SYLLABUS FOR POST GRADUATE PROGRAMME
M.Sc. CHEMISTRY
TWO YEAR COURSE EXAMINATIONS UNDER
CHOICE BASED CREDIT SYSTEM (CBCS)
w.e.f. The Academic Session 2023-24

RAMA DEVI WOMEN'S UNIVERSITY,
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COURSE STRUCTURE

COURSE STRUCTURE FOR M.SC. CHEMISTRY

COURSE STRUCTURE: The detailed Course structures for (MA/M.SC./M.COM) is given below

14 Hard Core Papers each of **05** Credit and **100** Marks
04 Core Elective Papers each of **05** credit and **100** marks
02 Allied Core Papers each of **03** credit and **50** marks
01 Open elective Paper each of **04** credit and **50** marks

SEMESTER – I								
Sl.No	Nature of Course	Course Code	Paper Title	Units	Credits	Marks		
						Mid-Sem.	End-Sem.	Total
1	Hard Core	HC-101	Inorganic Chemistry-I	5	5	20+10	70	100
2	Hard Core	HC-102	Organic Chemistry-I	5	5	20+10	70	100
3	Hard Core	HC-103	Physical Chemistry-I	5	5	20+10	70	100
4	Hard Core	HC-104	Inorganic Chemistry-I (**Practical)**	__	5	20+10	70	100
5	Allied Core	AC-101	Computer Application Course by e-learning centre	3	3	Mid-sem10 + Practical 10 =20 marks	30	50
	TOTAL				**23**	**140**	**310**	**450**

SEMESTER – II								
Sl.No	Nature of Course	Course Code	Paper Title	Units	Credits	Marks		
						Mid-Sem.	End-Sem.	Total
6	Hard Core	HC-201	Inorganic Chemistry-II	5	5	20+10	70	100
7	Hard Core	HC-202	Organic Chemistry-II	5	5	20+10	70	100
8	Hard Core	HC-203	Physical Chemistry-II	5	5	20+10	70	100
9	Hard Core	HC-204	Organic Chemistry-II (**Practical)**	__	5	20+10	70	100
10	Core Elective	CE-201	A. Spectroscopy-I OR B. Polymer Chemistry	5	5	20+10	70	100

11	Open Elective Theory (Open for other PG students)	OE-201	Environmental Chemistry OR MOOCs (From SWAYAM/ NPTEL etc.)	__	4	__	50	50
	TOTAL				**29**	**150**	**400**	**550**

SEMESTER – III

Sl.No	Nature of Course	Course Code	Paper Title	Units	Credits	Marks		
						Mid-Sem.	End-Sem.	Total
12	Hard Core	HC-301	Spectroscopy-II	5	5	20+10	70	100
13	Hard Core	HC-302	Pericyclic Reaction & Photochemistry	5	5	20+10	70	100
14	Hard Core	HC-303	Physical Chemistry **(Practical**	__	5	20+10	70	100
15	Core Elective	CE-301	A. Biochemistry B. Bio-inorganic and Supramolecular Chemistry (Theory)	5	5	20+10	70	100
16	Core Elective	CE-302	A. Organo transition Metal Complexes OR B. Solid State Chemistry (Theory)	__	5	20+10	70	100
17	Field Internship	FI-301	Field Internship	__	3	__	50	50
	TOTAL				**28**	**150**	**400**	**550**

SEMESTER – IV

Sl.No	Nature of Course	Course Code	Paper Title	Units	Credits	Marks		
						Mid-Sem.	End-Sem.	Total
18	Hard Core	HC-401	Organic Synthesis	5	5	20+10	70	100
19	Hard Core	HC-402	Applied Chemistry (**Practical**)	__	5	20+10	70	100
20	Hard Core	HC-403	Dissertation	__	5	30	70	100
21	Core Elective	CE-401	A. Spectroscopy-III OR B. Analytical Chemistry (Theory)	5	5	20+10	70	100
22	Allied Core	AC-401	Theory:"Women & Society" (For all PG subjects/ Programs)	3	3	10+5	35	50
	TOTAL				**23**	**105**	**345**	**450**

Summary

HC-HARD CORE	14 X 100	1400
CE-CORE ELECTIVE	4X100	400
OE-OPEN ELECTIVE	1X50	50
AC-ALLIED CORE	2X50	100
FI-FIELD INTERNSHIP	1X50	50
TOTAL MARKS :		**2000**

Summary

SEMESTER	**CREDITS**	**TOTAL MARKS**
SEMESTER-I	23	450
SEMESTER-II	29	550
SEMESTER-III	28	550
SEMESTER-IV	23	450
TOTAL	**103**	**2000**

PO1: Critical Thinking: Students will have the capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, and beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development

PO2: Effective Communication: Students will acquire the ability to express thoughts and ideas effectively in writing and orally in English and regional and make meaningful interpretation by people, ideas, books, media and technology.

PO3: Social Interaction: Elicit views of others, mediate disagreements and help reach conclusions in group settings.

PO4: Effective Citizenship: Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO5: Values and Ethics: Recognize different value systems including own, understand the moral dimensions of different decisions, and accept responsibility for them.

PO6: Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.

PO7: Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes

Programme Specific Outcomes (PSOs):

At the completion of the M.Sc. Analytical Chemistry program, the students of our Department willable to:

PSO1: Work in the interdisciplinary and multidisciplinary areas of chemical sciences and its aapplications.

PSO2: Analyse the data obtained from sophisticated instruments (like FTIR, NMR, and Apply green/sustainable chemistry approach towards planning and execution of research in frontier areas of chemical sciences.

PSO3: Have sound knowledge about the fundamentals and applications of chemical and scientific theories

PSO4: Apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and in industries.

PSO5: Helps in understanding the causes of environmental pollution and can open up new methods for environmental pollution control.

PSO6: Acquires the ability to synthesize, separate and characterize compounds using laboratory and instrumentation techniques.

PSO7: Carry out experiments in the area of organic analysis, estimation, separation, derivative process, and inorganic semi micro analysis, and preparation, conductmetric and potentiometric analysis. Learns about the potential uses of analytical industrial chemistry, medicinal chemistry.

PSO8: Understands the background of organic reaction mechanisms, complex chemical structures, and instrumental method of chemical analysis, molecular rearrangements and separation techniques.

Semester-I

HC-101

CH-101: INORGANIC CHEMISTRY-I

COURSE OBJECTIVE:

1. To discuss the concepts of Stereochemistry and bonding in main group compounds.

2. To know about metal ligand equilibria in solution.

3. Reaction mechanism of transition metal complexes, metal clusters etc.

UNIT-I

Stereochemistry and bonding in main group compounds:

VSEPR theory, Bent Rule and energetics of hybridisation, Walsch diagram (tri and penta atomic molecules), dz-pπbonds ,some simple reactions of covalently bonded molecules.

Wade's rule, styx number, carboranes, isolobal analogy, Lipscom topology, applications of boron compounds.

UNIT-II

Metal-ligand equilibria in solution:

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

UNIT-III

Reaction mechanism of transition metal complexes (I):

Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic applications of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism.

UNIT-IV

Reaction mechanism of transition metal complexes (II):

Anation reactions, Reactions without metal-ligand bond cleavage, Substitution reactions in square planar complexes, the Trans effect, mechanism of one electron transfer reaction, outer sphere type reactions, cross reactions and Marcus-Hush theory, Inner sphere type reactions.

UNIT-V:

Metal π- complexes:

Metal carbonyls, Structure and bonding, Important reactions of metal carbonyls, preparation, bonding structure and important reactions of Transition metal Nitrosyl, Dinitrogen and Dioxygen complexes ligands.

Metal clusters: Metalloboranes, Metallocarboranes, Metal carbonyls and Metal halide complexes

Books and references:

1. *Advanced Inorganic Chemistry: A Comprehensive Text*: F.A. Cotton and G. Wilkinson, John Wiley
2. *Inorganic chemistry,* J.E.Huheey, E.A. Keiter, R.L. Keiter, O.K. Medhi, 4th edition, Pearson education, (2006)

3. *Advanced Inorganic Chemistry:* F.A. Cotton, M. Bochmann, C.A. Murrilo, G. Wilkinson, 6th Edition, Wiley India(2007)
4. *Fundamental concepts of inorganic chemistry,* Vol. 2,4,&5; Asim K. Das, CBS publisher, 2nd edition,(2013)
5. *Comprehensive Co-ordination Chemistry eds:* G. Wilkinson,R.D. Gillards and J. A. Mc Cleverty, Pergamon (2003)
6. *Inorganic Chemistry;* K.F. Purcell & J. C. Kotz, Cengage Learning, Indian Ed.(2010).

COURSE OUTCOMES:

After reading this paper, students will be able to have

CO1 Students will understand stereochemistry and they will distinguish the stereochemistry of different inorganic compounds and ions.

CO2 They will be able to predict structures of main group compounds.

CO3 They will able to analyze the point group of various molecules.

CO4 Students will learn to apply the great orthogonality theorem by the use of character tables.

CO5 Students will be able to identify the synthesis and applications of main group elements like Boranes, Carboranes, Silicones, Silicates, Boron nitri de,Borazines, Phosphazenes etc. and also about Hydrides, Oxides and Oxoacids of pnictogens (N,P), chalcogens (S, Se &Te) and halogens, Xenon compounds, Pseudo halogens and Interhalogencompounds

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**2**	**3**	**1**	**2**	**2**	**1**	**3**	**2**	**3**
CO2	**3**	**2**	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**2**
CO3	**3**	**2**	**2**	**2**	**3**	**2**	**1**	**2**	**2**	**3**
CO4	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**3**	**3**	**2**
CO5	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**3**

Semester-I

HC-102

CH-102: ORGANIC CHEMISTRY-I

COURSE OBJECTIVE:

1. To introduce the students to thereaction dynamics i.e., the study ofreaction mechanism.

2. Stereochemistry of the reactant molecules, intermediate and the products.

UNIT-I

Reaction mechanism:

Types of mechanism, types of reactions, thermodynamics and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin- Hammett principle, Potential energy diagrams, transition states and intermediates, methods of determining mechanism, isotope effects, hard and soft acids and bases.

UNIT-II

Structure and reactivity,

Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. Effect of structure on reactivity, resonance and field effect, steric effect, quantitative treatment. The Hammet equation and linear free energy relationships, substituent and reaction constants. Taft equation.

UNIT-III

Aliphatic Nucleophillic Substitution:

The SN^2, SN^1, mixed $SN^1$and SN^2 and SET mechanisms.t6he neighbouring group mechanism, neighbouring group participation by σ and π bonds, anchimetric assistance, Nucleophillic substitution at an allylic , aliphatic trigonal and a vinylic carbon.

Reactivity effects of substrate, structure, attacking nucleophile , leaving group and reaction medium, phase transfer catalysis and ultrasound , ambient nucleophile, regioselectivity.

Aliphatic electrophilic substitution

Bimolecular mechanism-S_E2 and S_Ei. The S_E1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and solvent polarity on the reactivity.

UNIT-IV:

Aromatic nucleophilic substitution: the S_NAr, SN^i Benzyne and SR_N1 mechanism, reactivity – effect of substrate structure, leaving group and attacking nucleophile, the Von-Richter, Sommelet-Hauser and Smiles rearrangements.

Aromatic Electrophillic 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, Vilsmeier reaction, Gattermann-Koch reaction.

UNIT-V

Elimination reactions:

The E2, E1 and E1CB mechanisms. Orientation of free double bonds. Reactivity: effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination. Some name reactions involving elimination mechanism (Dehydration of alcohols, dehalogenation of vicinal dihalide, Peterson Elimination reactions, Hydro alkoxy elimination).

Books and References:

1. *Organic chemistry*: J. Clayden, N. Greeves, S,Warren and P.Wothers, Oxford University, Press
2. *Advanced organic chemistry reactions* , Mechanism and Structure:JerryMarch, John Wiley and Sons.
3. *Advanced organic Chemistry*:F.A.Carey and R.J. Sundberg. Plenum
4. *A Guide Book to Mechanism in Organic Chemistry:* Peter Sykes, Longman/ Pearson Education
5. *Structure and mechanism in Organic Chemistry:* C.K.Ingold. Cornell University Press
6. *Organic Chemistry:* R.T.Morrison and R.N.Boyd, Prentice Hall/ Pearson Education.

7. *Modern synthetic Reactions: second edition*, H.O.House, Benjamin, Menlo Park, 1972
8. *Reaction Mechanism in Organic Chemistry*, S. M. Mukherjee and S. P. Singh , Macmillan
9. 9. *Principles of Organic Synthesis*: R. O. C. Norman and J. M. Coxon. Blackie Academic and Professional / CBS Publishers.
10. *A logical Approach to Modern Organic Chemistry*: Dr. Jagdamba Singh and Dr. S. Anandvardhan. Pragati Prakasan.
11. *Advanced Organic Chemistry*: Reactions and Mechanism: B. Miller and R. Prasad. Pearson-Education.
12. *Stereochemistry of Organic Compounds*: D. Nasipuri, New Age International.
13. *Stereochemistry of Organic Compounds*: P. S. Kalsi, New Age International.
14. *Stereochemistry of Organic Compounds*: E. L. Eliel and S. H. Wilen. John Wiley.
15. *Stereochemistry, Conformation and Mechanism*: P. S. Kalsi, New Age International.

COURSE OUTCOMES:

After reading this paper, students will be able to have

CO1 Students will be able to explain reaction mechanism, kinetics and thermodynamics of organic reaction.

CO2 Students will be able to identify examples of various types of reactions and their application.

CO3 Students will be able to analyze the mechanism involved in organic reactions.

CO4 Students will be able to identify several name reactions with free radical, elimination reactions.

CO5 Students will understand the aromatic electrophilic & nucleophile reactions.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3	2	3	2	3
CO2	3	2	3	3	2	2	2	3	3	2
CO3	3	3	3	2	3	3	2	3	2	3
CO4	3	2	3	3	3	2	2	3	3	2
CO5	3	3	3	3	2	3	2	3	3	3

Semester-I

HC-103

CH-103: PHYSICAL CHEMISTRY-I

COURSE OBJECTIVE:

The topics covered the quantum chemistry, approximation methodsandstructure and bonding.

UNIT-I; Quantum Chemistry;

Postulates of quantum mechanics, Schrodinger's equation and discussion of solutions of the Schrodinger's equation to some model systems i.e. particle in one dimensional box, the Harmonic Oscillator, the Rigid Rotator, The Hydrogen atom.

UNIT-II: Approximation Methods:

The variation theorem, linear variation principle, perturbation theory (first order and non-degenerate), applications of variation method and perturbation theory to Helium atom

Angular Momentum: Ordinary angular momentum, generalised angular momentum, eigen function for angular momentum, eigen values of angular momentum, operator using ladder operators, addition of angular moments, spin, anti-symmetry and Pauli exclusion Principle.

UNIT-III: **Electronic Structure of atoms**: Multi electron atoms, electronic configuration, Russel -Saunders Coupling schemes, magnetic effects, spin- orbit coupling and Zeeman splitting.

UNIT-IV: Molecular Orbital Theory: H_2^+ and H_2 molecule: Valence bond Theory (VBT) and molecular orbital theory (MOT) approaches, Homonuclear and heteronuclear diatoms, Huckel theory of conjugated systems, bond order and charge density calculation, applications to ethylene, butadiene, cyclopropenyl radical and cyclobutadiene.

UNIT-V:

Unifying principles:

Interaction of electromagnetic radiation with matter: absorption, emission, transmission, uncertainty relation and natural line width and natural line broadening, transition probability, results of the time dependent perturbation theory, transition moment and intensity of spectral lines.

Books and References:

1. Physical Chemistry. P.W.Atkins and J.D.Paulo, Oxford, 2013, 10th edition, New Delhi
2. Introduction to quantum chemistry, A.K.Chandra, Tata Mc Graw Hill, 1997,4th edition, New Delhi.
3. Quantum Chemistry, R.K.Prasad, New Age International (P) Ltd.
4. Quantum Chemistry through problems and solutions, R.K.Prasad, New Age International (P) Ltd.
5. Physical Chemistry, T. Engel and P.Reid, Pearson, 2006, 1st Edition, New Delhi
6. Physical Chemistry Vol-II, K.L. Kapoor, Mc millan Publication
7. *Quantum Chemis*try: Ira N. Levine, Prentice Hall.
8. D. A. McQuarrie and J. D. Simon, *Molecular Thermodynamics*, University Science Books, California 2004.
9. R. S. Berry, S. A. Rice and J. Ross, *Physical Chem*istry, 2nd Edition, Oxford University Press, Oxford 2007.
10. D. A. McQuarrie, *Statistical Mechanics*, University Science Books, California (2005).
11. B. Widom, *Statistical Mechanics - A Concise Introduction for Chemists*, Cambridge University Press 2002.
12. D. Chandler, *Introduction to Modern Statistical Mechanics*, Oxford University Press 1987.
13. *Statistical Thermodynamics*: M. C. Gupta, New Age Pvt Publication..

COURSE OUTCOMES:

After reading this paper, students will be able to have

CO1 Students will be able to analyse concepts and realization of the development of scientific ideas about structure and bonding.

CO2 Students will be able to analyze the application of quantum chemistry.

CO3 Students will be able to identify the applications of variation method and perturbation theory to the Helium atom.

CO4 Students will understand the VBT and MOT foratoms.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3	2	3	2	3
CO2	3	2	3	3	2	2	2	3	2	2
CO3	3	2	3	2	2	3	2	3	2	3
CO4	3	2	3	3	3	2	2	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3

Semester-I

HC-104

CH-104: INORGANIC CHEMISTRY-Practical

COURSE OBJECTIVE:

1. How to classify acid and basic radicals into different groups and their chemical analysis.

2. Synthesis of some selected inorganic complexes is also covered under this course.

1. **Qualitative analysis of inorganic mixture**

   Semi-micro qualitative analysis of inorganic mixtures containing (not more than six radicals) three anions, common cations, less common metal ions (W, Mo, Ce, Th, Zr, V and U) and insoluble (sulphates, oxides, halides)

2. **Ion exchange Chromatography:**

   Separation of mixture of cations and anions by

   a) Paper chromatography

   b) Column chromatography- ion exchange: Co(II)/Ni(II); Cd(II)/Mg(II)

3. **Preparation of following compounds and their studies by elemental, IR and electronic spectra measurement.**
   a) cis- $K[Cr(C_2O_4)_2(H_2O)_2]$
   b) $K_3[Fe(C_2O_4)_3]$
   c) $[Ni(NH_3)_6]Cl_2$
   d) $Ni(dmg)_2$
   e) Potassium tri-(oxalato) aluminate(III)
   f) Tetraaminecopper(II)sulphate

Books Recommended:

1. Vogel's Qualitative inorganic Analysis, 7th Ed, Revised by G. Svehela, 4t Ed, Pearson (2007)
2. An Advanced Course OF Practical Chemistry, Nad, Ghosal and Mahapatra, Central Publisher(2000)
3. Practical inorganic chemistry, Z.Szafran, R. M.Pike and M.M.Singh, Wiley.

COURSE OUTCOMES:

After reading this paper, students will be able to have

CO1 Students will be able to understand the knowledge inorganic salts and insoluble inorganic samples.

CO2 Students will be able to identify the tests used to detect inorganic salts and insoluble inorganic samples.

CO3 Students will be able to analyze mixture of inorganic salts and insoluble inorganic samples.

CO4 Students will able to identify acid and basic radicals in a sample of unknown mixtures.

CO5 Students will able to handle air and moisture sensitive chemicals for the synthesis and study of complexes and inorganic reactions.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	2	3	2	3
CO2	3	2	3	3	2	2	2	3	3	2
CO3	3	3	3	2	3	3	2	3	2	3
CO4	3	2	3	3	3	2	2	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3

Semester-II

HC-201

CH-201: INORGANIC CHEMISTRY-II

COURSE OBJECTIVE:

1. Introduce students to chemistry of transition and inner transition elements and chemistry of lanthanides and actinides.

2. This course deals with the electronic spectra of transition metal complexes, the nature of metal-ligand bonding and coordination chemistry of metalions.

UNIT-I: Metal-Ligand Bonding:

Crystal -Field theory: limitations of crystal Field Theory, Molecular Orbital theory for octahedral, tetrahedral and square planar complexes, σ and π bonding in Molecular Orbital Theory, Applications of MOT to Corelation diagrams.

UNIT-II: Electronic spectra and magnetic properties of transition metal complexes:

Spectroscopic ground states, correlation, Orgel and Tanabe- Sugano Diagrams for Transition metal complexes (d1- d9 states), calculations of Dq, B and β parameters, Charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchanges coupling and spin cross over.

UNIT-III: Magneto Chemistry and EPR : Induction and susceptibility, Lande interval Rule, calculation of g- Values, Van-Vleck's equation and its use, effect of spin orbit coupling, magnetic properties of AET terms with reference to Co(I) and Ni(II) complexes.

Electron paramagnetic resonance spectroscopy: Hyperfine splitting, spin-orbit coupling, significance of g-tensor, Zerofield splitting, Kramer's degeneracy, Application to inorganic systems.

UNIT-IV: Chemistry of Inner Transition Elements:

Chemistry of lanthanides and actinides, lanthanide contraction, separation of lanthanide elements, oxidation state, spectral and magnetic properties, stereochemistry, use of lanthanide compounds as Shift reagents, Actinide contraction, oxidation states, comparison between lanthanides and actinides.

UNIT-V: Symmetry and Group theory in Chemistry:

Symmetry elements and symmetry operations, definitions of group, subgroup, relation between orders of a finite group and its subgroup, conjugacy relation and classes, generators, point symmetry group.

Representations of group operators, the great orthogonality theorem (without proof) and its explanation, Irreducible and reducible representation, bases of representation, character of a representation, character table and its meaning, reduction formula.

Books and References:

1. Advanced Inorganic Chemistry, F. A. Cotton, M. Bochmann, C. A. Murillo, G. Wilkinson,

6 th Ed., Wiley India (2007).

2. Inorganic Chemistry, J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, 4th Ed., Pearson Education (2006).

3. Chemistry of the Elements, N.N. B. Greenwood and A. Earnshow, Pergamon, 2nd Ed (1997)

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

5. Magnetochemistry, R.L.Carlin, Springer Verlag.

6. Comprehensive Coordination Chemistry eds., G.Wilkison, R.D.Gillars and J.A.Mc Cleverty, Pergamon.

7. Elements of Magneto Chemistry, R. L. Dutta, A. Syamal; 2nd Ed. East West Press Pvt Ltd (2009).

8. Fundamental Concepts of Inorganic Chemistry, Vol. 5; Asim K. Das, CBS Publisher, (2015).

9. Fundamental Concepts of Inorganic Chemistry, Vol. 6; Asim K. Das, CBS Publisher, 2nd Ed., (2013).

10. Organometallic Chemistry, R.C. Mehrotra & A. Singh, New Age International, 2nd Ed (2013).

11. Inorganic Chemistry, C. L. Miessler, D. A. Tarr, Pearson, 3rd Ed., (2004)

COURSE OUTCOMES:

After reading this paper, students will be able to have

CO1 Students will apply scientific knowledge to understand CFT and MOT of transition metal complexes.

CO2 Students will be able to analyse Orgel and Jahn-Teller diagrams, structure of mixed metal oxides and chemistry of inner transition elements.

CO3 Students will be able to analyze the chemistry of transition metal complexes and transition elements.

CO4 Students will be able to identify the CFSE of various metal complexes.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3	2	3	2	3
CO2	3	2	3	3	2	2	2	3	2	2
CO3	3	2	3	2	2	3	3	3	2	3
CO4	3	2	3	3	3	2	3	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3

CO5 Students will understand the various bonding in metal-ligand complexes.

Semester-II

HC-202

CH-202: ORGANIC CHEMISTRY-II

COURSE OBJECTIVE:

1. This course deals with brief understanding of nature of bonding inorganic compounds and stereochemical aspects.

2. Different types of addition reaction to carbon-carbon double bonds and carbon-hetero multiple bonds, different classes of pericyclic reactions are introduced in this course.

3. Students are also introduced to target oriented synthesis through retrosynthetic approaches

UNIT-I:

Stereochemistry:

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

Elements of Symmetry, Chirality, Molecules with more than one chiral centre, threo and erythron isomerts, methods of resolution, optical purity, enantiotropic and diastereotropic atoms, groups and faces, stereospecific and stereoselective synthesis, asymmetric synthesis, optical activity in the absence of chiral carbon atoms (biphenyls: allenes and spiranes), chirality due to helical shape, stereochemistry of the compounds containing nitrogen, sulphur and phosphorus.

UNIT-II

Free radical reactions: Types of free radical reactions: free radical substitution, mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead, reactivity in the attacking radicals, the effect of solvents on reactivity, Allylic halogenation(NBS), oxidation of aldehydes to carboxylic acids, autooxidation, coupling of alkynes and acylation of aromatic compounds by diazonium salts, Sandmeyer's reaction. Free radical rearrangements, Hunsdiecker reaction

UNIT-III:

Addition to carbon- carbon multiple bonds: Mechanistic and stereochemical aspects of addition reactions, hydrogenation, halogenation, hydrohalogenation, hydroboration, oxymercuration, sulfenylation, selenylation, 1.3-dipolar species addition, hydroxylation: Prevost &Woodward hydroxylation, using $KMnO_4$ and OsO_4, Epoxidation, Sharpless asymmetric epoxidation, Michael reaction, Prins reaction, addition to cyclopropane ring, addition to conjugated systems.

UNIT-IV: Addition to carbon- Hetero multiple bonds;

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles, addition of Grignard' reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds, Wittig reaction.

Mechanism of condensation reactions involving Enolates- Aldol, Knoevenagel , Claisen, Mannich, Benzoin, Perkin and Stobbe reactions

UNIT-V;

Rearrangements: A detailed study of the following rearrangements;

Pinacol-Pinacolone , Wagner- Meerwein, Demjanov, Benzil-Benzillic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hoffmann, Curtius, Schmidt, Bayer-Villiger, Shapiro reaction.

Books and References:

1. *Organic chemistry*: J. Clayden, N. Greeves, S. Warren and P. Wothers, Oxford University Press.

2. *Advanced Organic Chemistry Reactions, Mechanism and Structure*: Jerry March. John Wiley and Sons.

3. *Advanced Organic Chemistry*: FA Carey and RJ. Sundberg. Plenum.

4. *Photo Chemistry and Pericyclic Reactians*: Jagdamba Singh and Jaya Singh, New Age Internatianal.

COURSE OUTCOMES:

After reading this paper, students will be able to have

CO1 Students will be able to explain the bonding of complex polyenes, aromaticity.

CO2 Students will be able to analyse the idea of reaction mechanism of carbonyl compounds and get an insight into different theories and application of pericyclic reactions.

CO3 Students will be able to design logical synthetic steps toward synthesis of a target molecule.

CO4 Students will identify the concepts of various pericyclic reactions and disconnection approach.

CO5 Students will be able to discuss about stereochemistry of organic compounds.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**2**	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**3**
CO2	**3**	**2**	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**
CO3	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**3**
CO4	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**2**

CO5	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**3**

Semester-II

HC-203

CH-203: PHYSICAL CHEMISTRY-II

COURSE OBJECTIVE:

1. To discuss about classical and statistical thermodynamics.

2. To discuss Surface chemistry including adsorption and surface tension. An outline on micelles is provided here.

3. The course also deals with electrochemistry and ion-ion, ion-solvent interactions and electrodics.

4. Lastly, an introduction to error analysis is given.

UNIT-I: Classical Thermodynamics:

Brief resume of concepts of laws of thermodynamics, entropy and free energy. The concept of chemical potential and partial molar properties: partial molar free energy, partial molar volume and partial molar heat content and their significance. Determination of these quantities, concept of fugacity and determination of fugacity, activity activity coefficient.

UNIT-II: Statistical Thermodynamics:

Concept of distribution, thermodynamic probability and most probable distribution, Ensemble averaging, postulates of ensemble averaging, Canonical, grand canonical and micro canonical ensembles, corresponding distribution laws (using Lagrange's method of undetermined multipliers)

UNIT-III: Partition functions- translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition function, Fermi-Dirac statistics, distribution law and application to metal, Bose- Einstein statistics-distribution law and application to helium.

UNIT-IV: Electrochemistry:

Electrochemistry of solutions, Debye- Huckel; Onsager treatment and its extension, ion-solvent interactions, Debye-Huckel- Bjerrum model, solution of strong electrolytes,

Debye-Huckel theory for activity coefficient of electrolytic solutions, determination of activity and activity coefficients: ionic strength.

UNIT-V: Electrodics:

Thermodynamics of electrified interface equations, derivation of electrocapillarity. Lippmann Equations (surface excess), methods of determination, structure of electrified interfaces, over potentials, exchange current density, derivation of Butler-Volmer equation, tafel plot, Interface theory of double layer at semiconductor- electrolyte solution interfaces, effect of Light at semiconductor solution interface.

Books and References:

1. Physical Chemistry, P.W.Atkins and J. D. Paulo, Oxford, 2013, 10th edition New Delhi.

2. Introduction to Quantum Chemistry, A.K.Chandra, Tata McGraw Hill, 1997, 4th edition, New Delhi.

3. Quantum Chemistry, Ira N. Levine, Pearson, 2007, 5th edition, New Delhi.,

4. Quantum Chemistry, D. A. McQuarrie and Simon, Viva, 2007, 1st edition, New Delhi.

5. Molecular Quantum Mechanics, Atkins and Friedman, Oxford Univ. Press, 1997, 3rd edition, New York.

6. Quantum Chemistry, J. P. Lowe, Academic Press, 2nd edition, New York.

7. Quantum Chemsitry- R.K. Prasad, New Age International (P) Ltd .

8. Quantum Chemsitry through problems and solution- R. K. Prasad, New Age International (P) Ltd .

9. A textbook of Physical chemistry – H.K. Moudgil

10. Physical Chemistry, T. Engel and P. Reid, Pearson, 2006, 1st edition, New Delhi.

11. Thermodynamics, G. N. Lewis and M. Randall, McGraw Hill, 2nd edition, 1961, New York.

12. Molecular Thermodynamics, D. A. McQuarrie and Simon. Viva, 2009, 1st edition, New Delhi.

13. Non Equilibrium Thermodynamics, S.R. deGroot and Mazur, Dover, New York.

14. Introductory Statistical Thermodynamics, T. Hill, Dover, 1986, New York.

15. Statistical Thermodynamics, Oxford, Oxford Chemistry Primer vol. 58, 1997.

16. Introduction to Statistical Mechanics, R. Bowley and M. Sanchez, Clarendon press,

17. Statistical Mechanics and Thermodynamics, C. Garrod, Oxford Univ. Press, 1995, New York.

18. Introduction to thermodynamics of irreversible processes, 2nd edition, Interscience, 1961,

New York

COURSE OUTCOMES:

After reading this paper, students will be able to have

CO1 Students will be able to identify micellar systems, CMC, solubilisation and reverse micelles.

CO2 Students will be able to analyse adsorptionisotherms and catalytic activity in surfaces.

CO3 Students will identify the concepts of electrochemistry and ion-ion, ion-solvent interactions and electrodics.

CO4 Students will be able to explain about error analysis.

CO5 Students will be able to identify ion-ion and ion-solvent interactions.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	2	3	2	3
CO2	3	2	3	3	2	2	2	3	2	2
CO3	3	3	3	2	3	3	2	3	3	3
CO4	3	2	3	3	3	2	2	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3

Semester-II

HC-204

CH-204: ORGANIC CHEMISTRY PRACTICAL

COURSE OBJECTIVE:

1. To impart knowledge of basic separation techniques and purification of organic samples using TLC and column chromatography.

2. Synthesis of certain derivatives of amino group and hydroxyl groups and some aromatic nitro compounds are also included in this course.

1. Separation ,purification and identification of compounds of binary mixtures (solid-solid, solid-liquid, liquid-liquid) using TLC and column chromatography
2. **Organic synthesis**:
   a) Preparation of methyl orange
   b) Preparation of anthranilic acid
   c) Preparation of adipic acid by chromic acid oxidation of cyclohexanol
   d) Synthesis of p-Nitro aniline and p- bromo aniline(aromatic electrophilic substitution)
   e) Synthesis of triphenyl methanol from benzoic acid (Grignard's reaction)
3. **Qualitative analysis:**
   Identification of organic compounds having at least two functional groups.
4. **Quantitative Analysis:**
   a) Estimation of Phenol/ Aniline using Bromate- bromide solution.
   b) Determination of iodine and saponification value of an oil sample
   c) Determination of ascorbic acid in Vitamin C tablets.

COURSE OUTCOMES:

After reading this paper, students will be able to have

CO1 Students will be able to purify and separate a mixture of organic samples.

CO2 Students will able to perform synthesis of derivatives of simple functional groups and purify them.

CO3 Students will be able to understand the use of TLC and column chromatography.

CO4 Students will identify the functional groups present in organic molecules.

CO5 Students will able to isolate organic compounds from a mixture of organic samples.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	2	3	3	3
CO2	3	3	3	3	2	2	2	3	2	2
CO3	3	2	3	2	2	3	2	3	3	3
CO4	3	2	3	3	3	2	2	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3

Semester-II

CE-201

CH-205(A): ORGANIC SPECTROSCOPY-I

COURSE OBJECTIVE:

1. Structure determination of organic molecules using spectroscopic method such as ultra violet (UV), infrared (IR), nuclear magnetic resonance (NMR) spectroscopy of 1 H and 13C and mass spectroscopy (MS).

2. This course introduces the basic principles of electronic transition, selection rule, molecular vibrations and absorption of electromagnetic radiation.

3. Also nuclear spin and interaction of radiation with nucleus and fundamental principle of NMR spectroscopy is discussed. 2D NMR is also discussed such as COSY, NOESY, DEPT, and APT for structure determination.

4. Basic principles, instrumentation and application of MS are also covered.

UNIT-I:

Ultra violet and visible spectroscopy:

Various electronic transitions, beer-lambert's law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, Woodward -Fieser rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds, steric effect in biphenyls.

UNIT-II:

Infrared spectroscopy:

Instrumentation and sample handling, characteristics vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detail study of vibrational frequencies of carbonyl; compounds (ketones, aldehydes. Esters. Amides. acids, acid anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi Resonance, FTIR , IR of gaseous, solid and polymeric materials.

UNIT-III:

Nuclear Magnetic Resonance Spectroscopy (NMR):

Nuclear spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift and its measurements, factors influencing chemical shift, deshielding, spin-spin interactions, factors influencing coupling constant'J'. Classification (ABX, AMX, ABC, A2B2 etc). Spin-decoupling use of NMR in medical diagnostics.

UNIT-IV:

Carbon-13 NMR Spectroscopy: General considerations, chemical shift (aliphatic,olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants, two dimension NMR spectroscopy-COSY, NOESY, DEPT, APT and INADEQUATE technique.

UNIT-V:

Mass Spectrometry;

Introduction. Ion production- EI, CI, and FAB factors affecting fragmentation, ion analysis, ion abundance, mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, Mc-lafferty rearrangement, nitrogen rule, high resolution mass spectrometry, examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

Books and References;

1. Spectrometric identification of organic compounds, 6^{th} edition: Silverstein, R.M.: Webster, F.X.:Wiley: New York, 1998
2. Organic structural spectroscopy, Lambert, J.B.: Shurvell, H.F., Prentice Hall, 1998.

3. Organic spectroscopy: Kemp, W. 3rd edition: Macmillan Education: Hound mills, Basing stoke, Hampshire, 1991.
4. Levitt, Malcolm H.; *Spin Dynamics-Basics of Nuclear Magnetic Resonance*, Second edition; John Willey & Sons Ltd.

COURSE OUTCOMES:

After reading this paper, students will be able to have

CO1 Students will understand various spectroscopies such as UV, IR, NMR, MS.

CO2 Students will be able to demonstrate the skill about the instrumentation of UV, IR, NMR, MS.

CO3 Students will calculate the absorption maxima of conjugated molecules using Woodward rule.

CO4 Students will be able apply the idea of functional groups present in a molecule from IR spectroscopic idea.

CO5 Students will elucidate the structure and molecular mass of small organic molecules by using UV,IR,NMR, MS.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3	2	3	2	3
CO2	3	2	3	3	2	2	3	3	3	2
CO3	3	2	3	2	2	3	2	3	2	3
CO4	3	2	3	3	3	2	2	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3

Semester-II

CE-201

(B) POLYMER CHEMISTRY

COURSE OBJECTIVE:

1. To introduce the about the fundamental aspects of polymers, their synthesis, their properties and their uses in various commercial sectors.

2. Brief idea about nano world

UNIT-I:

Basic concepts of Polymer Chemistry:

Importance of polymers, monomers, repeat units, degree of polymerisation, linear, branched and network polymers, Classification of polymers, Polymerisation Process- condensation, addition, radical chain, ionic and coordination and co-polymerisations. Polymerization conditions and polymer reactions, Polymerisation in homogeneous and heterogeneous systems.

UNIT-II

Polymer characterization methods:

Polydispersion- average molecular weight concept, number, weight and viscosity average molecular weights, polydispersity and molecular weight distribution, the practical significance of molecular weight. Measurement of molecular weights- end group, viscosity, light scattering, osmotic and ultracentrifugation methods.

UNIT-III;

Analysis and testing of polymers,

Spectroscopic methods: IR, UV , X-RAY diffraction, Microscopic analysis: optical, SEM, and TEM, thermal analysis- TGA, DSC, DTA, DMA and physical testing- Tensile strength, Flexural strength, Fatigue, Impact Strength, tear resistance, hardness and abrasion resistance.

UNIT-IV;

Morphology and order in crystalline poymers-configuration of polymer chains, crystal structure of polymers-crystalline , amorphous structure, factors affecting crystallinity, degree of crystallinity, techniques to determine the degree of crystallinity

Glass transition temperature, effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking on glass transition temperature,

Tm- factors affecting Tm (chain flexibility, steric factor, entropy and heat of fusion), relation between Tg and Tm.

UNIT-V:

Properties of commercial Polymers:

Polyethylene, PVC, Poly amides, polyesters, Phenolic resins, epoxy resins and silicone polymers, Functional polymers- Fire retarding polymers and electrically conducting poymers (PANI, Poly acetylene). Polymer in biomedical applications: contact lens, dental polymers, artificial heater, kidney, skin and blood cells.

Books and References;

1. Text book of Polymer Science, F.W. Billmeyer, Jr.Wiley.

2. Polymer Science, V.R. Gowariker, N.V. Viswanathan and J. Sreedhar, Wiley-Eastern.

3. Functional Monomers and Polymers, K. Takemoto, Y. Inaki and R.M. Ottanbrite.

4. Contemporary Polymer Chemistry, H.R. Alcock and F.W. Lambe, Prentice Hall.

COURSE OUTCOMES:

After reading this paper, students will be able to have

CO1 Students will define and identify about polymeric systems, their classifications, the naming and their properties.

CO2 Students will apply gain knowledge of various synthetic methods for polymers for analysis.

CO3 Students will be able to explain and demonstrate idea about polymerization process, glass transition, crystallinity and morphology of polymers.

CO4 Students will understand about the preparation, properties and uses of natural and synthetic polymer.

CO5 Students will analyse idea about nanotechnology and its application.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3	2	3	2	3
CO2	3	2	3	3	1	2	2	3	2	2
CO3	3	2	3	2	2	3	3	3	2	3
CO4	3	2	3	3	3	2	2	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3

Semester-II

OE-201

CH 206: ENVIRONMENTAL CHEMISTRY

COURSE OBJECTIVE:

1. To acquaint the student with a basic understanding of the concept and structure of environment, about the chemical composition of the different matrices of the environment (air, water, soil) and the interaction involved between them.

2. Understand different types of air, water, soil and radiation pollution and its consequences, different steps of waste management.

3. To study about different industrial effluents, pollution by industry and their remedies, global environmental issues and disasters, and green solution to environmental problems.

UNIT-1

Environment

Introduction, composition of atmospheres, vertical temperature, heat budgetof the earth atmospheric system, vertical stability atmosphere, biogeochemical cycles of C, N,P,S and O, Bio distribution of elements

UNIT-II;

Hydrosphere;

Hydrological cycle. Aquatic pollution- inorganic, organic, pesticides, agricultural, industrial and sewage, detergents, oil spills and oil pollutants, water quality parameters-dissolved oxygen, biochemical oxygen demand, solids, metalsm, content of chloride, sulfate, phosphate, nitrate and micro-organism, water quality standards.

Analytical methods for measuring BOD, DO, COD ,F, Oils, metals (As, Cd, Cr, Hg, Pb, Se etc.) residual chloride and chlorine demand. Purification and treatment of water.

UNIT-III:

Atmosphere:

Chemical composition of atmosphere- particles, ions and radicals and their formation. Chemical and petrochemical reactions in atmosphere, smog formation, oxides of N, C, S, O and their effect, pollution by chemicals, petroleum, minerals, chlorofluoro hydrocarbon, greenhouse effect, acid rain, air pollution controls and their chemistry.

Analytical methods for measuring air pollutants, continuous monitoring instruments.

UNIT-IV:

Industrial pollution:

Pollution obtained due to cement, sugar, distillery, drug, paper and pulp, thermal power plants, nuclear power plants, polymers industry, steps to reduce pollution. Radionuclide analysis, solid waste management, disposal of wastes and their management.

Books and References;

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

2. Environmental Chemistry, A.K. De, Wiley Eastern.

3. Environmental Chemistry with Green Chemistry, A. K. Das, Books & Allied (P) Ltd., Kolkata, 1 st Edn, 2010.

4. Environmental Toxicology, Ed. J. Rose, Gordon and Breach Science Publication, Elemental

Analysis of Airborne Particles, Ed. S. Landsberger and M. Creatchman, Gordon and Breach Science Publication.

5. Environmental Chemistry, C. Baird, W.H. Freeman

6. Hand Book of Environmental Analysis, Pradyot Patnaik, Lewis Publishers (1997)

7. Standard Methods for the Examination of Water and Wastewater, APHA, AWWA, WPCF,

Washington D.C. 20005, USA, 17th Edition (1998).

COURSE OUTCOMES:

After the completion of course students will able to

CO1 Describe the structure and significance of the spheres of the environment, the important environmental issues and the factors responsible for their cause.

CO2 Understand the significance of environmental science as a subject, explain the chemical nature and interaction of the air, water and soil, apply analytical tools to determine and measure pollutants in various environmental samples.

CO3 Explain environmental pollution issues and the remedies thereof, and understand about green chemistry principles and their applications.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3	3	3	3	3
CO2	3	2	3	3	2	2	3	3	3	2
CO3	3	2	3	2	2	3	2	3	2	3
CO4	3	2	3	3	3	2	3	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3

Semester-III

HC-301

SPECTROSCOPY-II

COURSE OBJECTIVE:

To study molecular spectroscopy such as rotational, vibrational, electronic and ESR. This course also introduces instrumental methods of analysis in ESCA,NQR, IR, polarography, thermal analysis.

UNIT-I: Atomic spectroscopy;

Energies of atomic orbitals, vector representation of momenta and vector coupling, electronic configuration, Russel- saunders terms and coupling schemes, magnetic effects, spin-orbit coupling and Zeeman splitting, spectra of hydrogen atom and alkali metal atoms.

UNIT-II: Molecular spectroscopy:

Energy levels, molecular orbitals, vibronic transitions, vibrational progressions, frank condon principle, electronic spectra of diatomic molecules, electronic spectra of poly atomic molecules, emission spectra, radiative and non-radiative decay, internal conversion, spectra of transition metal complexes (d1 and d9 system), charge transfer spectra.

UNIT-III: Photoelectron spectroscopy

Basic principles, photoelectric effect, ionization process, Koopman's theorem, Photoelectron spectra of simple molecules (H_2,O_2,N_2,CO, H_2O), spectroscopy of core electrons, electron spectroscopy of Chemical Analysis, Chemical information from ESCA, Auger electron spectroscopy- basic idea.

UNIT-IV: Microwave spectroscopy:

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

UNIT-V: Nuclear Quadrupole Resonance Spectroscopy:

Quadrupole nuclei, quadrupole moments, electric field gradients, coupling constants, splittings applications.

Polarography: Current-Voltage Relationship, theory of polarographic waves, instrumentation, qualitative and quantitative application.

Books and References

1. Modern Spectroscopy, J.M. Hollas, John Wiley, 4th edition, Sussex.

2. Applied Electron Spectroscopy for Chemical Analysis Ed. H. Windawi and F.L.Ho, Wiley Inter science.

3. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood, 1st edition, 1990.

4. Physical Methods in Chemistry, R.S.Drago, Sauders College (1992).

5. Chemical Applications of Group Theory, F.A. Cotton. Wiley Inter science, 3rd ed., (1990).

6. Symmetry and Spectroscopy of Molecules, , K.V. Reddy, New Age International (P) Ltd., Ist Ed., (1998).

7. Introduction to Molecular Spectroscopy, G.M.Barrow, McGraw Hill

8. Basic Principles of Spectroscopy, R.Chang, McGraw Hill.

9. Theory and Applications of UV Spectroscopy, H.H.Jaffe and M.Orchin, IBH-Oxford.

10. Introduction to Photoelectron Spectroscopy, P.K.Ghosh, John Wiley.

11. Introduction to Magnetic Resonance, A. Carrington and A.D. Maclachalan, Harper & Row.

12. Inorganic spectroscopic methods, A.K. Brisdon, Oxford Chem. Primers, 1997, New York.

13. Spectroscopy, S. Walker and H. Straw, Chapman and Hall ltd.

14. Energy levels in atom and molecules, W.G. Richards and P.R. Scott, Oxford, Oxford Chemistry Primer vol. 26, 1994, New York.

15. Atomic Spectra, T.P. Softley, Oxford, Oxford Chemistry Primer, Vol. 19, New York.

16. Introduction to Spectroscopy, Pavia, Brooks/Cole Cenage, 4th edition, 2009, Belmont.

17. Electronic Absorption Spectrocopy and related Techniques- D. Sathyanarayanan

18. Fundamental concept of Inorganic Chemistry vol-7- A.K. Das and Mahua Das, CBS Publisher

19. Fundamental of Molecular Spectroscopy- C. N Banwell, Tata McGraw Hill.

COURSE OUTCOMES:

After the completion of course students will able to

CO1 Students identify and list various spectroscopic techniques.

CO2 The students will understand molecular spectroscopy and their application to different Molecules.

CO3 Students will be able to analyse instrumental methods such as ESCA, NQR, IR, polarography, thermal analysis which will help them in practical life.

CO4 Students will be able to discuss spectroscopy, in particular, rotational, vibrational, electronic and ESR.

CO5 Students able to analyse and interpret knowledge about analysis of data.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**2**	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**
CO2	**3**	**2**	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**
CO3	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**3**
CO4	**3**	**2**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**2**
CO5	**3**	**1**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**3**

Semester-III

HC-302

PERICYCLIC REACTIONS AND PHOTOCHEMISTRY

COURSE OBJECTIVE:

To impart knowledge of pericyclic reactions, photochemistry of alkene, carbonyl compounds and aromatic compounds.

UNIT-I

Pericyclic Reaction:

Molecular orbital symmetry, Fourier orbitals of ethylene, 1,3- butadiene, 1,3,5 -hexatriene and allyl systems, classification of pericyclic reaction, WoodWard -Hoffmann corelation diagrams, FMO and PMO approach. Electrocyclic reactions- conrotatory and disrotatorymotions. 4n,4n+2 and allyl systems, Cycloadditions- antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions.

UNIT-II:

Sigmatropic Rearrangements: suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties, 3,3- and 5,5- sigmatropic rearrangements. Some variants of Claisen rearrangements, Fluxional tautomerism, Ene Reaction

UNIT-III:

Photo chemical reactions

Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule(singlet, triplet state), Jablonski diagram, Excimer, Exciplex, Quantum yield/quantum efficiency, transfer of excitation energy(sensitisation and quenching), Actinometry, types of photochemical reactions- photo dissociation , gas phase photolysis.

UNIT-IV

Photochemistry of alkenes:

Intramolecular reactions of the olefinic bonds- geometrical isomerism, cyclisation reactions, rearrangement of 1,4 and 1,5-dienes, di-π methane arrangements

Photochemistry of carbonyl compounds:

Intramolecular reactions of carbonyl compounds- saturated, cyclic and acyclic, β,γ unsaturated and α,βunsaturated compounds, Norrish type I and II Reaction, Paterno-Buechi reaction, cyclohexadienones, photodimerization of carbonyl compounds.

UNIT-V:

Photochemistry of aromatic compounds:

Ring isomerisation, additions, and substitutions, Cyclisation reaction.

Miscellaneous photochemical reactions:

Photo-Fries Rearrangement, Photo-Fries reactions of anilides, Barton reaction, singlet molecular oxygen reactions, Photochemical formation of smog, photo degradation of polymers.

Books and References;

1. Pericyclic Reactions, S. M. Mukherji, Macmillan, India.
2. Conversion of Orbital Symmetry, R.B. Woodward and R. Hoffman
3. Organic Reactions and Orbital Symmetry,R. C. Storr, T. L Gilchrist
4. Fundamentals of Photochemistry, K.K.Rohtagi-Mukherji, Wilcy-Eastern.
5. Molecular Photochemistry, N.J.Turro, W.a.Benjamin.
6. Introductory Photochemistry, A.Cox and T.Camp. McGraw-Hill.
7. Photochemistry, R.P.Kundall and A.Gibert, Thomson Nelson.
8. Organic Photochemistry, J.Coxon and B.Halton, Cambridge University Press.

COURSE OUTCOMES:

After the completion of course students will able to

CO1 Understand the molecular origin of pericyclic reactions.

CO2 Understand the concept of interaction of organic compounds with light and subsequently trigger the reaction.

CO3 Understand the mechanism photochemistry of alkene, carbonyl compounds and aromatic compounds.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3	2	3	2	3
CO2	3	2	3	3	2	2	2	3	2	2
CO3	3	2	3	2	2	3	2	3	2	3
CO4	3	2	3	3	3	2	2	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3

Semester-III

HC-303

PHYSICAL CHEMISTRY PRACTICAL

COURSE OBJECTIVE:

1. The laboratory course is framed on the basis of instruments such as conductivity meter, pH meter and potentiometer, where a number of experiments based on conductivity measurement, pH measurement and potential measurement can be performed.

2. To study chemical kinetics, energy of activation, saponification experiments and Adsorption experiments.

3. Determination of acid and basic strength by Stereochemistry isalso included.

Chemical kinetics:

1. Saponification of ethyl acetate with sodium hydroxide by chemical method.

2. Comparison of strength of acids by ester hydrolysis.

3. Determination of energy of activation of acid catalysed hydrolysis of methyl acetate.

Adsorption:

1. Adsorption of acetic acid and oxalic acid on animal charcoal.
2. Construction of phase diagram for a three component system (chloroform- acetic acid-water)

Electrochemistry:

1. Determination of solubility and solubility product of sparingly soluble (eg $PbSO_4$, $BaSO_4$) conductometrically.
2. Determination of the strength of strong and weak acids in a given mixture conductometrically

Potentiometry/ pH metry:

1. Determination of the strength of strong and weak acid in a given mixture using a potentiometer/ pH meter
2. Determination of the strengths of halides in a mixture potentiometrically.
3. Determination of the dissociation constant of acetic acid in acetone by titrating it with KOH in water medium.

Polarimetry:

Determination of rate constant for hydrolysis /inversion of sugar using a polarimeter.

COURSE OUTCOMES:

After the completion of course students will able to

CO1 Students will be able to perform saponification Experiments.

CO2 Students performing the experiments will be capable of handling the conductivity meter, pH meter and potentiometer.

CO3 Also it gives a real feel of the electrochemistry, such a verification of Debye-Huckel-Onsager equation, neutralisation of weak acids.

CO4 Determination of K_{sp} of sparingly soluble salt and conductometric titrations, which are taught in theory.

CO5 Students will analyse surface tension.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3	2	3	2	3
CO2	3	2	3	3	2	2	2	3	2	2
CO3	3	2	1	2	2	3	2	1	2	3
CO4	3	2	3	3	1	2	2	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3

Semester-III

CE-301

(A) BIOCHEMISTRY

COURSE OBJECTIVE:

To impart knowledge of biological catalysts, mechanism of enzyme action and reactions catalyzed by enzymes and co-enzyme.

UNIT-I:

Bio physical chemistry- I:

Introduction, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation, nomenclature and classification, Fischer's lock and key and koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity, labelling and enzyme modifications by the site directed mutagenesis.

UNIT-II:

Bio physical chemistry-II:

Enzyme kinetics, Michaelis- Menten and Lineweaver -burk plots, reversible and irreversible inhibition, Transition state theory, Orientation and steric effect, acid base catalysis, covalent catalysis, strain or distortion.

UNIT-III:

Bio-Physical chemistry-III:

Surface active agents, classification of surface active agents, concepts on micelle, micellization, Critical Micellar Concentration, Kraft temperature, Factors affecting theCMC of surfactants, reverse micelles, micro emulsion, Nucleosides and nucleotides, concept of lipids and liposome.

UNIT-IV:

Bio-organic chemistry-I:

Example of some typical enzyme mechanism: chymotrypsin, ribonuclease, lysozyme, carboxypeptidase A. cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes, structure and biological functions of coenzyme A, thiamine pyrophosphate, pyrophosphate, NAD+, NADP+, FMN, FAD, Lipolic acid, Vitamin B12.

UNIT-V:

Bio-organic chemistry-II:

Mechanism of reactions catalysed by cofactors, Nucleophillic displacement on a phosphorous atom, multiple displacement reaction and coupling of ATP cleavage to endergonic processes, transfer of sulfate, addition and elimination reactions, enolic intermediates in the isomerization reactions, β-cleavage and condensation, isomerisation, rearrangement, carboxylation, decarboxylation.

Books and References

1. *Bioorganic Chemistry: A chemical approach to enzyme action*-Hermann Dugas, C. Penny,

Springer Verlag.

2. *Biochemistry (The Chemical reactions of living cells)*: D. E. Metzler, (Academic Press)

3. *Enzyme chemistry Impact and applica*tions, Ed. Collin J. Sucklins, chapman and Hall

4. *Enzyme reaction mechanisim*: C. Walsh and W. H. Freeman.

5. *Enzyme structure and mechanisim*: A. Fersht and W. H. Freeman.

6. *Fundamentals of Biochemistry*: A. C. Daeb, New Central Book Agency, pvt. Ltd.

7. *Biochemistry*: C. B. Powar and G. R. Chatwal, Himalaya publishing House.

COURSE OUTCOMES:

After the completion of course students will able to

CO1 Upon completion of this course students will be able to understand how enzyme catalyzes the reaction with outmost efficiency.

CO2 Acid-base catalysis and covalent catalysis of enzyme, strain and distortion during enzyme catalysis.

CO3Structure and biological functions of various coenzymes, and the origin of mechanism of enzyme action.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3	2	3	2	3
CO2	3	2	3	3	2	2	2	3	2	2
CO3	3	2	3	2	2	3	2	3	2	1
CO4	3	2	3	3	1	2	2	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3

Semester-III

CE-301

(B) BIO-INORGANIC AND SUPRAMOLECULAR CHEMISTRY

COURSE OBJECTIVE:

1. To study the role on the role of metals in biological systems and medicine.

2. To introduce the student on structure, stereochemistry and biological functions of different metalloenzymes.
3. To study the structure and function of biomolecules in nitrogen fixation and photosynthesis.
4. To introduce concept molecular recognition, interactions in supramolecular systems and their applications

UNIT-I:

Metal ions in biological systems and its storage transport and bio mineralization: Essential and trace elements, Ferritin, Transferrin and siderophores. Calcium in biology Transported regulation, intracellular Ca2+ transport, Ca2+ AT pase, Na+/ Ca2+ exchange, mitochondrial influx and efflux, inositol triphosphate, Ca2+ regulated intracellular processes, Calmodulin, Troponin C.

UNIT-II:

Metalloenzymes:

Zinc enzymes: carboxypeptidase and carbonic anhydrase, Iron enzymes: catalase peroxidase and cytochromes, Cyt-P450: Copper Enzymes, superoxide dismutase, Molybdenum oxatransferase enzymes: xanthine oxidase, Coenzyme Vitamin B12, Sulfur proteins.

UNIT-III:

Nitrogen fixation

Biological nitrogen fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenases model systems.

Photosynthesis

Chlorophylls, photo system -I and photo system -II in cleavage of water

UNIT-IV:

Transport and storage of dioxygen

Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin. Hemocyanins and hemerthrin, model synthetic complexes of iron, cobalt and copper.

UNIT-V:

Supramolecular Chemistry:

Concepts and language:

a) Molecular recognition: molecular receptors for different types of molecules including anionic substrates, design and synthesis of co-receptor molecules and multiple recognition.
b) Supramolecular reactivity and catalysis.

c) Transport processes and carrier designs
d) Supramolecular devices, supramolecular photo chemistry, supramolecular electronic, ionic and switching devices.

Some examples of self-assembly in supramolecular chemistry.

Books and References:

1. *Priciple of Biochemistry (Lehninger)*: D. L Nelson and M. M Cox, W. H. Freeman and company, New York.

2. *Fundamentals of Biochemistry*: D. Voet, J. G. Voet and C. W. Pratt; John wiley and sons.

3. *Inorganic Chemistry of Biological process*- M. Huges.

4. *Bio Inorganic Chemistry* – E. Ochiai.

COURSE OUTCOMES:

After the completion of course students will able to

CO1 Understand and acquire knowledge of effect of deficiency and toxicity of metals in both human and plant systems.

CO2 Describe the structural and functional relationships, mechanisms and importance of metaloenzymes.

CO3 Understand the fundamentals of supramolecules, supramolecular reactions and catalysis, devises.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3	2	3	2	3
CO2	3	2	3	3	2	2	2	2	2	2
CO3	3	2	2	2	2	3	2	3	2	3
CO4	3	2	3	3	3	2	2	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3

Semester-III

CE-302(A)

ORGANO TRANSITION METAL CHEMISTRY

COURSE OBJECTIVE:

1. To introduce the students on preparations, structure and bonding aspects of simple organometallic compounds
2. To study the methods of synthesis, properties and reactivity of organometallic compounds with metal-carbon multiple bonds.
3. To introduce on types of common organometallic reactions and mechanistic study of some homogeneous catalytic reaction systems involving organometallic compounds
4. To study the concept of fluxionality in organometallic compounds

UNIT-I:

Alkyl and aryls of transition metals

Types routes of synthesis, stability and decomposition pathways organo-copper in organic synthesis.

Compounds of transition metal-carbon multiple bonds. Alkylidenes, Alkylidynes, low valent carbenes and carbynes-synthesis, nature of bond, structural characteristics, nucleophilic and electrophilic reactions on the ligands, role in organic synthesis.

UNIT-II;

Transition metal π-Complex:

Transition metal π-Complexes with unsaturated organic molecules, alkenes, alkynes, allyl, diene, dienyl, arene and trienyl complexes, preparations, properties, nature of bonding and structural features, important reactions relating to nucleophilic and electrophilic attack on ligands and to organic synthesis.

UNIT-III:

Transition metal compounds with bonds to Hydrogen

Transition metal hydrides: Synthesis, properties and reactivity, transition metal dihydrogen compounds: preparation, properties and reactivity.

UNIT-IV:

Catalysis by Transition Metal Complexes-I

Coordinative unsaturation, oxidative addition and reductive elimination reactions, Insertion reactions (Insertion of CO, SO_2 and alkenes), reactions of coordinated Co in metal carbonyls.

Homogeneous hydrogenation of alkenes, hydro formylation of alkenes, isomerisation of olefins.

UNIT-V:

Catalysis by Transition Metal Complexes-II

Wacker's process, Zeigler Natta polymerisation of ethylene, Monsanto acetic acid, Reduction of CO by Hydrogen (Fischer-Tropsch reaction)

Fluxional Organometallic compounds

Fluxionality and dynamic equilibria in compounds such as η2- olefin, η3- allyl and dienyl complexes.

Books and References;

1. Principles and Application of Organotransition Metal Chemistry, J. P. Collman, L.S. Hegedus, J.R. Norton and R.G. Finke, University Science Books.

2. The Organometallic Chemistry of the Transition Metals, R .H. Carbtree, John Wiley.

3. Metallo-organic Chemistry, A.J.Pearson, Wiley.

4. The Organometallic Chemistry of the Transition Metals, R.H. Crabtree, 4th Ed, Willey (2005).

5. Fundamental Concepts of Inorganic Chemistry, Vol. 6; Asim K. Das, CBS Publisher, 2nd Ed., (2013).

6. Organometallic Chemistry, R.C. Mehrotra & A. Singh, New Age International, 2nd Ed (2013).

COURSE OUTCOMES:

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

1. Describe the structure and bonding aspects of different organotransition metal compounds and their correlations with the stability and reactivity of such compounds.
2. Identify the different types of organotranstion metal complexes catalyzed reactions and explain mechanistic pathways of different catalytic reactions.
3. Describe the important applications of organometallic homogeneous catalysis in the production of organic chemicals**.**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3	2	3	2	3
CO2	3	2	3	3	2	2	2	2	2	2

CO3	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**3**
CO4	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**2**
CO5	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**3**

4.

Semester-III

CE-302(B)

SOLID- STATE CHEMISTRY

COURSE OBJECTIVE:

1. To obtain the knowledge on understanding solid state reactions, chemical synthesis methods, the structure of solids and crystal defects, insight into electronic structure and properties of crystals.

2. These portions of solid state chemistry involves to introduction of optical and magnetic properties of solids, with basic understanding of several physical concepts such as optical reflectance, optical refraction and magnetic hysteresis.

3. Also it gives an account of the generation of X-ray radiation and its effects of on matter. It includes neutron diffraction with a basic understanding of neutron properties and their utility in analysis of soft materials.

UNIT-I:

Solid state reactions

General principles, experimental procedures, co-precipitation as a precursor to solid state reactions, sol-gel method

Crystal defects and non-stoichiometry:

Perfect and imperfect crystals, intrinsic and extrinsic defects-point defects- vacancies Schottky defects and Frenkel defects, Thermodynamics of Schottky and Frenkel defect formation, colour centres, non-stoichiometry defects, line defect-edge dislocation and Screw dislocation and plane defects- Grain boundaries- Tilt boundaries.

UNIT-II:

Electronic properties of solids

Metals, insulators and semiconductors, electronic structure of solids, band theory, band structure of metals, insulators and semiconductors, intrinsic and extrinsic semiconductors, doping semiconductors, p-n- junctions, super conductors (low temperature super conductor, BCS theory, High temperature super conductor)

Surface chemistry:

Surface tension, capillary action, pressure difference across curved surface (Laplace equation). Vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET Equation),surface films on liquids (Electrokinetic phenomenon),

UNIT-III:

Optical properties of solids

Optical reflectance, photoconduction-photoelectric effects, refraction, dispersion, polarization.

Magnetic properties of solids: Classification of materials, Quantum theory of paramagnetics-cooperative phenomena, magnetic domains, hysteresius.

UNIT-IV:

Diffraction methods, X-ray diffraction.

Generation of X-rays, properties of X-rays, continuous spectrum, characteristic spectrum, Filters, Bragg condition, Miller Indices, Structure factor and its relation to intensity, identification of unit cells from systematic absences in diffraction pattern, structure factor calculation for NaCl, KCl.

Description of the procedure for an X-ray structure analysis, Laue method, Bragg method, Debye-Scherrer method of X-ray structural analysis of crystals, indexing of crystals, Ramchandran diagram or [φ,ψ]plot.

UNIT-V

Neutron Diffraction

Scattering of neutrons by solids and liquids, magnetic scattering, measurement techniques, Elucidation of structure of magnetically ordered unit cell.

Organic Solids

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

Books and References;

1. Solid State Chemistry and its Applications, A.R.West, Wiley, 1989, Singapore. 2 nd Ed.,,

Singapore.

2. Principles of the Solid State, H.V.Keer, Wiley Eastern, 1993, New Delhi

3. Solid State Chemistry, N.B. Hannay.

4. Solid State Chemistry, D.K. Chakrabarty, New Age International. 1996, New Delhi

5. Understanding solids, The Science of Materials, R. J. Tilley, John Wiley & Sons, 2004, Sussex.

6. Solid state Physics, Aschroft and Mermin, Harcourt College Press, 1976, Florida.

7. Solid state Physics, J.P. Srivastava.

8. Applications of neutron Powder diffraction, Kisi and Howard, Oxford Science, 2008, New York.

9. Elements Of X Ray Diffraction, B. D Cullity, Addison-Wesley Publishing Company Inc., 1956, USA.

10. Chemistry of solids: A.K. Galwey., Science paperbacks and Chapman and Hall Ltd

COURSE OUTCOMES:

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

CO1 Learn the structure, properties and the synthesis of solid materials.

CO2 More significantly, crystal defects, electronic properties of solid can be easily explained. Also it will enable the student to interpret of crystal structure by X-ray diffraction and neutron diffraction method.

CO3 After going through the course, it is believed that the student will be self-confident to explain certain optical and magnetic properties of solid state materials.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3	2	3	2	3
CO2	3	2	3	3	2	2	2	2	2	2
CO3	3	2	3	2	2	3	2	3	2	3
CO4	3	2	3	3	2	2	2	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3

Semester-IV

HC-401

ORGANIC SYNTHESIS

COURSE OBJECTIVE:

To impart knowledge of oxidation and reduction, protection of alcohol, amine, carbonyl and carboxyl compounds and disconnection approach in synthesis of various natural products.

UNIT-I:

Oxidation:

Oxidation of organic molecules using ruthenium tetraoxide, hypervalent iodine, thallium (III) Nitrate, dichloro dicyanobenzoquinone (DDQ), selenium dioxide, dimethyl sulfoxide, peracids, oxone, dioxiranes, tetramethyl piperidine nitroxide,Ozone, molybdenum, Suzuki coupling, Negishi coupling, Stille coupling, Heck reaction.

UNIT-II:

Reduction:

Reduction of organic molecules using boron based reagents, Aluminium- based reagents, free radical reagent, Silane based reagents, Dissolving metal reduction, Diimide reduction, Wolff-Kishner reduction, Hydrogenation using Pd, Pt, Rh, Ni on solid support.

UNIT-III:

Protecting groups:

Principle of protection of alcohol,amine, carbonyl and carboxyl groups.

Disconnection approach:

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

UNIT-IV:

One group C-C disconnection

Alcohols and carbonyl compounds, regioselectivity, alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis.

Two group C-C disconnection:

Diels-Alder reaction, 1,3- difunctionalised compounds, α ,β- unsaturated carbonyl compounds, control in carbonyl condensations, 1,5- difunctional compounds, Micheal addition and Robinson annelation.

UNIT-V:

Ring synthesis

Saturated heterocycles, synthesis of 3-,4-, 5-, and 6- membered rings, aromatic heterocycles in organic synthesis

Synthesis of some complex molecules

Application of the disconnection approach in the synthesis of following compounds. Camphor, longifolene, Cortisone, Reserpine, Prostaglandin, Juvabione, Aphidicolin and Fredericamycin A.

Books and References;

1. *Organic chemistry*: J. Clayden, N. Greeves, S. Warren and P. Wothers, Oxford University Press.

2. *Advanced Organic Chemistry Reactions, Mechanism and Structure*: Jerry March. John Wiley and Sons.

3. *Advanced Organic Chemistry*: FA Carey and RJ. Sundberg. Plenum.

4. *Photo Chemistry and Pericyclic Reactians*: Jagdamba Singh and Jaya Singh, New Age Internatianal.

COURSE OUTCOMES:

Upon completion of this course students will be able to understand

CO1 The philosophy of synthesis of various natural products.

CO2 Understand the reactivity pattern and underlying reaction mechanism of different oxidizing and reducing reagents.

CO3 Understand the art of selective protection and deprotection of alcohol, amine, carbonyl and carboxyl groups in organic compounds.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3	2	3	2	3
CO2	3	3	2	3	2	2	2	1	2	2
CO3	3	2	3	2	2	3	2	3	2	3
CO4	3	3	2	3	3	2	2	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3

Semester-IV

HC-402

APPLIED CHEMISTRY PRACTICAL

COURSE OBJECTIVE:

1. To familiar the student with the chemistry of synthesis of Nylon 6, 6 and other similar polymers,
2. To acquire a minimum practical skill to determine the molecular weight of polymers and their characterization by other methods
3. To learn the conventional techniques of analysis of different water parameters and specific components in different samples by classical/instrumental methods.

1. Analysis of water parameters:

a) Determination of DO, COD and BOD of water samples.
b) Analysis of ground water sample for sulphate by titrimetry (EDTA) and turbidimetry
c) Analysis of water sample for phosphate by molybdenum blue method.
d) Determination of Fluoride in drinking water / ground water by spectrophotometry (alizarin red lake method)

2. Synthesis of Polymers:

a) Novolac/ resole resin using phenol and formaldehyde
b) Po;yethylene tetrasulfide by emulsion polymerization

3. Characterisation of polymers;

a) Determination of viscosity average molecular weight of polystyrene(PS) , poly vinyl alcohol(PVA)
b) Thermal and spectral analysis (IR) of selected polymers

4. Miscellaneous:

a) Analysis of fat in a butter sample
b) Spectrophotometric estimation of hexavalent chromium in water samples.
c) Spectrophotometric estimation of phosphate in cola drinks.
d) Verification of beer-lambert's law.

COURSE OUTCOMES:

CO1To perform experiment on preparation of polymers and their basic characterizations.

CO2 To perform the analysis of different water parameters using classical and instrumental methods.

CO3 To understand the principles behind the experiment performed in the laboratory.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3	2	3	2	3
CO2	3	2	3	2	2	2	2	1	2	2
CO3	3	2	3	2	2	3	2	3	2	3
CO4	3	2	3	3	3	2	2	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3

Semester-IV

HC-403

DISSERTATION

COURSE OBJECTIVE:

1. To get an idea about a small project while doing research work under faculty members of the department.

2. The students will learn about doing literature survey and basing upon that carrying out different experiments to execute their project work.

The dissertation shall consist of conducting a small project under faculty members of the department. In general the student is expected to do literature review in the assigned topic, and to do some kind of experimental investigation and result analysis. However, final decision regarding the execution of project work rests with the supervisor/co-supervisor and the committee on mutual discussion to the best benefit of the student for academic career. The guideline provided by UGC shall be also taken into account in this regard.

COURSE OUTCOMES:

CO1 Students will gain skill regarding searching, selecting and arranging papers while doing the literature survey.

CO2 Students will be able to conduct of these experiments will enable a student to know about the concept of experimental investigation.

CO3 Students will be able to analyze the results.

CO4 Students will be able to write the dissertation ineffective way by discussing with their supervisor.

CO5 Students will be able to apply again knowledge in higher studies.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3	2	3	2	3
CO2	3	2	3	3	2	2	2	2	2	2
CO3	3	2	3	2	2	3	2	3	2	3
CO4	3	2	2	3	3	2	2	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3

Semester-IV

CE-401(A)

SPECTROSCOPY-III:

COURSE OBJECTIVE:

1. The course is designed to understand the nuclear and electron spin resonance spectroscopy in a fundamental way.

2. It also contains vibrational and Raman spectroscopy.

3. A thorough discussion on all basic principles and applications are being included.

UNIT-I:

Electron spin resonance spectroscopy:

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

Nuclear quadrupole resonance spectroscopy:

Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant, splittings, applications.

UNIT-II;

Vibrational spectroscopy:

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

UNIT-III:

Raman spectroscopy:

Classical and quantum theories of Raman effect, pure rotational, vibrational, and vibrational-rotational Raman spectra, selection rules, Mutual exclusion principle, Resonance Raman spectroscopy, coherent anti stokes Raman spectroscopy (CARS).

UNIT-IV:

Nuclear magnetic resonance of paramagnetic substances in solution:

The contact and pseudo contact shifts, factors affecting nuclear relaxation,some applications including biochemical systems, an overview of NMR of metal nuclides with emphasis of Pt^{195} and Sn ^{119} NMR.

UNIT-V:

Mossbauer spectroscopy:

Basic principles, spectral line shape and natural line width, characteristics of Mossbauer nucleides, Dopplers effect, Mossbauer spectra of Fe57 system, parameters to evaluate Mossbauer Spectra; chemical shift or isomeric shift, quadrupole interaction, magnetic field interaction, application of the technique to the studies of bonding and structures of Fe+2 and Fe+3 compounds including those of intermediate spin, Sn+2 and Sn+4 compounds, nature of M-L bond. Structure and detection of oxidation states and inequivalent MB atoms.

Books and References:

1. Fundamentals of molecular spectroscopy, C.N.Banwell and E. McCash, tata McGraw Hill, 4th edition, 1994, NewDelhi
2. Introduction to spectroscopy, Pavia, Brooks/Cole Cengage, 4th edition, 2009
3. Inorganic electronic spectroscopy, A.P.B.Lever, Elsevier
4. Mossbauer spectroscopy-Greenwood and Gibbs
5. Molecular structure and spectroscopy- Aruldhas
6. Analytical chemistry- theory and practice- U.N.Das
7. Physical methods for Chemistry, R,S, Drago- Saunders company
8. Infrared and raman spectra; inorganic and co-ordination compounds, K. Nakamoto, Wiley.

COURSE OUTCOMES:

CO1 As it can be seen the spectroscopic techniques discussed are very routine and useful, it is essential every student must have exposure to the course.

CO2 They will be competent in explaining and solving most of chemical structure analysis.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3	2	3	2	3
CO2	3	2	3	3	2	2	2	2	2	2
CO3	3	2	2	2	2	3	2	3	2	3
CO4	3	2	3	3	3	2	2	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3

Semester-IV

CE—401(B)

ANALYTICAL CHEMISTRY

COURSE OBJECTIVE:

1. To familiarize the students with some instrumental techniques of characterization of different sample.
2. To understand the basic/working principles, instrumentation, analysis of thermal and electrochemical methods.
3. To understand the basic/working principles and instrumentation of some spectroscopic techniques and their use in chemical analysis.

UNIT-I

Thermal analysis:

Thermos gravimetric analysis (TGA): instrumentation, derivative thermogravimetric analysis (DTG), applications of thermogravimetry

Differential thermal analysis (DTA): principle, instrumentation and applications of differential thermal analysis, simultaneous TG-DTA curves

Differential scanning calorimetry (DSC). Principle, basic instrumentation and applications, Thermogravimetric titration, principle and applications

UNIT-II:

Electroanalytical methods:

Classification of electro analytical methods, principles and applications of voltammetry, cyclic voltammetry, anodic stripping voltammetry, polarography, coulometry, conductometry and ion selective electrodes (extensive instrumentations are to be excluded)

UNIT-III:

Atomic absorption spectroscopy:

Principle and instrumentation, flame atomization, hollow cathode lamps, interference in AAS, applications of AAS in qualitative and quantitative analysis.

UNIT-IV

Flame photometric methods:

Basic principle and instrumentation, interference in flame photometry, applications in quantitative analysis.

Nephelometric method: principle and instrumentation applications in analysis.

UNIT-V:

Error analysis;

Statistical methods in chemical analysis, theory of error and treatment of quantitative data, accuracy, and precission, ways of expressing accuracy and precision, Normal errorcurve and its equation, useful statistical tests with equation, test of significance, the F-test, The students t-test, Chi test, the correlation coefficient, confidence limit of the mean, comparison of two standard values ,comparison of standard deviation with average deviation, comparison of mean with true values, regression analysis(least square method for linear plots).

Books and References;

1. Fundamentals of analytical chemistry, D.A. Skog, D.M. West and F.J. Hollar, 7th edition, Harcourt college publishers.
2. Analytical chemistry, Gary D. Christian, 6th edition, John Wiley& sons(Aisa) Pte. Ltd.(Wiley Student Edn)2004
3. Introduction to thermal analysis: techniques and application, M.E. Brown, Kluer Academic Publisher, New York(2004)
4. Instrumental methods of analysis, H.H.Willard, L.L.Merritt and J.A.Dean, East-West Press, New Delhi, 1988.
5. Principle and practice of analytical Chemistry, F.A. Fifield & Dacid Kealy, Blackwell Publishing, 5th edition, 2000.
6. Analytical chemistry,(Theory and practice) U.N.Dash
7. Basic concepts of analytical chemistry; S.M.Khopkar, Wiley Eastern.

COURSE OUTCOMES:

At the end of the students will be able

CO1 Explain the theoretical basis of different analytical techniques with understanding on operational procedure.

CO2Selection of appropriate analytic techniques for analysis of sample and interpretation of analytical results.

CO3 Interference in different analytical techniques and their elimination.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	3	2	3	2	3
CO2	3	2	3	3	2	2	2	3	2	2
CO3	2	2	3	2	2	3	2	3	3	3
CO4	3	2	3	1	3	2	2	2	3	2
CO5	3	3	3	3	2	3	2	3	3	3