inculcate moral and human values for the sustainable growth of the society.
4. To become professionally strong by taking responsibility for what they do in there professional and social life.

10. Course Outcomes (COs):

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

1. Understand the values of ethics and moral values deeply.
2. Understand the value of environment and respect for nature.
3. Realize the values of responsible citizens to work for the society.
4. Take strong decisions and perform their duties responsibly as a professional.

11. Unit wise detailed content

Unit-1	**Number of lectures = 6**	**Title of the unit: Introduction to Ethics and Bioethics**

Introduction, Definition, Understanding Ethics, Medical Ethics and Bioethics, History and Development of Ethics, Universal declaration on Bioethics, Need and Importance of professional ethics,

Unit –2	**Number of lectures = 6**	**Title of the unit: Different types of Ethics**

Environmental Ethics, Respect for nature, Respect for cultural diversity and pluralism. Bio-Safety and Ethical use of animals in the laboratory, Disaster Bioethics, Ethics in Media and Technology, Research Ethics, Ethical Issues in Cyber space.

Unit –3	**Number of lectures = 7**	**Title of the unit: Value of Human Life**

Human Rights and Values: Autonomy, Consent, Equality, Confidentiality, Vulnerability and Personal Integrity, Religious and Cultural Values, Importance of a Family, Guidance to youngsters, Gender Equality sharing of benefits,

Unit - 4	Number of lectures = 7	Title of the unit: Professional Ethics
Professional Ethics and Public Policy, Goals, Dignity of Labour, Responsibilities towards Safety and Risk, Voluntary vs involuntary Risk, Designing and Research ethics, Privacy, Authorship, Intellectual Property Rights.		
12. Brief Description of self learning / E-learning component		
1. https://www.youtube.com/watch?v=cFOZplkRqsk **2.** https://www.youtube.com/watch?v=Fqt7m8LH5GY **3.** https://www.youtube.com/watch?v=2VYF_t51FyE **4.** https://www.youtube.com/watch?v=9JJykyE2MHw		
13. Books Recommended		
1. Professional Ethics and Morals by Prof.A.R.Aryasri, DharanikotaSuyodhana – Maruthi Publications. 2. Professional Ethics and Human Values by A. Alavudeen, R.KalilRahman and M. Jayakumaran – University Science Press. 3. Professional Ethics and Human Values by Prof.D.R.Kiran-Tata McGraw-Hill – 2013		

1. Name of the Department: Chemistry						
2. Course Name	**Analytical Chemistry**	**L**		**T**		**P**
3.Course Code	17060108	26		0		0
4. **Type of Course (use tick mark)**		**Core (✓)**	**DSE ()**	**AEC ()**	**SEC ()**	**GE ()**
5. **Pre-requisite (if any)**	NA	6. **Frequency use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. **Total Number of Lectures, Tutorials, Practicals.**						
Lectures = 26		**Tutorials = 0**		**Practical = 0**		
8. **Course Description:**						
This paper will help the students to understand basic knowledge of various analytical techniques involved in research. The course highlights the application of different polarography (DC, AC and pulse), electro-analytical and chromatographic techniques. Instrumentation methods of Infrared, Raman and other optical spectroscopy techniques. Students will also be made familiar with analytical instruments.						
9. **Course Objectives:**						
The objectives of this course are: 1. To introduce students to instruments used in chemistry. 2. To explain all the polarographic and chromatographic techniques used and their working. 3. To introduce instrumentation and working of IR and Raman techniques 4. To provide the knowledge for quantitative and qualitative estimation of inorganic and organic compounds						
10. **Course Outcomes (COs):**						
Upon successful completion of this course, the student will be able to: 1. Illustrate the knowledge of various analytical techniques 2. Identify and solve the problems related to the structural elucidation of various compounds 3. Apply the analytical reasoning for explaining the structure of compounds using their analytical data. 4. Explain the principle and applications of different analytical instruments.						
11. **Unit wise detailed content**						
Unit-1	**Number of lectures = 6**	**Title of the unit: Polarography and Electroanalytical methods**				
Polarography (DC, AC and pulse), cyclic voltammetry, coulometry and anode stripping voltammetry.						
Unit – 2	**Number of lectures = 7**	**Title of the unit: Optical Spectroscopic Techniques**				
Atomic absorption and emission spectroscopy, X-ray photoelectron spectroscopy (XPS), Auger Electron Spectroscopy (AES)						
Unit – 3	**Number of lectures = 6**	**Title of the unit: Infrared and Raman Spectroscopy**				
Dispersive and Fourier Transform Infrared Spectroscopy, Resonance Raman and Surface Enhanced Raman Spectroscopy.						
Unit – 4	**Number of lectures = 7**	**Title of the unit: Chromatographic Techniques**				

Thin Layer Chromatography, Gas Chromatography, Size exclusion Chromatography, Ion-Exchange Chromatography, HPLC (High Performance Liquid Chromatography), Chiral Chromatography.
12. **Brief Description of self-learning/ E – learning component**
1. https://www.youtube.com/watch?v=Av_Mrlz_wRI 2. https://nptel.ac.in/courses/113/106/113106069
13. **Books Recommended**
1. Cheetham, A. K. & Day, P., Eds. Solid State Chemistry Techniques Clarendon Press, Oxford (1987) 2. Christian, G. D., Analytical Chemistry, 6th Ed., John Wiley & Sons, Inc. (2004). 3. Skoog, D. A., West, D. M., Holler, R. J & Nieman, T. A. Principles of Instrumental Analysis Saunders Golden Sunburst Series (1997). 4. Willard, H. H., Merritt, L. L., Dean, J. A. & Settle, F. A. (Eds.) Instrumental Methods of Analysis - 7th Ed., Wadsworth Publishing (1988) ISBN 0534081428 5. Khopkar, S. M. Concepts in Analytical Chemistry Halsted (1984). 6. Cullity, B.D. & Stock, S.R. Powder X-Ray Diffraction, 3rd edition, Kindle Publisher 2001. 7. Stout, G.H. & Jensen, L. H. X- Ray structure Determination A Practical Guide IIed (John Wiley & Sons), 1989.

Semester - II

1. Name of the Department: Chemistry						
2. Course Name	Bioinorganic Chemistry and Metal Clusters	**L**	**T**	**P**		
3. Course Code	17060201	3	0	0		
4. Type of Course (use tick mark)	**Core (✓)**	**DSE ()**	**SEC ()**			
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40	**Tutorials = Nil**	**Practical = Nil**				

8. Course Description:

This special paper in Inorganic chemistry will demonstrate the comprehensive knowledge of 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.

General introduction of Chemistry of Inorganic Rings, Cages and Metal Cluster Compounds will be discussed.

9. Course Objectives:

The objectives of this course are:

1. To introduce students to essential and trace elements
2. To explain role of metal ions in biological systems and nucleotides
3. To explain role of metals in proteins (structure and function)
4. To explain role of metal ions in enzymes (structure and function)
5. To explain the Chemistry of Inorganic Rings, Cages and Metal Cluster Compounds

10. Course Outcomes (COs):

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

1. Demonstrate the knowledge of the role of inorganic metals and compounds in nature.
2. Identify essential and trace elements found in nature and describe their function
3. Apply the analytical reasoning for explaining the functioning of vital biological systems
4. Explain the structure and function of vial metalloproteins and metalloenzymes
5. Explain the Cages and Metal Cluster Compounds

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**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-potassium 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 nucleic acids.

Unit – 2	**Number of lectures = 10**	**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 = 10**	**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 = 10**	**Title of the unit: Chemistry of Inorganic Rings, Cages and Metal Cluster Compounds**
Chemistry of inorganic rings, cages and metal cluster compounds, borazines, phosphazenes, polyhedral boranes, carboranes, metalloboranes and metallocarboranes.		
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, Pearson **ISBN-13:** 978-0063503526 2. Metal Ions in Biochemistry by P.K. Bhattacharya, Alpha Science International Ltd; 1 edition**ISBN-13:** 978-1842652404 3. Bioorganic, Bioinorganic and Supramolecular Chemistry by P.S. Kalsi and J.P.Kalsi, New Academic Science; 2nd Revised edition**ISBN-13:** 978-9386286628		

1. Name of the Department : Chemistry						
2. Course Name		Chemical Kinetics & Electrochemistry	**L**		**T**	**P**
3. Course Code		17060202	3		0	0
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 40		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description:

This course will enable the post graduate students to understand and rationalize the concept involved in chemical kinetics. It focuses the basics of chemical kinetics such as rate of reaction, rate law and apart form that it also covers the collision theory, activated complex theory and the kinetics of polymerisation. Students will also focuses on the interesting concepts of non-equilibrium thermodynamics and electrochemistry.

9. Course Objectives:

The objectives of this course are:

1. To provide a firm foundation in chemical kinetics & electrochemistry and thermodynamics.
2. To introduce order of reaction along with collision theory and activated complex theory.
3. To provide the knowledge of kinetics of polymers
4. To introduce various concepts Non-Equilibrium Thermodynamics and electrochemistry

10. Course Outcomes (COs):

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

1. Demonstrate the knowledge of chemical kinetics & electrochemistry and thermodynamics
2. Identify and solve the problems related to order of reaction
3. Explain the mechanism and further studies in chain reactions
4. Explain the thermodynamic criteria for non-equilibrium states

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the Unit: Chemical Kinetics-I**

Rate of reaction , rate law and rate constant , units of rate constant , integrated rate laws for Zero, First and Second order reaction , 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, the comparison of collision and activated complex theory

Unit – 2	**Number of lectures = 10**	**Title of the Unit: Chemical Kinetics : Kinetics of Polymerization**

Kinetics of Polymerization Reactions of functional groups, kinetics of step polymerization, kinetics of reversible reactions, open and closed systems, molecular weight control, stoichiometric and quantitative aspects; molecular weight distribution in linear and non-linear polymerization

Unit – 3	**Number of lectures = 10**	**Title of the Unit: Non Equilibrium Thermodynamics**

Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, entropy

balance equations for different irreversible processes (e.g., heat flow, chemical reaction, etc.) transformations of the generalized fluxes and forces, non equilibrium stationary states, phenomenological equations, Onsager's reciprocity relations, electrokinetic phenomena, diffusion.		
Unit – 4	**Number of lectures = 10**	**Title of the Unit: Electrochemistry**
Nonideal Systems: Excess functions for nonideal solutions. Activity, activity coefficient, Debye-Huckel Theory for activity coefficient of electrolyte solutions, Determination of activity and activity coefficients ionic strength. Debye-Huckel-Bjerrum model. Overpotential, exchange current density, derivation of Butler-Volmer equation, Tafel plot.		
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 5. https://chemistry.mit.edu/classes/		
13. Books Recommended		
1. Bockris, J.O.M. and A.K.N. Reddy. Modern Electrochemistry Vol.1 **ISBN:**978-0-306-46909-1 2. Laidler, K.J. Chemical Kinetics **ISBN:**9780060438623 3. Frost, A. & G.Pearson. Kinetics & Mechanism of Reaction Rates **ISBN:** 978-0471035589 4. Eyring, H. Modern Chemical Kinetics **ISBN:** 978-0442173968 5. Laidler, K.J., H.Eyring & S. Glasstone Theories of Reaction Rates **ISBN:**978-3-540-63975-6		

1. Name of the Department: Chemistry						
2. Course Name	Organic Spectroscopy	**L**	**T**		**P**	
3. Course Code	17060203	3	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals		
Lectures = 40	**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 organic chemistry. 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.

9. Course Objectives:

The objectives of this course are:

1. To understand similarities and differences between spectroscopy and spectrometry
2. To identify the basic components of spectroscopic instrumentation
3. To introduce the theory of the various instruments and the signals produced when analyzing compounds
4. To demonstrate a working knowledge of ultraviolet-visible (UV-Vis) spectroscopy, infrared (IR) spectroscopy, nuclear magnetic resonance (NMR) spectroscopy, mass spectrometry (MS), and ORD & CD

10. Course Outcomes (COs):

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

1. Determine the functional groups in organic compounds
2. Explain the instrumentation and application of IR, NMR, UV Visible spectroscopy
3. Elucidate the structures of different organic compounds by using IR, NMR and Mass Data.
4. Predict the stereochemistry of chiral molecules

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Ultraviolet and Visible Spectroscopy**

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,Absorption and Intensity shifts, The ultraviolet spectrometer,Woodward 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.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Infrared Spectroscopy**

Introduction – Basic theory and instrumentation including FT IR infrared spectrum. Units of frequency wavelength and wave number, Molecular vibrations. Functional group and fingerprint regions. Types of IR Bands, Frequency of vibrations of a diatomic molecule, factors influencing vibrational frequencies, sampling techniques, characteristic frequencies of organic molecules and interpretation of spectra.

Unit – 3	Number of lectures = 10	Title of the unit: Nuclear Magnetic Resonance Spectroscopy (^{1}H and ^{13}C NMR)
Introduction, Principles of NMR, Instrumentation techniques (CW & FT NMR), equivalent and non-equivalent protons, Chemical shift and its measurements. Factors affecting the chemical shift, spin - spin coupling, multiplicity of splitting, Short range and long-range couplings, coupling constants, Techniques for simplification of complex spectra: solvent effects, Lanthanide shift reagents, spin decoupling (double resonance), NOE. Effect of sensitivity of ^{13}C NMR compared to ^{1}H NMR, Chemical shifts of ^{13}C NMR. Resolution and multiplicity of ^{13}C NMR,Decoupling Techniques. Applications of ^{13}C NMR and ^{1}H NMRin structural elucidation of simple and complex compounds.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Mass Spectrometry& (ORD and CD)**
Mass Spectrometry: Introduction – Elementary theory, instrumentation, Measurement techniques (EI, CI, FD, FAB, ESI, APCI and MALDI), Mass spectrum, base peak, molecular ions, isotope ions, rearrangement ions, fragment ions, even electron rule, nitrogen rule, metastable ions. Salient features of fragmentation pattern of organic compounds including compounds containing oxygen, sulphur, nitrogen and halogens; α-, β-, allylic and benzylic cleavage, McLafferty rearrangement, retro Diels – Alder fragmentation and ortho effect. **Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD):** Linear and circularly polarised lights, circular birefringence and circular dichroism, ORD and CD curves, Cotton effect. The axial haloketone rule,octant diagrams, Application of ORD and CD to structural and stereochemical problems.Structure elucidation of organic compounds using IR, NMR and Mass Spectra.		
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 4. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5		
13. Books Recommended		
1. Spectrometric Identification of Organic Compounds,R.M. Silverstein & G.C. Bassler, John Wiley & Sons Ltd., 0471 63404 2 **2.** W. Kemp. Organic Spectroscopy, Palgrave USA, ISBN: 9781403906847 **3.** Spectroscopic Methods in Organic Chemistry,D.H. Williams and I. Fleming. McGraw-Hill, ISBN: 9780077118129 **4.** Organic Spectroscopy, Jag Mohan. Narosa Publishing House, ISBN: 9788173195662 **5.** Application of Spectroscopy of Organic Compounds,Dyer, J.R. Phi Learning, ISBN: 9788120302525 **6.** Organic Spectroscopy, Pavia. Red Globe Press; second edition (1 May 2019), ISBN-13: 978-1403906847 **7.** Spectroscopic Methods in Organic Chemistry,Williams, D.H. and I. Fleming McGraw-Hill Education; 6th edition (December 1, 2007), ISBN-13: 978-0077118129		

1. Name of the Department: Chemistry							
2. Course Name	Inorganic Chemistry Practical II			**L**	**T**	**P**	
3. Course Code	17060204			0	0	4	
4. Type of Course (use tick mark)	**Core (✓)**	**DSE ()**		**SEC ()**			
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/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 in qualitative analysis of the inorganic salt mixtures using different methods which also includes green approaches. Students will made familiar with different microanalysis techniques for the identification of various heavy metals in the water and soil.

9. Course Objectives:

The objectives of this course are:

1. To understand the procedures for the identification of different cations and anions in an inorganic mixtures.
2. To explain specific properties of cations and anions.
3. To explain the microanalysis techniques for the identification of various heavy metals.
4. To learn the determination of inorganic salts in water, soil.

10. Course Outcomes (COs):

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

1. Demonstrate the knowledge of separation and determination of the components in an inorganic mixture
2. Predict the quality of any inorganic mixture
3. Identify various heavy metals as well as inorganic salts in water and soil
4. Perform the qualitative analysis of inorganic compounds which leads to a safe laboratory environment.

11. List of Experiments

Semi-micro qualitative analysis (using H_2S or other methods) of mixtures - not more than eight ionic species (four anions and four cations, excluding insoluble salts) out of the following:

Cations : NH_4^+, Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^+

Anions : CO_3^{2-} , S^{2-}, SO_2^{-}, $S_2O_3^{2-}$, NO_3^-, CH_3COO^-, Cl^-, Br^-, I^-, NO_3^-, SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$, F^-

(Spot tests and flame tests should be carried out wherever feasible)

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

1. https://www.academia.edu/10186454/SEMI_MICRO_QUALITATIVE_ANALYSIS_OF_SIMPLE_INORGANIC_SALT
2. https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&cad=rja&uact=8&ved=2ahUKEwiGz-nxrKziAhWhheYKHVkEC_4QFjADegQIAxAC&url=http%3A%2F%2Fwww.kchn.pg.gda.pl%2Fdidactics%2Fskrypt_lab%2Flab_gtm_salts.pdf&usg=AOvVaw2UQZFzj2vPJk2kgTohZ9kh
3. https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=6&cad=rja&uact=8&ved=2ahUKEwiGz-nxrKziAhWhheYKHVkEC_4QFjAFegQIBBAC&url=https%3A%2F%2Fwww.kau.edu.sa%2F

Files%2F0017486%2FSubjects%2Fex._6_7_and_8__inorganic_qualitative_analysis_acidic_radical.pdf&usg=AOvVaw3qS6PTSyRaV7eZdao2PXX7
13. Books Recommended
1. Vogel's Qualitative Inorganic Analysis, Svehla, G., Pearson Education, 2012, **ISBN-13:** 978-8131773710 2. Vogel's Quantitative Chemical Analysis, Mendham, J., Pearson, 2009, **ISBN-13:** 978-0582226289

1. Name of the Department : Chemistry							
2. Course Name	Physical Chemistry Practical-II		**L**		**T**		**P**
3. Course Code	17060205		0		0		4
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/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 post graduate students to learn various potentiometric titration and hands on experience of using potentiometers. Students will also be work on refractometer and able to learn other experimental studies on chemical kinetic and thermochemistry. This course will also give a platform to develop methods of analysis of various properties of liquids.

9. Course Objectives:

The objectives of this course are:

1. To explain the principle of potentiometric titration of various systems.
2. To explain the concepts of thermochemistry and refractometry.
3. To explain the handling of instruments such as the refractometer.
4. To learn the kinetics of various reactions.

10. Course Outcomes (COs):

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

1. Describe various potentiometric titrations of Strong acid/Strong base and Weak acid/Strong base etc.
2. Describe application of thermochemistry in determination of heat of neutralization.
3. Know the handling of instruments such as the refractometer.
4. Determine the kinetics of various reactions.

11. List of Experiments

1. Potentiometry

i. HCl vs NaOH titration.
ii. Oxalic acid NaOH titration.
iii. CH_3 COOH vs NaOH titration.

2. 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.

3. Chemical Kinetics

i. To study kinetics of hydrolysis of ester in the presence of acid.
ii. To compare the relative strength of acids (HCl and H_2SO_4).

4. Thermochemistry

Determination of heat of neutralization of the followings:-

i. HCl NaOH
ii. CH_3COOH vs NaOH

iii. Oxalic acid NaOH

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

1. https://nptel.ac.in/courses/103108100/37
2. https://youtu.be/w-YIzLQwtUk
3. https://youtu.be/N_zXl9n9SKA
4. https://youtu.be/UNvAZVaFLLs

13. Books Recommended

1. Khosla,B.D., V.C. Garg and A.Gulati.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	17060206		0	0	6	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/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 is about structural determination of organic compounds using spectroscopic methods (IR, NMR & Mass) followed by chemical methods. It includes synthesis of derivatives of functional groups, reaction monitoring, their separation and purification.

9. Course Objectives:

The objectives of this course are:

1. To explain structural determination of organic compounds using spectroscopic methods followed by chemical methods.
2. To study the characterization of compounds by using IR, NMR & Mass
3. To find out the methods for their separation and purification techniques.
4. To learn monitoring of the chemical reaction.

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. Executethe chemical reactions and monitoring using TLC.
4. Characterize and purify the synthesized compounds.

11. List of Experiments

i. Structural determination of organic compounds using spectroscopic methods (IR, NMR & Mass) followed by chemical methods (Monofunctional and Bifunctional compounds).
Note: Students need to analyze at least 5 compounds.
ii. Analytical and preparative TLCs (mixtures containing three or more compounds, natural extracts and use of different developing agents)
iii. Separation of mixture (mixtures containing two or three compounds) using column chromatography.

Note: Students need to perform at least 5experiments (each of mixture of 2 or 3 compounds).

12. E-learning component

1. https://www.youtube.com/watch?v=qdmKGskCyh8
2. https://www.youtube.com/watch?v=UmWMlKJAdSk
3. https://www.youtube.com/watch?v=kPx6BlJj5DU

13. Books Recommended

1. Chapman and Hall, 5th edition, Textbook of Practical Organic Chemistry, 1996.
2. Nicolas Bogliotti, RobaMoumné ,Multi- step Organic Synthesis, A Guide through Experiments,Dec 2017.
3. Brian S, Furniss, Vogel's Textbook of Practical Organic chemistry, 5th edition,.
4. Tatchell, A. R. Vogel’s Textbook of Practical Organic Chemistry. John Wiley.

1. Name of the Department : Chemistry						
2. Course Name	Research Methodology and Technical Writing			**L**	**T**	**P**
3. Course Code	17060207			2	0	0
4. Type of Course (use tick mark)		**Core ()**		**DSE ()**	**SEC (✓)**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/Medical)	**6. Frequency (use tick marks)**	Even ()	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 26		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description:

This course offers an overview of research methodology including basic concepts employed in quantitative and qualitative research methods. The need for research and literature review, steps in conducting research, research methods associated with conducting scholarly research, lab safety and measures. Ethical, legal, social & scientific issues in research are also included.

9. Course Objectives:

The objectives of this course are:

1. To understand some basic concepts of research and its methodologies
2. To identify appropriate research topics
3. To select and define appropriate research problem and parameters
4. To organize and conduct research in a more appropriate manner

10. Course Outcomes (COs):

On completion of the course, each student will be able to:

1. Demonstrate the knowledge on qualitative research techniques.
2. Have adequate knowledge on quantitative data analysis.
3. Expressthe knowledge of research processes (reading, evaluating, and developing).
4. Identify, explain, compare, and prepare the key elements of a research proposal/report.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit:Introduction of Research Methodology**

Introduction and basic concepts in Research Methodology:Meaning of research, objectives and significance of research, Criteria for good research & problems encountered by research scholars.
Research Problem: Necessity and techniques of defining research problem, Formulation of research problem, Objectives of research problem
Literature search- source of information

Unit – 2	**Number of lectures = 11**	**Title of the unit:Research Design**

Research Design: Need and features of good research design, Basic Principles of Experimental Designs, Design of experiments and performing experiments.
Data Collection and Validation

Unit – 3	**Number of lectures = 10**	**Title of the unit:Ethical, legal social, & scientific issues and Lab Safety Measures**

Introduction to Research Ethics, Objectives in Research Ethics, Ethical, legal social & scientific issues in research, informed concept, Role of ethical committee. Important to adhere to ethical norms in research, Ethical Principles.

Lab Safety Measures: Introduction, Code of conduct - while entering in the lab, while working with the chemicals, while disposal of chemicals, Storage and disposal of chemical wastes - aqueous wastes, organic wastes and radioactive wastes, Human contribution to reduce hazardous wastes.		
Unit – 4	**Number of lectures = 15**	**Title of the unit:Report Writing**
Writing of report: Basic concepts of paper, their writing, review of literature, Concepts of Bibliography and References, significance of report writing, steps of report writing. Presentation of report/paper: Oral, Poster presentation, research paper, review articles, peer reviewed journals		
12. Brief Description of self learning / E-learning component		
1. http://www2.ift.ulaval.ca/~chaib/IFT-6001/articles/RMethodology_Marzuki_1.pdf 2. https://shodhganga.inflibnet.ac.in/bitstream/10603/71970/14/14_chapter%204.pdf 3. http://www.tamuc.edu/academics/cvSyllabi/syllabi/201440/40503.pdf		
13. Books Recommended		
1. Blum, Deborah and Mary Knudson, eds. A field guide for science writers: the official guide of the National Association of Science Writers, New York: Oxford University Press, 1997. 2. Davis, Martha. Scientific Papers and Presentations. San Diego: Academic Press, 1997. 3. Fuscaldo, AA, Erlick, BI, Hindman, B. Laboratory Safety: Theory and Practice. New York: Academic Press, 1980. 4. Bajpai, PK. Biological Instrumentation and Methodology. New Delhi: S. Chand & Co. Ltd. 2006. 5. CR Kothari, Research Methodology: Methods & techniques, Gaurav Garg. New Age Publishers.		

1. Name of the Department : Chemistry						
2. Course Name	Material Chemistry		**L**	**T**		**P**
3. Course Code	17060208		4	0		0
4. Type of Course (use tick mark)		**Core ()**	**DSE (✔)**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/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 = 26	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

This course gives comprehensive knowledge about materials and their classification. Advanced, future and modern materials, Economic, Environmental and societal considerations of materials. Recycling issues, Life cycle analysis and its use in design. Examples, properties and applications of polymers, ionic conductors, Glasses, Ceramics, Composites and nanomaterials. Organic solids, fullerenes and their applications in molecular devices

9. Course Objectives:

The objectives of this course are:

1. To learn the most common and important materials such as Glasses, Ceramics, Composites and polymers
2. To understand the atomic-level build-up of solid materials.
3. To learn the properties of materials such as electrical, thermal, magnetic and electrical properties
4. To learn the importance of ionic conductors

10. Course Outcomes (COs):

On completion of the course, the student should be able to:

1. Demonstrate the knowledge of material chemistry.
2. Apply the analytical reasoning for explaining the principles for the atomic-level build-up of solid materials.
3. Identify the most common and important materials.
4. Explain the importance of various properties of different types of materials.

11. Unit wise detailed content

Unit-1	**Number of lectures = 7**	**Title of the unit: Introduction of Materials**

Classification of materials. Advanced Materials, Future materials and modern materials. Properties of materials: electrical, thermal, magnetic and optical properties. Corrosion and Degradation of Materials: Corrosion of metals and ceremics, degradation of polymers.

Unit – 2	**Number of lectures = 6**	**Title of the unit: Polymers**

Polymer melts: The tube model, viscoelastic behaviour, experimental observations of single chain dynamics-Rouse and Zinn models, polymer blends, copolymers, incompatibility and segregation.

Unit – 3	**Number of lectures = 6**	**Title of the unit: Ionic conductors**

Types of ionic conductors, mechanism of ionic conduction, interstitial types (Frenkel); vacancy mechanism, diffusion superionic conductors; phase transitions and mechanism of conduction in

superionic conductors, examples and applications of ionic conductors.		
Unit – 4	**Number of lectures = 7**	**Title of the unit: Glasses, Ceramics, and Composites**
Glassy state, glass formers and glass modifiers, applications. Ceramic structures, mechanical properties, clay products. Refractories, characterization, properties and applications. Microscopic composites, dispersion strengthened and particle-reinforced, fibre-reinforced composites, macrosopic composities.		

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

1. https://nptel.ac.in/courses/Webcourse-contents/IISc-BANG/Material%20Science/pdf/MS_Syllabus.pdf
2. https://nptel.ac.in/courses/112104122/14
3. https://www.youtube.com/watch?v=fuMuabkSbYM
4. http://textofvideo.nptel.ac.in/118102003/lec15.pdf

13. Books Recommended

1. Callisterm, W.D., Jr. Materials Science & Engineering: An Introduction, John Wiley & Sons: New York
2. Keer, H.V. Principles of the Solid State, Wiley Eastern Ltd.: New Delhi
3. Cowie, J. M.G. Polymers: Chemistry and Physics of Modern Materials, 2nd Ed CRC Press
4. Hamley, I. W. Introduction to Soft Matter: Polymers, Colloids, Amphiphiles and Liquid Crystals John Wiley & Sons.
5. O. P. Khaanna, Material Science and Matallurgy, Dhanpat Rai publications.

Semester-III
Specialization: Inorganic Chemistry

1. Name of the Department : Chemistry						
2. Course Name	Advanced Inorganic Spectroscopy		**L**	**T**	**P**	
3. Course Code	17060301		3	0	0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
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 = 40		**Tutorials = Nil**	**Practical = Nil**			

8. Course Description:

This course will enable students to understand the basics of Spectroscopic analysis which is based on the interaction of an atom or a molecule with electromagnetic radiation of specific wavelength.Students will get theoretical knowledge of electronic, NMR Spectroscopy and MÖssbauer Spectroscopy and study of symmetry elements in molecules and point group determination on basis of symmetry elements.

9. Course Objectives:

The objectives of this course are:

1. To explain the basic of group theory
2. To describe the principle and application of electron spin resonance spectroscopy
3. To explicate the principle and application of Mossbauer spectroscopy
4. To explain the application of nuclear magnetic resonance spectroscopy for study of inorganic compounds.

10. Course Outcomes (COs):

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

1. Demonstrate the knowledge of group theory.
2. express the knowledge of the principle and application of electron spin resonance spectroscopy , Mossbauer spectroscopy, NMR
3. Apply the analytical reasoning for explaining the application of Mossbauer spectroscopy, ESR in structure determination of inorganic compounds
4. Explain the application of nuclear magnetic resonance spectroscopy for study of inorganic compounds.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the Unit: Group theory**

Molecular symmetry: Symmetry elements and symmetry operations, definition of group and its characteristics, subgroups, classes, similarity transformation.

Products of symmetry operations, relations between symmetry elements and operations, classes of symmetry operations, point groups and classification.
Representation of groups, reducible and irreducible representations. The Great Orthogonality theorem, character tables.

Unit – 2	**Number of lectures = 10**	**Title of the Unit: Electron Spin Resonance Spectroscopy**

Principles 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.

Unit – 3	**Number of lectures = 10**	**Title of the Unit: MÖssbauer Spectroscopy**

MÖssbauer Spectroscopy: Basic Principles, spectral display, isomer shift, factors affecting the magnitude of isomer shift, quadrupole and magnetic hyperfine interaction, applications of the technique to the study of bonding and structure of Fe^{2+}, Fe^{3+}; Sn^{2+} and Sn^{4+} compounds.

Unit – 4	**Number of lectures = 10**	**Title of the Unit : Nuclear Magnetic Resonance Spectroscopy**

Nuclear Magnetic Resonance Spectroscopy: ^{19}F and ^{31}P NMR spectra – Chemical shifts, coupling 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 ^{31}P NMR for structural determination of Complexes with phosphorus ligands.
Introduction of Spectra of Paramagnetic materials

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

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

13. Books Recommended

1. Inorganic Spectroscopic Methods by Alan K. Brisdon, **ISBN**: 9780198559498
2. Spectroscopy in Inorganic Chemistry by C.N.R. Rao, **ISBN**: 9780125802024
3. NMR, NQR, EPR and Mössbauer spectroscopy in Inorganic Chemistry by R.V. Parish, **ISBN** 0-13-625518-3
4. NMR Spectroscopy in Inorganic chemistry by Jonathan A. Iggo, **ISBN**-13: 978-0198558903;
5. Structural Methods in Inorganic Chemistry by E.A.O. Ebsworth, **ISBN**-13: 978-0849377327
6. Physical Methods in Chemistry by R.S. Drago, **ISBN**-13: 978-0721631844;
7. Introduction to Magnetic Resonance by A. Carrington & A.D. McLachlan, **ISBN**-13: 978-0063561076;
8. Magnetism and Transition Metal Complexes by F.E. Mabbs & D.J. Machin, **ISBN**- 978-1-5041-2035-7

1. Name of the Department: Chemistry						
2. Course Name	Coordination Chemistry	**L**	**T**	**P**		
3. Course Code	17060302	3	0	0		
4.Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 40		**Tutorials = Nil**	**Practical = Nil**			

8. Course Description:

This core paper 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.

9. Course Objectives:

The objectives of this course are:

1. To introduce students to important theories postulated to understand bonding in transition metal complexes)
2. To demonstrate how spectroscopic states are derived from spectroscopic terms
3. To explain important features of the electronic spectra of complexes- Jahn-Tellar effect, Spectrochemical and nephelauxetic series, charge transfer spectra
4. To explain basic principles of magnetochemistry and apply them in structure determination
5. To explain structure and bonding in metal clusters (boranes, carboranes and metal carbonyl clusters) and transition metal-pi complexes (metal carbonyls, phosphines, nitrosyls, dinitrogen, and dioxygen complexes)

10. Course Outcomes (COs):

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

1. Demonstrate the knowledge of coordination chemistry
2. Explain the bonding in transition metal complexes
3. Apply the analytical reasoning for explaining spectroscopic states from spectroscopic terms
4. Apply the analytical reasoning for Interpretingthe Orgel and Tanabe-Sugano diagrams
5. Demonstrate the fundamentals of magnetochemistry in structure determination.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**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, Ligand field theory and application.

Unit – 2	**Number of lectures = 10**	**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 = 10**	**Title of the unit: Magnetic Properties of Transition Metal Complexes**

Elementary theory of magnetochemistry, 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 magnetochemistry in structure determination, magnetic exchange coupling and spin state crossover.		
Unit – 4	**Number of lectures = 10**	**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://nptel.ac.in/courses/104106064/lectures.pdf.		
13. Books Recommended		
1. Selected Topics in Inorganic Chemistry by Malik, Tuli and Madan, **ISBN**: 9788121906005, 2. Concepts in Inorganic Chemistry, Vol. 3-7, Asim Das and Mahua Das, **ISBN** 13: 9788123918662 3. Advanced Inorganic Chemistry by Cotton and Wilkinson, **ISBN**: 978-0-471-19957-1 4. Advances in inorganic Chemistry by SK Agarwal and Keemti Lal, **ISBN-13**: 5551234096239 5. Inorganic Chemistry- Principles of Structure and Reactivity by James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, **ISBN-13:** 978-0060429959		

1. Name of the Department: Department of Chemistry							
2. Course Name	Organometallic Chemistry		**L**	**T**	**P**		
3. Course Code	17060303		3	0	0		
4. Type of Course (use tick mark)		**Core (✓)**		**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/Medical)	**6. Frequency (use tick marks)**		Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals							
Lectures = 40		**Tutorials = Nil**		**Practical = Nil**			

8. Course Description:

This course provides detailed knowledge about organometallic compounds, their classification, synthesis properties and applications in different fields.

9. Course Objectives:

The objectives of this course are:

1. To enable the students to get an idea about organometallic compounds and their chemistry.
2. To classify compounds on the basis of bonding.
3. To Explain synthesis and reaction mechanisms of organometallic compounds
4. To Explain kinetics and stability of organometallic compounds

10. Course Outcomes (COs):

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

1. Demonstrate the knowledge of organometallic chemistry.
2. Identify and solve the problems related to organometallic compound structure, synthesis and reaction mechanism.
3. Apply the analytical reasoning for explaining the properties of organometallic compounds for different applications like polymerization, catalytic hydrogenation etc
4. Explain the kinetics and stability of organometallic compounds.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction of organometallic compounds**

General introduction, Structure and bonding, π bonded organometallic compounds including carbonyls, nitrosyls, tertiary phosphines, hydrides, alkene, alkyne, cyclobutadiene, cyclopentadiene, arene compounds. Metal-carbon multiple bonds..

Alkyls and Aryls of Transition Metals: Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Transition Metal π–Complexes**

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

Unit – 3	**Number of lectures = 10**	**Title of the unit: Compounds of Transition Metal-Carbon Multiple Bonds**

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.

Unit – 4	Number of lectures = 10	Title of the unit:Fluxional Organometallic Compounds and role of organometallics as catalysts
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 5. Chhatwal, G.R and Anand, S.K (2000): Instrumental Methods of Chemical Analysis, Himalaya Publishing House, Delhi, ISBN-13: 978-0906654897		

1. Name of the Department: Chemistry						
2. Course Name	Inorganic Special Practical-I	**L**	**T**	**P**		
3. Course Code	17060303	0	0	6		
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/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 module of experiments designed here for students to understand the basic synthesis principles and learn the experimental part of complex preparation with transition elements.

9. Course Objectives:

The objectives of this course are:

1. To make students understand the difference between double salts and coordination compounds.
2. To identify the chemicals and apparatus required for the synthesis of coordination complexes.
3. To discuss and compare the stability of different complexes.
4. To 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. Demonstrate the knowledge of different methods of synthesis of coordination complexes.
2. Identify the various colours associated with the particular complexes.
3. Apply the analytical reasoning for comparing the properties of these complexes by preparing similar complexes changing the metal
4. Perform the synthesis of inorganic compounds which leads to a safe laboratory environment.

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. $[Cu(NH_3)_4(H_2O)_2]\ SO_4$
4. $[Mn(NH_3)_6]\ Cl_2$
5. $K_3\ [Fe(C_2O_4)_3]$
6. $VO\ (acac)_2$
7. Microcosmic salt
8. $[Ni(en)_3]S_2O_3$
9. Prussian blue
10. $[Co(NH_3)_5\ Cl]Cl_2$, $[Co(NH_3)_5\ NO_2]Cl_2$,$[Co(NH_3)_5ONO]Cl_2$
11. $K_3[Al\ (C_2O_4)_3]$
12. Green syntheses of

i. Bis (acetylacetonato) Copper(II)

ii. Tris (acetylacetonato) Iron (III)

iii. Tris (acetylacetonato) Manganese (III)

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. **ISBN :** 9789386633996
2. Agarwal, S.K., Lal, K. Advanced Inorganic Analysis, Pragati Prakashan, **ISBN:** 9789386306289
3. Mendham, J. (2009): Vogel's Textbook of Quantitative Inorganic Analysis, Pearson Education, **ISBN-13:** 978-8131723258
4. Svehla, G., Sivasankar, B. (2012); Vogel's Qualitative Inorganic Analysis, Pearson Education, **ISBN-13:** 978-8131773710

1. Name of the Department: Chemistry						
2. Course Name	Inorganic Special Practical - II		**L**	**T**	**P**	
3. Course Code	17060304		0	0	6	
4. Type of Course (use tick mark)	**Core (✓)**		**DSE ()**		**SEC ()**	
5. Pre requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/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 lab module focus on **spectrophotometry** which enable Students to analyses concentrations of selected cations (Fe, Ni, Mn, Cr, V, and Ti) and selected anions (Fluoride, Nitrate and Phosphate) will be determined along with study of determination of stoichiometry and stability constants of complexes by Job's method and slope ratio method.

9. Course Objectives:

The objectives of this course are:

1. To learn spectrophotometric determination of selected cations and anions
2. To learn spectrophotometric determination of pK value of an indicator
3. To study of complexation (stoichiometry and stability constant) by Job's method &Slope ratio method
4. To separate and determine different salts by complexometric titration

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. Apply the analytical reasoning to determine stoichiometry and stability constants of complexes by Job's method &Slope ratio method
4. Perform the complexometric titration for determination of different salts in safe laboratory environment.

11. List of Experiments

Spectrophotometric determination:

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

A. Fe-thiocynate,

B. Fe-phenanthroline
C. Cu-ethylenediamine

Complexometric Titration:

4. Determination of Calcium, Copper, Barium with Ethylene Diamine Tetraacetic Acid (EDTA) and Back titration
5. Titration of mixtures using masking agents

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, **ISBN-13:** 978-0906654897
2. Kamalesh Bansal, (2009): Analytical Spectroscopy, Campus Book International, **ISBN-13:** 978-8187815099
3. Spectrometry and Spectrofluorimetry: A Practical Approach by Michael G. Gore, **ISBN**: 0199638128,

1. Name of the Department: Chemistry						
2. Course Name		Inorganic Special Practical – III		**L**	**T**	**P**
3. Course Code		17060305		0	0	6
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/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 is on instrumental analysis. In this lab course students will be able to analyse different inorganic compounds by study of FTIR and IR spectra along with identifying fundamental and overtone peaks of compounds.

9. Course Objectives:

The objectives of this course are:

1. To identify the Infrared spectra of inorganic compounds
2. To learn to compare IR spectra of compound synthesized with the theoretical data
3. To identify the different bonding of of ligands in inorganic compounds by IR study
4. To check the denticity of ligands

10. Course Outcomes (COs):

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

1. Demonstrate the knowledge of Infrared spectroscopy
2. Apply the analytical reasoning to determine the peaks of compounds in IR spectra
3. Identify the fundamental peaks of inorganic salts
4. Identify and compare the IR peaks of inorganic ligands with theoretical data

11. List of Experiments

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

a. Ammonium salts [NH_4Cl, $(NH_4)_2 SO_4$, $NH_4 SCN$, $NH_4 NO_3$]
b. Sulphate ions in different bonding mode: ionic – K_2SO_4 , $CaSO_4$ etc., unidentate, bidentate, bridged etc.
c. Thiocynate and Isothiocynate complexes.
d. Oxalato complexes
e. Cyano complexes – $K_4Fe(CN)_6$, Na_2 [$Fe(CN)_5$ 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. Chhatwal, G.R and Anand, S.K (2000): Instrumental Methods of Chemical Analysis, Himalaya Publishing House, Delhi, **ISBN-13:** 978-0906654897

Semester III
Specialization: Physical Chemistry

1. Name of the Department: Chemistry						
2. Course Name	Chemical Dynamics & Surface Chemistry		**L**		**T**	**P**
3. Course Code	17060307		3		0	0
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/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 will enable the post graduate students to understand and rationalize the basics thermodynamics of electrified interfaces, including Helmholtz-Perrin, Gouy-Chapman model and Stern model of electrified interfaces Students will also focuses on the interesting concepts of surface chemistry and ionic liquids.

9. Course Objectives:

The objectives of this course are:

1. To provide a firm foundation in electrochemistry, chemical dynamics surface chemistry and ionic liquids.
2. To introduce the concept of thermodynamics of electrified interfaces and chemical dynamics.
3. To describe process of adsorption which focuses on surface tension and Gibb's adsorption equation?
4. To introduce the importance of ionic liquids and electrodics

10. Course Outcomes (COs):

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

1. Apply the concept of thermodynamics on electrified interfaces
2. Describe the simple ionic liquids & lattice oriented models
3. Explain the surface chemistry which includes the Gibb's adsorption equation and its applications
4. Identify and solve the problem related to calculation of energy of activation

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the Unit: Electrified Interfaces**

Thermodynamics of electrified interfaces: electrocapillary thermodynamics, 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 = 10**	**Title of the Unit: Chemical Dynamics**

Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and the activated complex theory; ionic reactions. Steady state kinetics, kinetic and thermodynamic control of reactions, treatment of unimolecular reactions. Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethene), general features

of fast reactions, study of fast reactions by flow method, relaxation method.		
Unit – 3	**Number of lectures = 10**	**Title of the Unit: Adsorption**
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. Surface tension, capillary action, pressure difference across curved surface (Laplace equation), Gibb's adsorption equation and its applications, BET equation and its application for the determination of surface area;		
Unit – 4	**Number of lectures = 10**	**Title of the Unit: Ionic Liquids & Electrodics**
Ionic Liquids: The thermal dismantling of an ionic lattice,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 simple picture of the symmetry factor and its dependence on overpotential. Polarizable and non-polarizable interfaces		
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. **ISBN:**978-0-306-46909-**1** 2. Laidler, K.J. Chemical Kinetics **ISBN:**9780060438623 3. Frost, A. and G.Pearson. Kinetics and Mechanism of Reaction Rates **ISBN:**978-0-471-03558-9 4. Laidler, K.J., H.Eyring and S. Glasstone. Theories of Reaction Rates Kinetics **ISBN:**9780060438623 5. Glasstone, S. Electrochemistry **ISBN:** 9781446545461		

1. Name of the Department: Chemistry						
2. Course Name	Advanced Quantum & Statistical Thermodynamics Mechanics		**L**	**T**	**P**	
3. Course Code	17060308		3	0	0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
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 = 40		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description:

This course will enable the post graduate students to understand and rationalize the advancement of quantum chemistry, includes the Approximation method and Born-Oppenheimer approximation. Students will also covers the interesting concepts of statistical thermodynamics such as concept of distribution, types of statistic and various partition functions.

9. Course Objectives:

The objectives of this course are:

1. To provide the firm foundation in statistical thermodynamics.
2. To explain the advancement in quantum mechanics
3. To introduce the concept of ensembles and partition function
4. To learn Born-Oppenheimer approximation, LCAO-MO approximation as well as the approximation and perturbation method.

10. Course Outcomes (COs):

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

1. Understand the concept of statistical thermodynamics, types of statistics and ensembles.
2. To calculate the entropy of idea; gases
3. Explain the chemical equilibrium and equilibrium constant in terms of partition functions
4. Demonstrate the concept of extension of MO theory to other systems-homo-nuclear and hetero-nuclear diatomic molecules

1. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Statistical Thermodynamics I**

Statistical Thermodynamics: Concept of distribution, thermodynamic probability and most probable distribution, Types of statistics: Maxwell Boltzmann, Bose-Einstein & Fermi-Dirac statistics and its statistical thermodynamic formulation, Idea of microstates and macrostates . Canonical, grand canonical and microcanonical ensembles. 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 content (v) work function (vi) pressure (vii) heat capacity at constant volume. Derivation of equation of state for a monoatomic ideal gas.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Statistical Thermodynamics II**

Evaluation of Translational partition function, calculation of absolute entropy of an ideal monoatomic gas, 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. Chemical equilibrium and equilibrium constant in terms of partition functions, Free

energy function.		
Unit – 3	**Number of lectures = 10**	**Title of the unit: Quantum Mechanics- I**
Approximate methods: First order time-independent perturbation theory for non-degenerate states, 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 = 10**	**Title of the unit: Quantum Mechanics- II**
Born-Oppenheimer approximation, Valence bond method to hydrogen molecule ion and hydrogen molecule their symmetric and anti-symmetric solution without actual evaluation of various integrals, energy of molecular hydrogen system, LCAO-MO approximation of hydrogen molecule , Configuration Interaction. Extension of MO theory to other systems- Homonuclear and heteronuclear diatomic molecules.		
11. 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.		
12. Books Recommended		
1. Glasstone, S. Theoretical Chemistry **ISBN:**9781446545461 2. Levine.Quantum Chemistry **ISBN:**978-9332558533 3. Pauling, Eyring and Wilson. Quantum Chemistry **ISBN:**978-0486648712 4. Nash, L.K. Introduction to Statistical Mechanics **ISBN:**978-0486449784 5. Donald. A. McQuarrie - Statistical Mechanics-2011 **ISBN:**978-8130918938 6. Frank L. Pilar, Elementary Quantum Chemistry – 2001 **ISBN:** 9780486414645.		

1. Name of the Department : Department of Chemistry						
2. Course Name	Solid State and Biophysical Chemistry	**L**	**T**	**P**		
3. Course Code	17060309	3	0	0		
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**SEC ()**		
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 = 40		**Tutorials = Nil**	**Practical = Nil**			

8. Course Description:

This course will enable the post graduate students to understand and rationalize the concept involved in solid state chemistry. It also covers the chemistry of biopolymer and macromolecular solutions. The students will also be made familiar with bio-molecular simulations

9. Course Objectives:

The objectives of this course are:

1. To provide an introduction to the concepts underlying solid state chemistry
2. To illustrate the wide range of materials and physical properties currently available
3. To enable students to identify different types of polymers in our surroundings
4. To introduce students to the practical application of polymers and explain bio-molecular simulations

10. Course Outcomes (COs):

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

1. Identify the structure and packing in solids and different defects in crystals.
2. Apply the simulations on bio-molecules
3. Demonstrate the solid solutions including phase transitions.
4. Understand the biopolymer interactions and the thermodynamics of macromolecular solutions

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Solid state – I**

Solid state reactions: experimental procedures, factors influencing solid state reactions. Characterization of solids: Physical techniques diffraction methods; X-rays diffraction, electron diffraction and neutron diffraction; microscopic techniques; SEM and TEM. Crystals defects and non stoichiometry: perfect and imperfect crystals, thermodynamics of Schottky and Frenkel defects, colour centres. extended defects; stacking faults, grain boundaries and dislocations.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Solid State – II**

Solid solutions: Substitutional and interstitial solid solutions, requirement for solid solution formation, experimental methods for studying solid solutions, Phase transitions, Buerger's and thermodynamic classifications of phase transitions. Conductivity in solids: structure and conduction mechanism in ionic conductors and superionic conductors, band theory of metals, band structure of semiconductors, n-type and p-type semiconductivity..

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

Biopolymer interactions and Thermodynamics of Macromolecular solutions: Non-covalent interaction, Electrostatic: dipole-dipole interaction, Dispersion force interaction, Hydrophobic interaction. Multiple Equilibria and various types of binding processes in biological systems. Thermodynamics of biopolymer solutions, Flory-Huggins model of macromolecular solvation,

Osmotic pressure and Donnan membrane equilibrium.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Statistical Mechanics and Biomolecular simulations**
Statistical Mechanics and Biomolecular simulations: Chain configuration of macromolecule, Random walk model and statistical distribution of end to end dimension. Calculation of average dimension of various chain structures. Conformational transitions: Helix-coil transition, Protein folding problem. Molecular mechanics and dynamics: Basic principles – molecular representations – force fields – atom-atom pair potentials – bond length and bond angle and torsion angle potential – van der Waals and electrostatic potential concepts of molecular dynamics – introduction to time-step integration algorithms and force fields.		
12. 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		
13. Books Recommended		
1. Biophysical Chemistry Part I, II, III – Charles R Cantor, Paul R. Schimmel, W. H. Freeman of Company **ISBN:** 978-0716711889 2. Biophysical Chemistry – P.S. Kalsi and N. Mahanta New Age International Publishers **ISBN:**978-1781830031 3. Textbook of Biophysical Chemistry- U N Dash Macmillan India Bockris, J.O.M. and A.K.N. Reddy. Modern Electrochemistry. Vol.1 & 2 **ISBN:**978-1-4615-7467-5 4. Glasstone, S. Electrochemistry **ISBN:**978-1443722940 5. Reiger, P.H. Electrochemistry **ISBN :**978-94-011-0691-7 6. Heyrovsky. Polarography **ISBN:**9781483227467 7. Kannala, Zutshi. Introduction to Polarography and Allied Techniques **ISBN:**978-8122417913		

1. Name of the Department: Chemistry						
2. Course Name	Physical Special Practical -1	**L**	**T**	**P**		
3. Course Code	17060310	0	0	6		
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/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 concepts of characterizing an acid without indicators. Students will also learn various concepts of, polarimeter 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:

The objectives of this course are:

1. To explain the principles of potentiometer, polarimeter and dipole meter.
2. To determine the specific rotation of optically active substances and identify the dextro and laevo-rotation of substances.
3. Topredict the dielectric constant
4. To learn the working of potentiometer, polarimeter and 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 concentrations and hence determination of *Dipole* Moment.
2. Describe various potentiometric titrations.
3. Describe application and functioning polarimeter.
4. Determine the specific rotation of various optically active substances.

11. List of Experiments

I. Potentiometric titrations

1. Mohr's salt or $FeSO_4$ vs $KMnO_4$titration
2. Mohr's salt or $FeSO_4$vs $K_2Cr_2O_7$titration.
3. KCl or KI vs $AgNO_3$titration
4. (KCl + KI) vs $AgNO_3$ mixture titration
5. (KCl + KBr +KI) vs $AgNO_3$ mixture titration
6. Ce^{4+} vsFe^{2+}titration.

II. Polarimetry

a. To determine specific rotation for various optically active substances.

b. To determine concentration of glucose or fructose or sucrose or tartaric acid in solution.

c. To determine the percentage composition of optical substances in the binary mixture (components comprise of Glucose or Fructose or sucrose or Tartaric acid)

III . Dipolemetry

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

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

1. https://youtu.be/g5z6EaT46iA
2. https://youtu.be/JwCeCS2YRVo
3. https://youtu.be/mFE1EBsPEas
4. www.iiserpune.ac.in/~bhasbapat/phy221_files/SITechPolar.pdf
5. https://www.jhuapl.edu/techdigest/views/pdfs/V07_N1_1967/V7_N1_1967_Tossman.pdf

13. Books Recommended

1. Khosla,B.D., V.C. Garg and A. Gulati.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	17060311	0	0	6		
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**SEC ()**		
5. Pre-requisite .	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/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 rationalize the applications of conductometer, pH meter 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 a conductometer. pH meter will help the students to find out pH of the solutions and make them familiar to Flame photometry.

9. Course Objectives:

The objectives of this course are to:.

1. To provide the firm foundation on conductometric titration.
2. To determine the conductivity of citrus fruits and succinic acid and with different acid and base
3. To demonstrate the pH of different solutions
4. To 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. Explain the theory behind conductivity of ions
2. Describe the application of pH meter
3. Verify the Debye Hückel Onsager equation for strong electrolytes
4. Demonstrate application and working of flame photometer.

11. List of Experiments

I. Conductometric titrations

a. Citric acid vs NaOH
b. Succinic Acid vs NaOH
c. CH_3COOH vs NH_4OH
d. HCl vs CH_3COONa
e. (HCl + CH_3COOH) vs NaOH mixture
f. (HCl + CH_3COOH + $CuSO_4$) vs NaOH 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. KCl or KI vs $AgNO_3$
   i. To determine solubility and solubility product of sparingly soluble salts (AgCl, $PbSO_4$, $BaSO_4$)
j. Verify of Debye Hükel Onsager equation for strong electrolytes.

II. pH metric titrations

1. Succinic Acid titration vs NaOH
2. Citric Acid titration vs NaOH
3. To predict composition of Copper amine complex from $CuSO_4$ vs.NH_4OH titration.
4. To determine dissociation constant of weak acid

III. Flame Photometry 1. To determine the concentration of Na+ or Li+ or Ca++ ions in solution.
12. Brief Description of self-learning / E-learning component
1. https://nptel.ac.in/courses/122101001/37 2. https://nptel.ac.in/courses/122101001/Slide/lect38/38_6.htm 3. https://nptel.ac.in/courses/122101001/Slide/lect38/38_4.htm 4. https://youtu.be/JhBs_8DrPYo 5. https://youtu.be/2tJqZStFwjU
13. Books Recommended
1. Khosla,B.D., V.C. Garg and A. Gulati.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	17060312	0	0	6		
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/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 on the use of special instruments like Ultrasonic Interferometer and spectrocalorimeter. 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. To have clear concepts about kinetics of a reaction.
2. To explain terms like rate law, order of reaction, molecularity and chemistry behind iodine clock reaction.
3. To learn the activation energy for hydrolysis of an ester
4. To enable students to apply the basic principles of UV-visible spectrophotometer and determine concentration of unknown solutions from their λ_{max} values.

10. Course Outcomes (COs):

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

1. Measure the speed of sound for various liquids.
2. Verify Lambert-Beer's law by different coloured solutions and find the unknown concentration of any coloured solution.
3. Determine the activation energy for hydrolysis of an ester.
4. Study reaction kinetics of the iodine clock reaction.

11. List of Experiments

I. Ultrasonic Interferometry

a. To measure speed of sound for various liquids.

b. To determine the isentropic compressibility of liquids.

II. Calorimetry

a. To test the validity of Lambert- Beer's Law for $KMnO_4$ and $K_2Cr_2O_7$

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 determine 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 using the clock reaction.

d. To study the kinetics of acid catalyzed inversion of cane sugar.

12. Brief Description of self-learning / E-learning component
1. https://youtu.be/UG-pzCUsEq0 2. https://nptel.ac.in/courses/103108100/module2/module2.pdf 3. https://www.slideshare.net/TapeshwarYadav1/colorimeter-52697150 4. chemistry.bd.psu.edu/jircitano/kinetics.html
13. Books Recommended
1. Khosla,B.D., V.C. Garg and A. Gulati.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

1. Name of the Department: Chemistry						
2. Course Name	Photochemistry and Pericyclic Reactions	**L**	**T**	**P**		
3. Course Code	17060313	3	0	0		
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**SEC ()**		
5. **Pre-requisite (if any)**	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/Medical)	6. **Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem()	EverySem ()
7. **Total Number of Lectures, Tutorials,Practicals**						
Lectures = 40		**Tutorials = Nil**	**Practical = Nil**			

8. **Course Description:**

The course covers the study of organic chemical reactions in the presence and absence of light. Different photo physical and photochemical processes will be introduced and elaborate the interaction of Electromagnetic radiation with organic molecules. The involvement of different molecular orbitals in photochemical and pericyclic reactions will be briefly discussed in the course.

9. **Course Objectives:**

1. To demonstrate the effect of EMR on matter and how chemical reactions proceed by the action of EMR
2. To understand the photochemical reaction of alkene and photo rearrangements
3. To understand pericyclic reactions, its types and MOs change during different types of photochemical reactions.
4. To learn the different types of rearrangement reaction

10. **Course Outcomes (COs):**

On completion of this course, the students will be able to

1. Explain the phenomenon of photochemistry.
2. Perform the photochemical reactions of alkenes, carbonyl and aromatic compounds.
3. Apply the Woodward–Hoffmann rules governing pericyclic reactions.
4. Describe different types of rearrangement reactions

11. **Unit wise detailed content**

Unit-1	**Number of lectures = 10**	**Title of the unit: Photochemistry**

Photochemical reactions: Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, Jablonski diagram, energy pooling, exciplexes, excimers,photosensitization, quantum yield,solvent effects, transfer of excitation energy, actinometry, Stern-Volmer plot, delayed fluorescence.

Photochemistry of Alkenes: Intramolecular reactions of the olefinic bond- geometrical isomerism,non-vertical energy transfer; photochemicalAdditions, cyclisation,rearrangement of1,3-,1,4- and 1,5-dienes;dimerizations.

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: Isomerization, skeletal isomerizations, Dewar and prismanes in isomerization. Additions and substitutions.

Miscellaneous Photochemical Reactions: Photo-Fries rearrangement of ethers and anilides, Barton reaction. Singlet molecular oxygen reactions. Photodegradation of polymers, Hoffman-Loeflller-Freytag reaction.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Pericyclic Reactions**

General pericyclic selection rule and its applications, 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, Hückel–Mobius 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 cycloadditions and cheleotropic reactions.

Unit – 4	**Number of lectures = 10**	**Title of the unit: Sigmatropic Rearrangements**

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

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 – Charles Herbert DePuy (Author), Dennis Chapman (Author), Prentice Hall (1 June 1972), **ISBN-13:** 978-0135995716
2. Aspects of Organic Photochemistry – W.M. Horsepool,Academic Press (1976),**ISBN-13:** 978-0123566508
3. Organic Photochemistry. Coxon,J.M and Halton, B., Cambridge University Press; 2 edition (3 March 2011)**ISBN-13:** 978-0521189729
4. Pericyclic Reactions: A Mechanistic Study, Mukherji, S.M., Macmillan India Press,ISBN 13: 9780836406375
5. Principles of Molecular Photochemistry An Introduction,N.J.Turro, J.C.Scaiano,V.Ramamurthy, ISBN-13: 978-1891389573

1. Name of the Department :Chemistry							
2. Course Name	Heterocyclic Chemistry and Organic Synthesis			**L**	**T**		**P**
3. Course Code	17060314			3	0		0
4. Type of Course (use tick mark)		**Core (✓)**		**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/Medical)	**6. Frequency (use tick marks)**		Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals							
Lectures = 40		**Tutorials = Nil**		**Practical = Nil**			

8. Course Description:

The course introduces the chemistry of important five and six membered heterocyclic compounds and different name reactions which were widely used by the organic chemists in the synthesis of drug molecules. This course also covers the disconnection approach which facilitates the chemists to design the pathway for the synthesis ofdrug molecules and natural products.

9. Course Objectives:

The objective of this course is

1. To describe the synthesis of heterocyclic compounds
2. To explain the reaction mechanisms of heterocyclic compounds
3. To describe the guidelines for choosing disconnections in chemical synthesis
4. To discuss the important name reactions widely used in organic synthesis

10. Course Outcomes (COs):

After completion of this course, students will be able to

1 Design the heterocyclic organic compounds
2. Design and synthesize fused ring heterocyclic compounds
3. Apply different name reactions in the synthesis of natural products
4. Apply the strategies of disconnection approach

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Five-membered Heterocycles**

Synthesis and reactions of Five membered rings with two heteroatoms: imidazole, oxazole, thiazole and benzo fused analogs: indole, benzofuran

Unit – 2	**Number of lectures = 10**	**Title of the unit: Six -membered Heterocycles**

Synthesis and reactions of six membered rings: Pyridine, Pyrazine and Benzofused six membered rings with one, two and three heteroatoms: benzopyran, quinoline, and acridine

Unit – 3	**Number of lectures = 10**	**Title of the unit: Name Reactions and Natural products**

Mechanism and applications of name reactions:Aldol, Perkin, Benzoin, Cannizarro, Wittig, Reformatsky, Mannich, Diels – Alder, Stork Enamine reactions and Michael addition.
Chemistry of natural products: Alkaloids, Terpenoids, and Steroids (General methods of structural elucidation)

Unit – 4	**Number of lectures = 10**	**Title of the unit: Disconnection Approach**

Introduction to disconnection approach, Synthons and synthetic equivalents, Guidelines for

choosing disconnections, Functional group interconversions.

One group C-C Disconnections: Synthesis of alcohols and carbonyl compounds by 1,1 C-C disconnections, synthesis of alcohols and carbonyl compounds by 1,2 C-C disconnections.
Regioselectivity in Michael reactions, Alkene synthesis by Wittig reaction, use of acetylenes (alkynes) and aliphatic nitro compounds in organic synthesis.
Two group C-C Disconnections: Diels Alder reaction: stereospecificity and stereoselectivity, endo selectivity, regioselectivity. 1,3-dicarbonyl compounds, Michael addition and Robinson annulation.

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. Singh, J.,Yadav, L.D.S. and Singh J. Organic synthesis (2018),PragatiPrakashan, 14th Edition, ISBN: 978-93-87812-50-5
2. Ahluwalia, V.K. Heterocyclic Chemistry(2016), revised edition, Narosa Publishing House,ISBN: 978-8184875591
3. Gupta, R.R., M. Kumar and V. Gupta. Heterocyclic Chemistry, Volume II: Five-Membered Heterocycles (1999), Springer, ISBN 978-3-662-07757-3
4. Organic Chemistry,Finar, I.L. Volume 1, 6th Edition, Pearson, ISBN: 978-81-7758-542-1
5. Organic synthesis : The Disconnection Approach(2008), Sturant Warren, Paul Wyatt, 2nd Edition, Publisher: Wiley, ISBN: 978-0-470-71236-8
6. Advanced Organic Chemistry, Parts A & B, Carey, F.A. &Sundberg, R. J. Plenum: U.S. (2004).
7. Modern Methods of Organic Synthesis, Carruthers, W. Cambridge University Press (1971).
8. Introduction to the Chemistry of Heterocyclic Compounds, Acheson, R. M. John Wiley &Sons(1976).

1. Name of the Department :Chemistry						
2. Course Name	Reagents and Rearrangements	**L**	**T**	**P**		
3. Course Code	17060315	3	0	0		
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 40		**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 synthesis of organic compounds. .

9. Course Objectives:

The objectives of this course are:

1. To study the preparation,properties and applications of organometallic reagents
2. To study the preparation,properties and applications of oxidizing agents
3. To study the preparation,properties and applications of reducing agents
4. To discuss different molecular rearrangements.

10. Course Outcomes (COs):

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

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

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Organometallic 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, Organo silicon reagents and Organo Palladium reagents.

Unit – 2	**Number of lectures = 10**	**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.Sharpless Asymmetric epoxidation, Asymmetric hydroxylation and aminohydroxylation.

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

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

Unit – 4	**Number of lectures = 10**	**Title of the unit: Molecular rearrangements**

Definition and classification. Molecular rearrangements involving 1) electron deficient carbon:

Wagner- Meerwein, Pinacol-Pinacolone, Allylic and Wolff 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, Trans annular, 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. Organic Synthesis Concepts, Methods and Starting Materials,Fuhrhop, J.-H. andPenzilin , G.. Vch Pub (May 1997), ISBN-13: 978-1560818144
2. Some Modern Methods of Organic Synthesis,Carruthers, W. Cambridge University Press; 3 edition (January 30, 1987), ISBN-13: 978-0521311175
3. Modern Synthesis Reactions, House, H.O. and W.A. Benjamin. w. a. benjamin; 2nd edition (1972), **ISBN-13:** 978-0805345018
4. Advanced Organic Chemistry – Jerry March, John Wiley & Sons Inc; 3rd edition, ISBN:978-0471854722
5. Principles of Organic Synthesis,Norman, R.O.C. and Coxon, J.M. Springer; Softcover reprint of the original 3rd ed. (1993)
6. Advanced Organic Chemistry: Part B: Reaction and Synthesis,Carey, F.A. and R.J. Sundburg. Springer; (2008), **ISBN-13:** 978-0387683546
7. Organic synthesis : The Disconnection Approach (2008),Sturant Warren, Paul Wyatt, 2nd Edition, Publisher: Wiley, ISBN: 978-0-470-71236-8

1. Name of the Department: Chemistry						
2. Course Name	Organic Special Practical –I		**L**	**T**	**P**	
3. Course Code	17060316		0	0	4	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
8. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/Medical)	**9. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = Nil		**Tutorials = Nil**		**Practical = 52**		

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 isolation of some important natural products, their separation and purification as well as estimation experiments.

9. Course Objectives:

1. To make students able to carry out organic isolations of natural products
2. To learn the methods for their separation and purification.
3. To learn the estimation of organic compounds.
4. To learn the method of extraction of natural products.

10. Course Outcomes (COs):

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

1. Apply the application of analytical methods based on titrations, isolation, separations, etc
2. Design and apply the analysis related to a question of relevance based on experience in the laboratory and research of the scientific literature
3. Solve most important problems of quantitative analysis.
4. Develop methods for extraction of natural products.

11. List of Experiments

Quantitative Analysis

Isolation of natural products:

i) Isolation of caffeine from tea leaves
ii) Isolation of piperene from black pepper
iii) Isolation of β-carotene from carrots
iv) Isolation of lycopene from tomatoes
v) Isolation of limonene from lemon peel
vi) Isolation of casein from milk
vii) Isolation of DNA from Onion/ Strawberries

Quantitative analysis:

1. Estimation of Amines using bromate-bromide solution method.
2. Estimation of phenols using bromate-bromide solution method.
3. Estimation of Iodine by Vij's Solution
4. Estimation of glucose and sucrose by chemical methods.

5. Estimation of amino acids by chemical methods

Students need to perform a total 10 experiments in all.

12. Books Recommended

1. Vishnoi, N. K., Advanced Practical Organic Chemistry, 3rd edition, ISBN: 9788125931287, 9788125931287
2. Brian S,Furniss, A.J. Hannaford, Peter W.G. Smith and Tatchell, A. R., Vogel's Textbook of
3. Practical Organic chemistry, 5th edition, John Wiley & Sons, New York, ISBN:0582462363
4. Natural Products Isolation, Editors: Sarker, Satya D. (Ed.), ISBN 978-1-59259-955-4.

E link:

1. https://www.youtube.com/watch?v=Gexf_PNPefU
2. https://www.youtube.com/watch?v=9tcErJzejUY
3. https://www.youtube.com/watch?v=ZtMwjEnqlMo
4. https://www.youtube.com/watch?v=qzfFajukhTU
5. https://www.n-analytech.co.jp/archives/003/201602/ApplicationSheet_GT-200-OF032E.pdf

1. Name of the Department: Chemistry							
2. Course Name	Organic Special Practical –II	**L**		**T**		**P**	
3. Course Code	17060317	0		0		4	
4. Type of Course (use tick mark)		**Core (✓)**		**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/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 processes and will enable them 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.

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

Advanced Multistep synthesis :

1. Benzaldehyde → Bezoin → Benzil → Benzilic acid
2. Benzophenone → benzopinacol → benzopinacolone.
3. Benzaldehyde → chalcone → chalcone epoxide

4. Cyclohexanone → cyclohexanone oxime → caprolactone

(Or) other suitable multi-step synthesis

Note: Students need to perform at least 5 experiments in all.

12. Books Recommended

1. Chapman and Hall, 5th edition, Textbook of Practical Organic Chemistry, 1996.
2. Nicolas Bogliotti, RobaMoumné,Multi step organic synthesis, A guide through experiments,.Dec 2017.ISBN: 9783527340651.
3. Vogel's Textbook Of Practical Organic Chemistry (5th Edition)by A.I. Vogel; A.R. Tatchell; B.S. Furnis; A.J. Hannaford; P.W.G. Smith, ISBN 13: 9780582462366
4. Vishnoi, N. K., Advanced Practical Organic Chemistry, 3rd edition, ISBN: 9788125931287, 9788125931287

E link:

1.https://venturacollegeorganicchemistry.weebly.com/uploads/1/4/2/3/1423190/12blexpt12benzilica

cid.pdf
2. https://www.youtube.com/watch?v=1sjtTV7WGMI
3. http://publications.rwth-aachen.de/record/459429/files/2681.pdf
4. https://www.youtube.com/watch?v=2pxBqBBAuwo
5.https://www.youtube.com/watch?v=9bElvg9t13k

1. Name of the Department: Chemistry						
2.Course Name	Organic Special Practical –III		**L**	**T**		**P**
3.Course Code	17060318		0	0		4
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical/Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		**Tutorials = 0**	**Practical = 52**			

8. Course Description:

This Course will introduce the students to synthesize the organic compounds through various oxidation/reduction reactions and will enable them to develop and practice independent learning skills. This course will also give a platform to learn different reagents 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 various oxidation/reduction reactions through modern methods.
3. Learn the various reagents of organic chemistry.
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 reagents used for synthesis of organic compounds.
2. Describe disposal techniques and laboratory emergency procedures.
3. Know the handling of different chemicals and instruments.
4. Prepare himself/herself according to the modern research field.

11. List of Experiments

Organic Synthesis

1. Protection and deprotection reactions of carboxylic acids, amines, alcohols, 1,2- diols, aldehydes/ketones, etc.
2. Oxidation reactions of alcohols, aldehydes, etc.
3. Reduction reactions of aldehydes/ ketones, carboxylic acids, carbon-carbon multiple bonds, nitro compounds
4. Metals/ metal salts catalyzed coupling reactions
5. Diels-Alder reactions
6. Diazotisation reactions for substitutions and couplings

Note :Students need to perform at least 10 experiments (Green chemistry techniques may be practiced while performing the experiments).

12. Books Recommended

1. Chapman and Hall, 5th edition, Textbook of Practical Organic Chemistry, 1996.
2. Nicolas Bogliotti, RobaMoumné, Multi step organic synthesis, A guide through experiments, .Dec 2017. ISBN: 9783527340651.
3. Vogel's Textbook Of Practical Organic Chemistry (5th Edition) by A.I. Vogel; A.R. Tatchell; B.S. Furnis; A.J. Hannaford; P.W.G. Smith, ISBN 13: 9780582462366

4. Vishnoi, N. K., Advanced Practical Organic Chemistry, 3rd edition, ISBN: 9788125931287, 9788125931287

E link:

1. https://www.youtube.com/watch?v=HTxa7-oqvew
2. https://www.youtube.com/watch?v=XLrDBM-EIuw
3. https://www.youtube.com/watch?v=LQ4sdDSFE3U
4. https://www.youtube.com/watch?v=HdvrTQpzfjc
5. https://www.youtube.com/watch?v=xYvzciNQiao

1. Name of the Department : Department of Chemistry						
2. Course Name	Drug Design and Development		**L**	**T**	**P**	
3. Course Code	17060319		2	0	0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✔)**		**SEC ()**	
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 = 26	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

This discipline specific elective course will enable postgraduate students to develop an understanding of design of drug. Concepts involved in understanding drug targets through study of various drug receptors will be explained. Various concepts such as isosterism, bioiososterism and prodrugs with their applications in drug design will be explained. Role of stereoselectivity in drug design will also be discussed. Role of QSAR studies and molecular properties will also be part of study. Finally, Computer aided drug design and Pharmacophore modeling will be explained.

9. Course Objectives:

1. This course will explore the process of drug development from target identification
2. It will present drug development as a process involving target selection, lead discovery using computer-based methods and combinatorial chemistry/high-throughput screening.
3. Students will learn about molecular recognition, computer aided drug design, and toxicology as applied to the development of new medicines.
4. To acquaint students with deep knowledge about drug receptors

10. Course Outcomes (COs):

Students will be able to:
1. Develop an understanding of drug targets as a recognition site for pharmaceutical agents; how the chemical structure of a substance influences interaction with a drug target
2. Identify new drug targets for future drug discovery.
3. Understand the key concepts of drug design.
4. Apply knowledge to QSAR and molecular properties in designing of new drugs.

11. Unit wise detailed content

Unit-1	**Number of lectures = 6**	**Title of the unit: Drug Receptors**

Basic concept and classification of receptors, Forces involved in drug receptors- interactions, Receptor agonism and antagonism, Concept of Spare receptors, Ion Channel receptors, Topographical study of the following receptors: Adrenergic, Cholinergic, Opioid receptors, H-1 & H-2 receptors.

Unit – 2	**Number of lectures = 6**	**Title of the unit: Drug Design**

Concept of isosterism and bioiososterism and their applications in drug design, Antimetabolite approach to drug design, Analog drug design, Prodrugs, General pathways of drug metabolism, Stereochemical aspects of drug action

Unit – 3	Number of lectures = 7	Title of the unit: QSAR and Molecular properties in drug design
Basic introduction of QSAR and its Applications in drug design Molecular modeling: Prediction and analysis of ADMET properties of new molecules and its importance in drug design. Basics of combinatorial chemistry, Rational approach to drug design, Basic strategies of drug discovery.		
Unit – 4	**Number of lectures = 7**	**Title of the unit: Computer aided drug design and Pharmacophore modeling**
Introduction to computer aided drug design (CADD) Physicochemical parameters and methods to calculate them: Hammett equation and electronic parameters (sigma), lipophilicity effects and parameters (log P, π-substituent constant), steric effects (Taft steric and molar refractivity). Biological parameters. Introduction to Pharmacophore modelling.		

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

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4975341/
2. https://nptel.ac.in/noc/individual_course.php?id=noc18-bt28
3. https://nptel.ac.in/courses/102106065/58

12. Books Recommended

1. Manfred E. Wolff, Burger's medicinal Chemistry and Drug Discovery, Vol. I to V, 5thed., A Wiley-Interscience publication John Wiley & Sons, Inc. (New York), 1995.
2. William O. Foye, Principles of Medicinal Chemistry, 3rd ed., Varghese Publishing House, Mumbai, 1989.
3. Kadam & Mahadik, Bothara, Principles of Medicinal Chemistry vol. I & II, 4th ed. Nirali Prakash Pune, 1997.
4. Leach A., Molecular Modeling: Principles and Applications, Pearson, New York.
5. Langer T., Hoffmann R.D., Pharmacophores and Pharmacophore Searches, Volume-32, Wiley-VCH, Weinheim.
6. Perun T.J. and Propst C.L., Computer-aided Drug Design Methods and Applications, Saurabh Prakashan Pvt.Ltd., New Delhi.
5. Veerapandian P., Structure Based Drug Design, CRC Press, London.

Semester – IV

Students have to complete a project work of six months either in-house or at an industrial/scientific organization

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Note:

The syllabus to be revised and updated every two years based upon the Academic, Industrial and Scientific needs.