A.D.M.COLLEGE FOR WOMEN (AUTONOMOUS),

(Nationally Accredited With 'A' Grade by NAAC 4th Cycle)
(Affiliated to Bharathidasan University, Tiruchirappalli)

NAGAPATTINAM- 611 001

PG & RESEARCH DEPARTMENT OF CHEMISTRY

SYLLABUS

M.Sc., CHEMISTRY

2024-2026

PG AND RESEARCH DEPARTMENT OF CHEMISTRY
(For the candidates admitted from 2024 – 2026)

M.Sc. CHEMISTRY

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO 1:	To develop critical analysis and problem solving skills required to interpret the data into structures and mechanisms.
PEO 2:	Gain knowledge of experimental techniques and instrumentation enables to work Independently in research in different areas at a global level.
PEO 3:	Actively participate in organizing and presenting acquired knowledge coherently both orally and in written discourse relating to chemistry
PEO 4:	To prepare the students to successfully compete for current employment opportunities and emerge as entrepreneurs.
PEO 5:	Work alongside of physicists, engineers, environmentalists, biomedical scientists, Pharmacists, doctors and other professionals to help solving scientific problems.

PG AND RESEARCH DEPARTMENT OF CHEMISTRY

TANSCHE REGULATIONS ON LEARNING OUTCOME BASED CURRICULUM FRAMEWORK FOR POST GRADUATE EDUCATION	
Programme	**M.Sc.**
Programme Code	
Duration	**2 years for PG**
Programme Outcomes (Pos)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society. **PO 9 : Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures anda global perspective. **PO 10: Moral and ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one's life.

Programme Specific Outcomes (PSOs)	**PSO 1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO 3 – Research and Development** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO 4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustainin the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

M.Sc. CHEMISTRY 2024-2026 Batch

CURRICULUM STRUCTURE FOR PG PROGRAMMES (OBE- CBCS) - 2024

Category of the courses	No. of Courses	Hours	Credits
Core Course (CC)	12	72	54
Core Choice Courses (CCC)	03	18	12
Elective Course (EC)	03	16	11
Entrepreneurship / Industry Based Course	01	04	3
Internship (III to IV Semester Vacation)	0	0	2
Skill Enhancement Course(SEC)	02	4	4
Project	01	06	4
Value Added Courses (Extra Credit)*	02	0	4
Total	**24**	**120**	**90+4**

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A.D.M. COLLEGE FOR WOMEN (AUTONOMOUS), NAGAPATTINAM
PG & RESEARCH DEPARTMENT OF CHEMISTRY
M.Sc., CHEMISTRY
SCHEME OF EXAMINATIONS– 2024-2025 Onwards

PART	COURSE CODE	COURSES	HRS	CREDITS	EXAM DURATION	MAX. MARKS	
						CIA	EXT
SEMESTER I							
PART III	CC-I	CC I - ORGANIC REACTION MECHANISM-I	6	5	3	25	75
	CC-II	CC II -ORGANIC CHEMISTRY PRACTICAL –I	6	4	6	40	60
	CC-III	CC III - INORGANIC CHEMISTRY PRACTICAL – I	6	4	6	40	60
	CCC -I	CCC I- MOLECULAR SPECTROSCOPY/ ELECTROCHEMISTRY	6	4	3	25	75
	EC- I	EC I - STRUCTURE & BONDING IN INORGANIC COMPOUNDS / BIOINORGANIC CHEMISTRY	6	4	3	25	75
		Total – 5	**30**	**21**			

SEMESTER II							
COURSE TYPE	**COURSE CODE**	**COURSES**	**HRS**	**CREDITS**	**EXAM DURATION**	**MAX. MARKS**	
PART III	CC- IV	CC IV -PHYSICAL CHEMISTRY-I	6	5	3	25	75
	CC-V	CC V - ORGANIC CHEMISTRY PRACTICAL –II	6	4	6	40	60
	CC-VI	CPC VI - INORGANIC CHEMISTRY PRACTICAL – II	6	4	6	40	60
	CCC -II	CCC II - GREEN CHEMISTRY / NANO MATERIALS & NANO TECHNOLOGY	6	4	3	25	75
	EC -II	EC II - ORGANIC SYNTHESIS & PHOTOCHEMISTRY/ MATERIAL CHEMISTRY	4	3	3	25	75
	SEC -I	SEC I - CHEMISTRY IN EVERYDAY LIFE	2	2	3	25	75
*Extra Credit 2	VAC -I	VAC -I CHEMISTRY IN CONSUMER PRODUCTS (SELF LEARNING)	-	2	3	-	100
		Total – 6+1	**30**	**22+2**			
Internship/Industrial Activity during the Summer Vacation after I Year							

SEMESTER III							
COURSE TYPE	**COURSE CODE**	**COURSES**	**HRS**	**CREDITS**	**EXAM DURATION**	**MAX. MARKS**	
	CC -VII	CC VII-ORGANIC REACTION MECHANISM-II	6	5	3	25	75
	CC -VIII	CC VIII - COORDINATION CHEMISTRY -I	6	5	3	25	75
	CC-IX	CC IX - PHYSICAL CHEMISTRY PRACTICAL - I	6	4	6	40	60
	CCC -III	CCC III - NON CONVENTIONAL ENERGY SOURCES /PHARMACOGNOSY AND PHYTOCHEMISTRY	6	4	3	25	75
	INDUSTRY BASED COURSE	IBC-I CHEMOMETRICS AND QUALITY IN INDUSTRY / COMPUTER APPLICATIONS AND C PROGRAMMING	4	3	3	25	75
PART III	SEC - II	SEC II - INDUSTRIAL CHEMISTRY	2	2	3	25	75
		INTERNSHIP/INDUSTRIAL ACTIVITY	-	2	-	-	-
*Extra Credit 3	VAC - II	VAC - II ANALYTICAL TECHNIQUES (SELF LEARNING)	-	2	-	-	100
		Total – 6+1	**30**	**25+2**			

SEMESTER IV							
COURSE TYPE	**COURSE CODE**	**COURSES**	**HRS**	**CREDITS**	**EXAM DURATION**	**MAX. MARKS**	
	CC -X	CC X -COORDINATION CHEMISTRY – II	6	5	3	25	75
	CC -XI	CC XI - PHYSICAL CHEMISTRY - II	6	5	3	25	75
	CC -XII	CP XII - PHYSICAL CHEMISTRY PRACTICAL – II	6	4	6	40	60
	CC XIII	CC XIII PROJECT	6	4	3	25	75
PART III	EC -III	EC III - POLYMER CHEMISTRY/ CHEMISTRY OF NATURAL PRODUCTS	6	4	3	25	75
		Total – 5	**30**	**22**			
			120	**90+4**			

Grand Total – Credit 90 & Extra Credit 4

Semester-I/ Core Course -I	CC I- ORGANIC REACTION MECHANISM – I	Course Code:
Instruction Hours : 6	Credits : 5	Exam Hours: 3
Internal Marks: 25	External Marks: 75	Total Marks: 100
Cognitive Level	K1 – Recalling K2 – Understanding K3 - Applying K4 – Analyzing K5 – Evaluating K6 - Creating	
Objectives ofthe course	• To understand the feasibility and the mechanism of various organic reactions. • To comprehend the techniques in the determination of reaction mechanisms. • To understand the concept of stereochemistry involved in organic compounds. • To correlate and appreciate the differences involved in the various types of organic reaction mechanisms. • To design feasible synthetic routes for the preparation of organic compounds.	
Course Outline	**UNIT-I: Methods of Determination of Reaction Mechanism:** Reaction intermediates, The transition state, Reaction coordinate diagrams, Thermodynamic and kinetic requirements of reactions: Hammond postulate. **Methods of determining mechanism:** non-kinetic methods - product analysis, determination of intermediates-isolation, detection, and trapping. Cross-over experiments, isotopic labeling, isotope effects and stereo chemical evidences. **Effect of structure on reactivity**: Hammett and Taft equations. Linear free energy relationship, partial rate factor, substituent and reaction Constants.	
	UNIT-II: Aromatic and Aliphatic Electrophilic Substitution: Aromaticity: Aromaticity in benzenoid, non-benzenoid, heterocyclic compounds and annulenes. Aromatic electrophilic substitution: Orientation and reactivity of di- and polysubstituted phenol, nitrobenzene and halobenzene. Reactions involving nitrogen electrophiles: nitration, nitrosation and diazonium coupling; Sulphur electrophiles: sulphonation; Halogen electrophiles: chlorination and bromination; Carbon electrophiles: Friedel-Crafts alkylation, acylation and arylation reactions. Aliphatic electrophilic substitution Mechanisms: SE2 and SEi, SE1- Mechanism and evidences.	
	UNIT-III: **Aromatic and Aliphatic Nucleophilic Substitution:** Aromatic nucleophilic substitution: Mechanisms - S_NAr, S_N1 and Benzyne mechanisms - Evidences - Reactivity, Effect of structure, leaving group and attacking nucleophile. Reactions: Oxygen and Sulphur-nucleophiles, Bucherer and Rosenmund reactions, von Richter, Sommelet- Hauser and Smiles rearrangements. S_N1, ion pair, S_N2 mechanisms and evidences. Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon.S_N1, S_N2, S_Ni, and S_E1 mechanism and evidences, Swain- Scott, Grunwald-Winstein relationship - Ambident nucleophiles.	

	UNIT-IV: Stereochemistry-I: Introduction to molecular symmetry and chirality – axis, plane, center, alternating axis of symmetry. Optical isomerism due to asymmetric and dissymmetric molecules with C, N, S based chiral centers. Optical purity, prochirality, enantiotopic and diastereotopic atoms, groups, faces, axial and planar chirality, chirality due to helical shape, methods of determining the configuration. Racemic modifications: Racemization by thermal, anion, cation, reversible formation, epimerization, mutarotation. D, L system, Cram's and Prelog's rules: R, S-notations, pro R, pro S, side phase and re phase Cahn-Ingold-Prelog rules, absolute and relative configurations. Configurations of allenes, spiranes, biphenyls, cyclo octene, helicene. Criteria for optical purity: Resolution of racemic modifications, asymmetric transformations, asymmetric synthesis, destruction. Stereoselective and stereospecific synthesis.
	UNIT-V: Stereochemistry-II: Conformation and reactivity of acyclic systems, intramolecular rearrangements, neighbouring group participation, chemical consequence of conformational equilibrium - Curtin-Hammett Principle. Stability of five and six-membered rings: mono-, di- and polysubstituted cyclohexanes, conformation and reactivity in cyclohexane systems. Fused and bridged rings: bicyclic, poly cyclic systems, decalins and Brett's rule. Optical rotation and optical rotatory dispersion, conformational asymmetry, ORD curves, octant rule, configuration and conformation, Cotton effect, axial haloketone rule and determination of configuration.
Recommended Text	1. J. March and M. Smith, Advanced Organic Chemistry, 5th edition, John-Wiley and Sons.2001. 2. E. S. Gould, Mechanism and Structure in Organic Chemistry, Holt, Rinehart and Winston Inc., 1959. 3. P.S.Kalsi, Stereochemistry of carbon compounds, 8th edition, New Age International Publishers, 2015. 4. P. Y. Bruice, Organic Chemistry, 7th edn, Prentice Hall, 2013. 5. J.Clayden, N. Greeves, S. Warren, Organic Compounds, 2nd edition, Oxford University Press, 2014.
Reference Books	1. F.A. Carey and R.J. Sundberg, Advanced Organic Chemistry Part-A and B, 5th edition, Kluwer Academic / Plenum Publishers, 2007. 2. D. G. Morris, Stereochemistry, RSC Tutorial Chemistry Text 1, 2001. 3. N.S. Isaacs, Physical Organic Chemistry, ELBS, Longman, UK, 1987 4. E. L. Eliel, Stereochemistry of Carbon Compounds, Tata-McGraw Hill, 2000. 4. I. L. Finar, Organic chemistry, Vol-1 & 2, 6th edition, Pearson Education Asia, 2004..
Website ande-learning source	1. https://sites.google.com/site/chemistryebookscollection02/home/organic-chemistry/organic 2. https://www.organic-chemistry.org/

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able :

CO1: To recall the basic principles of organic chemistry.

CO2: To understand the formation and detection of reaction intermediates of organicreactions.

CO3: To predict the reaction mechanism of organic reactions and stereochemistry oforganic compounds.

CO4: To apply the principles of kinetic and non-kinetic methods to determine the mechanism of reactions.
CO5: To design and synthesize new organic compounds by correlating the stereochemistry of organic compounds.

CO-PO Mapping With Pos and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester- I / Core Course -II	CC II- ORGANIC CHEMISTRY PRACTICAL-I	Course Code :
Instruction Hours : 6	**Credits: 4**	**Exam Hours: 6**
Internal Marks: 40	**External Marks: 60**	**Total Marks: 100**
Cognitive Level	**K1 – Recalling** **K2 – Understanding** **K3 - Applying** **K4 – Analyzing** **K5 – Evaluating** **K6 - Creating**	
Objectives of the course	• To perform the qualitative analysis of a given organic mixture. • To carry out the preparation of organic compounds.	
SCourse Outline	**1. Qualitative analysis of an organic mixture containing two components** A. Mixtures containing two components are to be separated (pilot separation) and purified (bulk separation) – physical constants are to be reported (analysis)	
	2. Preparation of organic compounds (single stage) 1. Methyl-m-nitro benzoate from ethyl benzoate (nitration) 2. Glucose penta acetate from glucose (acetylation) 3. Resacetophenone from resorcinol (acetylation) 4. Benzo phenone oxime from benzophenone (addition) 5. o-Chlorobenzoic acid from anthranilic acid (Sandmayer reaction) 6. p-Benzoquinone from hydroquinone (oxidation) 7. Phenylazo-2-naphthol from aniline (diazotization)	
Recommended Text	1. J.Mohan,Organic Analytical Chemistry: Theory and Practice; Narosa,2003. 2. V.K.Ahluwalia P.Bhagat, and R.Agarwal, Laboratory Techniques in Organic Chemistry; I.K. International, 2005.	
Reference Books	1.N.S.Gnanaprakasam and G.Ramamurthy, Organic Chemistry LabManual; S.V.Printers, 987. 2.A.I.Vogel, A.R.Tatchell, B.S.Furniss, A.J.Hannaford and P.W.G.Smith, Vogel's Text book of Practical Organic Chemistry; 5thEd., Prentice Hall, 1989.	
Website and e-learning source	1. https://organicchemistry data	

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able **:**

CO 1: Gain knowledge on the skills of doing separation, preparation of chemical compounds.

CO 2: Learn about the methods of qualitative analysis of organic compounds

CO-PO Mapping With Pos and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**S**	**S**	**M**	**M**	**S**	**M**	**S**	**S**	**S**	**S**

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
Weightage	6	6	6	6	6
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester- I/ Core Course -III	CC III- INORGANIC CHEMISTRY PRACTICAL-I	Course Code :
Instruction Hours : 6	**Credits : 4**	**Exam Hours: 6**
Internal Marks: 40	**External Marks: 60**	**Total Marks: 100**
Cognitive Level	**K1 – Recalling** **K2 – Understanding** **K3 - Applying** **K4 – Analyzing** **K5 – Evaluating** **K6 - Creating**	
Objectives of the course	• Perform the semi micro qualitative analysis. • Estimate the metal ions using colorimeter.	
Course Outline	**1. Semi-micro qualitative analysis** of a mixture containing two common cations (Pb, Bi, Ca, Cd, Fe, Cr, Al, Co, Ni, Mn, Zn, Ba, Sr, Ca, Mg, NH_4) and two less common cations (W, Tl, Se, Te, Mo, Ce, Th, Zr, Ti, V, U, Li). **2. Estimation** of copper, ferric, nickel, chromium and manganese ions using photo electric colorimeter	
Recommended Text	1.V.V.Ramanujam, Inorganic Semimicro Qualitative Analysis; 3rd Ed., National Pubs, London, 1988. 2.G.Svehla, Text Book of Macro and Semi micro Qualitative Inorganic Analysis; 5th Ed.,Longman group Ltd, London, 1987.	
Reference Books	1. A.I.Vogel, Text Book of Quantitative Inorganic Analysis; 6th Ed., Longman, New Delhi, 2000	
Web - Resources:	1. http://edu.rsc.org	
Course Learning Outcomes (for Mapping with POs and PSOs) Students will be able: **CO 1:**Understand advanced method of estimation of metal ions through complexation **CO 2:** Acquire knowledge about colorimetric analysis.		

CO-PO Mapping With Pos and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**S**	**S**	**M**	**M**	**S**	**M**	**S**	**S**	**S**	**S**

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
Weightage	6	6	6	6	6
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester- I Core Choice Course-I	CCC I- MOLECULAR SPECTROSCOPY	Course Code:
Instruction Hours : 6	Credits: 4	Exam Hours: 3
Internal Marks: 25	External Marks: 75	Total Marks: 100
Cognitive Level	K1 – Recalling K2 – Understanding K3 - Applying K4 – Analyzing K5 – Evaluating K6 - Creating	
Objectives of the course	• To understand the influence of rotation and vibrations on the spectra of the polyatomic molecules. • To study the principle of Raman spectroscopy, ESR spectroscopy, EPR spectroscopy and fragmentation patterns in Mass spectroscopy. • To highlight the significance of Franck-Condon principle to interpret the selection rule, intensity and types of electronic transitions. • To interpret the first and second order NMR spectra in terms of splitting and coupling patterns using correlation techniques such as COSY, HETCOR, NOESY. • To carry out the structural elucidation of molecules using different spectral techniques.	
Course Outline	**UNIT-I: Rotational and Raman Spectroscopy:** Rotational spectra of diatomic and polyatomic molecules. Intensities of rotational spectral lines, effect of isotopic substitution. Non-rigid rotators. Classical theory of the Raman effect, polarizability as a tensor, polarizability ellipsoids, quantum theory of the Raman effect, Pure rotational Raman spectra of linear and asymmetric top molecules, Stokes and anti-Stokes lines. Vibrational Raman spectra, Raman activity of vibrations, rule of mutual exclusion, rotational fine structure-O and S branches, Polarization of Raman scattered photons.	
	UNIT-II: ESR spectroscopy ESR spectroscopy Characteristic features of ESR spectra, line shapes and line widths; ESR spectrometer. The g value and the hyperfine coupling parameter (A), origin of hyperfine interaction. Interpretation of ESR spectra and structure elucidation of organic radicals using ESR spectroscopy; Spin orbit coupling and significance of g- tensors, zero/non-zero field splitting, Kramer's degeneracy, application to transition metal complexes (having one to five unpaired electrons) including biological molecules and inorganic free radicals. ESR spectrum of metal complexes $[Ti(H_2O)_6]^{3+}$ and $[Cu(NH_3)_4]^{2+}$.	

	UNIT-III: Electronic spectroscopy: Electronic Spectroscopy: Electronic spectroscopy of diatomic molecules, Frank-Condon principle, dissociation and predissociation spectra. $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ transitions and their selection rules. Photoelectron Spectroscopy: Basic principles, photoelectron spectra of simple molecules, Xray photoelectron spectroscopy (XPS). Lasers: Laser action, population inversion, properties of laser radiation, examples of simple laser systems.
	UNIT-IV: NMR spectroscopy: Chemical shift, Factors influencing chemical shifts: electronegativity and electrostatic effects; Mechanism of shielding and deshielding. Spin systems: First order and second order coupling of AB systems, Simplification of complex spectra. Spin-spin interactions: Homonuclear coupling interactions - AX, AX2, AB types. Vicinal, germinal and long-range coupling-spin decoupling. Nuclear Overhauser effect (NOE), Factors influencing coupling constants and Relative intensities. 13CNMR and structural correlations, Satellites. Brief introduction to 2D NMR – COSY, NOESY. Introduction to 31P, 19F NMR. Interpretation of NMR: C_3H_7Cl and $C_{11}H_{14}O_2$.
	UNIT-V: Mass Spectrometry, EPR and Mossbauer Spectroscopy: Ionization techniques- Electron ionization (EI), chemical ionization (CI), desorption ionization (FAB/MALDI), electrospray ionization (ESI), isotope abundance, molecular ion, fragmentation processes of organic molecules, deduction of structure through mass spectral fragmentation, high resolution. Effect of isotopes on the appearance of mass spectrum. EPR spectra of anisotropic systems - anisotropy in g-value, causes of anisotropy, anisotropy in hyperfine coupling, hyperfine splitting caused by quadrupole nuclei. Zero-field splitting (ZFS) and Kramer's degeneracy. Applications of EPR to organic and inorganic systems.
Recommended Text	1. C. N. Banwell and E. M. McCash, *Fundamentals of Molecular Spectroscopy*, 4th Ed., Tata McGraw Hill, New Delhi, 2000. 2. R. M. Silverstein and F. X. Webster, *Spectroscopic Identification of Organic Compounds*, 6th Ed., John Wiley & Sons, New York, 2003. 3. W. Kemp, *Applications of Spectroscopy*, English Language Book Society, 1987. 4. D. H. Williams and I. Fleming, *Spectroscopic Methods in Organic Chemistry*, 4th Ed., Tata McGraw-Hill Publishing Company, New Delhi, 1988. 5. R. S. Drago, *Physical Methods in Chemistry*; Saunders: Philadelphia, 1992.

eference Books	1. P.W. Atkins and J. de Paula, *Physical Chemistry*, 7th Ed., Oxford University Press, Oxford, 2002. 2. I. N. Levine, *Molecular Spectroscopy*, John Wiley & Sons, New York, 1974. 3. A. Rahman, *Nuclear Magnetic Resonance-Basic Principles*, Springer-Verlag, New York,1986. 4. K. Nakamoto, *Infrared and Raman Spectra of Inorganic and coordination Compounds*, PartB: 5th ed., John Wiley& Sons Inc., New York, 1997. 5. J. A. Weil, J. R. Bolton and J. E. Wertz, *Electron Paramagnetic Resonance*; Wiley Interscience, 1994.
Website and e-learning source	1. https://onlinecourses.nptel.ac.in/noc20_cy08/preview 2. https://www.digimat.in/nptel/courses/video/104106122/L14.html

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: To understand the importance of rotational and Raman spectroscopy.

CO2: To apply the vibrational spectroscopic techniques to diatomic and polyatomic molecules.

CO3: To evaluate different electronic spectra of simple molecules using electronic spectroscopy.

CO4: To outline the NMR, ^{13}C NMR, 2D NMR – COSY, NOESY, Introduction to ^{31}P, ^{19}F NMR and ESR spectroscopic techniques.

CO5: To develop the knowledge on principle, instrumentation and structural elucidation of simple molecules using Mass Spectrometry, EPR and Mossbauer Spectroscopy techniques.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-I / Extra Credit-I	EC I - STRUCTURE AND BONDING IN INORGANIC COMPOUNDS	Course Code:
Instruction Hours : 6	Credits: 4	Exam Hours: 3
Internal Marks: 25	External Marks: 75	Total Marks: 100
Cognitive Level	K1 – Recalling K2 – Understanding K3 - Applying K4 – Analyzing K5 – Evaluating K6 - Creating	
Objectives of the course	• To determine the structural properties of main group compounds and clusters. • To gain fundamental knowledge on the structural aspects of ionic crystals. • To familiarize various diffraction and microscopic techniques. • To study the effect of point defects and line defects in ionic crystals. • To evaluate the structural aspects of solids.	
Course Outline	**UNIT-I: Structure of main group compounds and clusters:** VB theory – Effect of lone pair and electronegativity of atoms (Bent's rule) on the geometry of the molecules; Structure of silicates - applications of Paulings rule of electrovalence - isomorphous replacements in silicates – ortho, meta and pyro silicates – one dimensional, two dimensional and three-dimensional silicates. Structure of silicones, Structural and bonding features of B-N, S-N and P-N compounds; Poly acids – types, examples and structures; Borane cluster: Structural features of closo, nido, arachano and klado; carboranes, hetero and metalloboranes; Wade's rule to predict the structure of borane cluster; main group clusters –zintl ions and mno rule.	
	UNIT-II: Solid state chemistry – I: Ionic crystals: Packing of ions in simple, hexagonal and cubic close packing, voids in crystal lattice, Radius ratio, Crystal systems and Bravais lattices, Symmetry operations in crystals, glide planes and screw axis; point group and space group; Solid state energetics: Lattice energy – Born-Lande equation - Kapustinski equation, Madelung constant.	
	UNIT-III: Solid state chemistry – II: Structural features of the crystal systems: Rock salt, zinc blende & wurtzite, fluorite and anti-fluorite, rutile and anatase, cadmium iodide and nickel arsenide; Spinels -normal and inverse types and perovskite structures. Crystal Growth methods: From melt and solution (hydrothermal, sol-gel methods) – principles and examples.	

	UNIT-IV: Techniques in solid state chemistry: X-ray diffraction technique: Bragg's law, Powder diffraction method – Principle and Instrumentation; Interpretation of XRD data – JCPDS files, Phase purity, Scherrer formula, lattice constants calculation; Systematic absence of reflections; Electron diffraction technique – principle, instrumentation and application. Electron microscopy – difference between optical and electron microscopy, theory, principle, instrumentation, sampling methods and applications of SEM and TEM.
	UNIT-V: Band theory and defects in solids Band theory – features and its application of conductors, insulators and semiconductors, Intrinsic and extrinsic semiconductors; Defects in crystals – point defects (Schottky, Frenkel, metal excess and metal deficient)F centre and their effect on the electrical and optical property, laser and phosphors; Linear defects and its effects due to dislocations.
Recommended Text	1. A R West, Solid state Chemistry and its applications, 2ndEdition (Students Edition), John Wiley & Sons Ltd., 2014. 2. A K Bhagi and G R Chatwal, A textbook of inorganic polymers, Himalaya Publishing House, 2001. 3. L Smart, E Moore, Solid State Chemistry – An Introduction, 4th Edition, CRC Press, 2012. 4. K. F. Purcell and J. C. Kotz, Inorganic Chemistry; W.B. Saunders company: Philadelphia, 1977. 5. J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry; 4th ed.; Harper and Row: NewYork, 1983.
Reference Books	1. D. E. Douglas, D.H. McDaniel and J. J. Alexander, Concepts and Models in Inorganic Chemistry, 3rd Ed, 1994. 2. R J D Tilley, Understanding Solids - The Science of Materials, 2nd edition, Wiley Publication, 2013. 3. C N R Rao and J Gopalakrishnan, New Directions in Solid State Chemistry, 2nd Edition, Cambridge University Press, 199. 4. T. Moeller, Inorganic Chemistry, A Modern Introduction; John Wiley: New York, 1982. 5. D. F. Shriver, P. W. Atkins and C.H. Langford; Inorganic Chemistry; 3rd ed.; Oxford University Press: London, 2001.
Website and e-learning source	https://ocw.mit.edu/courses/3-091-introduction-to-solid-state-chemistry-fall-2018/video_galleries/lecture-videos/

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able

CO1: Predict the geometry of main group compounds and clusters.
CO2: Explain about the packing of ions in crystals and apply the radius ratio rule to predictthe coordination number of cations.
CO3: Understand the various types of ionic crystal systems and analyze their structural features.
CO4: Explain the crystal growth methods.
CO5: To understand the principles of diffraction techniques and microscopic techniques.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

SEMESTER II

Semester-II / Core Course - IV	CCIV- PHYSICAL CHEMISTRY-I	Course Code:
Instruction Hours : 6	Credits: 5	Exam Hours: 3
Internal Marks: 25	External Marks: 75	Total Marks: 100
Cognitive Level	K1 – Recalling K2 – Understanding K3 - Applying K4 – Analyzing K5 – Evaluating K6 - Creating	
Objectives of the course	• To recall the fundamentals of thermodynamics and the composition ofpartial molar quantities. • To understand the classical and statistical approach of the functions • To compare the significance of Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein. • To correlate the theories of reaction rates for the evaluation of thermodynamic parameters. • To study the mechanism and kinetics of reactions.	
Course Outline	**UNIT-I: Classical Thermodynamics:** Partial molar properties-Chemical potential, Gibb's- Duhem equation-binary and ternary systems. Determination of partial molar quantities. Thermodynamics of real gases - Fugacity- determination of fugacity by graphical and equation of state methods-dependence of temperature, pressure and composition. Thermodynamics of ideal and non-ideal binary mixtures, Duhem - Margulus equation applications of ideal and non-ideal mixtures. Activity and activity coefficients-standard states - determination-vapour pressure, EMF and freezing point methods.	
	UNIT-II: Statistical thermodynamics: Introduction of statistical thermodynamics concepts of thermodynamic and mathematical probabilities-distribution of distinguishable and non-distinguishable particles. Assemblies, ensembles, canonical particles. Maxwell - Boltzmann, Fermi Dirac & Bose-Einstein Statistics- comparison and applications. Partition functions-evaluation of translational, vibrational and rotational partition functions for monoatomic, diatomic and polyatomic ideal gases. Thermodynamic functions in terms of partition functions-calculation of equilibrium constants. Statistical approach to Thermodynamic properties: pressure, internal energy, entropy, enthalpy, Gibb's function, Helmholtz function residual entropy, equilibrium constants and equipartition principle.	

	UNIT-III: Irreversible Thermodynamics: Theories of conservation of mass and energy entropy production in open systems by heat, matter and current flow, force and flux concepts. Onsager theory-validity and verification- Onsager reciprocal relationships. Electro kinetic and thermo mechanical effects-Application of irreversible thermodynamics to biological systems.
	UNIT-IV: Kinetics of Reactions: Theories of reactions-effect of temperature on reaction rates, collision theory of reaction rates, Unimolecular reactions -Lindeman and Christiansen hypothesis-molecular beams, collision cross sections, effectiveness of collisions, Potential energy surfaces. Transition state theory-evaluation of thermodynamic parameters of activation-applications of ARRT to reactions between atoms and molecules, time and true order-kinetic parameter evaluation. Homogeneous catalysis- acid- base catalysis-mechanism of acid base catalyzed reactions- Bronsted catalysis law, enzyme catalysis-Michelis-Menton catalysis.
	UNIT-V: Kinetics of complex and fast reactions: Kinetics of complex reactions, reversible reactions, consecutive reactions, parallel reactions, chain reactions. Chain reactions-chain length, kinetics of $H_2 - Cl_2$ & $H_2 - Br_2$ reactions (Thermal and Photochemical reactions) - Rice Herzfeld mechanism. Study of fast reactions-relaxation methods- temperature and pressure jump methods electric and magnetic field jump methods - stopped flow flash photolysis methods and pulse radiolysis. Kinetics of polymerization-free radical, - Polycondensation. Enzyme catalysis.
Recommended Text	1. J. Rajaram and J.C. Kuriacose, Thermodynamics for Students of Chemistry, 2nd edition,S.L.N.Chand and Co., Jalandhar, 1986. 2. I.M. Klotz and R.M. Rosenberg, Chemical thermodynamics, 6th edition, W.A. BenjaminPublishers, California, 1972. 3. M.C. Gupta, Statistical Thermodynamics, New Age International, Pvt. Ltd., New Delhi, 1995. 4. K.J. Laidler, Chemical Kinetics, 3rd edition, Pearson, Reprint - 2013. 5. J. Rajaram and J.C. Kuriokose, Kinetics and Mechanisms of chemical transformation,M acmillan India Ltd, Reprint - 2011.
Reference Books	1. D.A. Mcqurrie And J.D. Simon, Physical Chemistry - A Molecular Approach, Viva Books Pvt. Ltd., New Delhi, 1999. 2. R.P. Rastogi and R.R. Misra, Classical Thermodynamics, Vikas Publishing, Pvt. Ltd., New Delhi, 1990. 3. S.H. Maron and J.B. Lando, Fundamentals of Physical Chemistry, Macmillan Publishers, New York, 1974 4. K.B. Ytsiimiriski, "Kinetic Methods of Analysis", Pergamom Press,1996. 5. Gurdeep Raj, Phase rule, Goel Publishing House, 2011.
Website and e-learning source	1. https://nptel.ac.in/courses/104/103/104103112/ 2. https://bit.ly/3tL3GdN

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:
CO1: To explain the classical and statistical concepts of thermodynamics.
CO2: To compare and correlate the thermodynamic concepts to study the kinetics of chemical reactions.
CO3: To discuss the various thermodynamic and kinetic determination.
CO4: To evaluate the thermodynamic methods for real gases ad mixtures.
CO5: To compare the theories of reactions rates and fast reactions.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

<table>
<tr><td>Semester-II/ Core Course -V</td><td>CC V-ORGANIC CHEMISTRY PRACTICAL-II</td><td>Course Code:</td></tr>
<tr><td>Instruction Hours : 6</td><td>Credits: 4</td><td>Exam Hours:</td></tr>
<tr><td>Internal Marks: 40</td><td>External Marks: 60</td><td>Total Marks: 100</td></tr>
<tr><td>Cognitive Level</td><td colspan="2">K1 – Recalling
K2 – Understanding
K3 - Applying
K4 – Analyzing
K5 – Evaluating
K6 - Creating</td></tr>
<tr><td>Objectives of the course</td><td colspan="2">• Carry out the qualitative analysis of an organic mixture.
• Perform the preparation of organic compounds.</td></tr>
<tr><td>Course Outline</td><td colspan="2">1. QUANTITATIVE ANALYSIS OF ORGANIC COMPOUNDS
Estimation of phenol, aniline, ketone, glucose, nitrobenzene, saponification value of an oil and iodine value of oil.
2. PREPARATION OF ORGANIC COMPOUNDS (DOUBLE STAGE)
a. p-Bromoacetanilide from aniline(acetylation and bromination)
b. Acetyl salicylicacid from methyl salicylate(hydrolysis and acetylation)
c. 1,3,5-Tribromobenzene from aniline (bromination, diazotization and hydrolysis)
d. p-Nitro aniline from acetanilide (nitration and hydrolysis)
e. Benzilic acid from benzoin (rearrangement)
f. p-Aminobenzoic acid from p-nitrotoluene (oxidation and reduction)
g. Benzanilide from benzophenone (rearrangement)
h. p-Bromoaniline from acetanilide (bromination and hydrolysis)
i. m-Nitroaniline from nitrobenzene(nitration and reduction) 1,2,4-Triacetoxybenzenefromhydroquinone(oxidation and acylation)</td></tr>
<tr><td>Recommended Text</td><td colspan="2">3. J.Mohan,Organic Analytical Chemistry: Theory and Practice; Narosa,2003.
4. V.K.Ahluwalia P.Bhagat, and R.Agarwal, Laboratory Techniques in Organic Chemistry; I.K. International, 2005.</td></tr>
</table>

Reference Books	1.N.S.Gnanaprakasamand G.Ramamurthy, OrganicChemistry LabManual; S.V.Printers, 987. 2.A.I.Vogel, A.R.Tatchell, B.S.Furniss, A.J.Hannaford and P.W.G.Smith, Vogel's Text book of Practical Organic Chemistry; 5thEd., Prentice Hall, 1989.
Website and e-learning source	https://organicchemistry data

Course Learning Outcomes (for Mapping with POs and PSOs)
Students will be able:

CO 1: Study the estimation of chemicals, which provide knowledge about the purity and concentration

CO 2: Synthesise using new organic synthetic methods.

CO-PO Mapping With Pos and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	S	S	M	M	S	M	S	S	S	S

CO-PO Mapping (Course Articulation Matrix)

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
Weightage	6	6	6	6	6
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-II/ Core Course -VI	CC VI- INORGANIC CHEMISTRY PRACTICAL-II	Course Code:
Instruction Hours : 6	**Credits: 4**	**Exam Hours: 6**
Internal Marks: 40	**External Marks: 60**	**Total Marks: 100**
Cognitive Level	**K1 – Recalling** **K2 – Understanding** **K3 - Applying** **K4 – Analyzing** **K5 – Evaluating** **K6 - Creating**	
Objectives of the course	• Carry out the titrimetric and gravimetric analyses. • Perform the preparation of compounds	
Course Outline	**1. Titrimetry and Gravimetry** A mixture of solution(s) should be given for Estimation of Cu(V) and Ni(G) Cu(V) and Zn(G) Fe(V) and Zn(G) Fe(V) and Ni(G) ZnI and Cu(G) **2 .Preparation of complexes** 1.Tris(thiourea) copper(I) chloride 2.Tetraammine copper(II) sulphate 3.Potassium tri oxalate ferrate 4.Potassium tri 30xalate aluminate(III) 5.Potassium tri 30xalate chromate(III) 6.Hexammine cobalt(III)chloride	
Recommended Text	1.V.V.Ramanujam, Inorganic Semimicro Qualitative Analysis; 3rd Ed., National Pubs, London, 1988. 2.G.Svehla, Text Book of Macro and Semi micro Qualitative Inorganic Analysis; 5th Ed.,Longman group Ltd, London, 1987.	
Reference Books	1. A.I.Vogel, Text Book of Quantitative Inorganic Analysis; 6th Ed., Longman, New Delhi, 2000	
Web - Resources:	1. http://edu.rsc.org	

Course Learning Outcomes (for Mapping with POs and PSOs)
Students will be able:

CLO 1: Develop skills in estimation and preparation of inorganic compounds.

CLO 2: Get training in the complexometric titration.

CO-PO Mapping With Pos and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**S**	**S**	**M**	**M**	**S**	**M**	**S**	**S**	**S**	**S**

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
Weightage	6	6	6	6	6
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-II/ Core Choice Course -II	CCC II- GREEN CHEMISTRY	Course Code:
Instruction Hours : 6	**Credits: 4**	**Exam Hours: 3**
Internal Marks: 25	**External Marks: 75**	**Total Marks: 100**
Cognitive Level	**K1 – Recalling** **K2 – Understanding** **K3 - Applying** **K4 – Analyzing** **K5 – Evaluating** **K6 - Creating**	
Objectives of the course	• To discuss the principles of green chemistry. • To propose green solutions for chemical energy storage and conversion. • Propose green solutions for industrial production of Petroleum and Petrochemicals. • Propose solutions for pollution prevention in Industrial chemical and fuel production, automotive industry and Shipping industries. • Propose green solutions for industrial production of Surfactants, Organic and inorganic chemicals.	
Course Outline	**UNIT-I:** Introduction- Need for Green Chemistry. Goals of Green Chemistry. Limitations/ of Green Chemistry. Chemical accidents, terminologies, International green chemistry organizations and Twelve principles of Green Chemistry with examples.	
	UNIT-II: Choice of starting materials, reagents, catalysts and solvents in detail, Green chemistry in day today life. Designing green synthesis-green reagents: dimethyl carbonate. Green solvents: Water, Ionic liquids-criteria, general methods of preparation, effect on organic reaction. Supercritical carbon dioxide- properties, advantages, drawbacks and a few examples of organic reactions in SC-CO_2. Green synthesis-adipic acid and catechol.	
	UNIT-III: Green Catalysis-Acid catalysts, Oxidation catalysts, Basic catalysts, Polymer supported catalysts-Poly styrene aluminum chloride, polymeric super acid catalysts, Poly supported photosensitizers.	
	UNIT-IV: Phase transfer catalysis in green synthesis-oxidation using hydrogen peroxide, crown ethers-esterification, saponification, anhydride formation, Elimination reaction, Displacement reaction. Applications in organic synthesis.	
	UNIT-V: Micro wave induced green synthesis-Introduction, Instrumentation, Principle and applications. Sonochemistry – Sonication. Instrumentation, Cavitation theory - Ultra sound assisted green synthesisand Applications.	

Recommended Text	1. Ahluwalia, V.K. and Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers, 2005. 2. W. L. McCabe, J.C. Smith and P. Harriott, Unit Operations of Chemical Engineering, 7th edition, McGraw-Hill, NewDelhi,2005. 3. J. M. Swan and D. St. C. Black, Organometallics in Organic Synthesis, Chapman Hall,1974. 4. V. K. Ahluwalia and R. Aggarwal, Organic Synthesis: Special Techniques, Narosa Publishing House, New Delhi,2001. 5. A. K. De, Environmental Chemistry, New Age Publications, 2017.
Reference Books	1. Anastas, P.T. and Warner, J.K. Oxford Green Chemistry -Theory and Practical, University Press, 1998 2. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker, 2001 3. Cann, M.C. and Connely, M.E. Real-World Cases in Green Chemistry, American Chemical Society, Washington, 2000 4. Ryan, M.A. and Tinnesand, M., Introduction to Green Chemistry, American Chemical Society Washington, 2002. 5. Chandrakanta Bandyopadhyay, An Insight into Green Chemistry, Books and Allied (P) Ltd, 2019.
Website and e-learning source	2. https://www.organic-chemistry.org/ 3. https://www.studyorgo.com/summary.php

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: To recall the basic chemical techniques used in conventional industrial preparations and in green innovations.

CO2: To understand the various techniques used in chemical industries and in laboratory.

CO3: To compare the advantages of organic reactions assisted by renewable energy sources and non-renewable energy sources.

CO4: To apply the principles of PTC, ionic liquid, microwave and ultrasonic assisted organic synthesis.

CO5: To design and synthesize new organic compounds by green methods.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

S – Strong **M-Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-II/ Extra Credit - II	EC II- ORGANIC SYNTHESIS AND PHOTOCHEMISTRY	Course Code:
Instruction Hours : 4	Credits : 3	Exam Hours: 3
Internal Marks: 25	External Marks: 75	Total Marks: 100
Cognitive Level	K1 – Recalling K2 – Understanding K3 - Applying K4 – Analyzing K5 – Evaluating K6 - Creating	
Objectives of the course	• To understand the molecular complexity of carbon skeletons and the presence of functional groups and their relative positions. • To study various synthetically important reagents for any successful organic synthesis. • To apply disconnection approach and identifying suitable synthons to effect successful organic synthesis. • To learn the concepts of pericyclic reaction mechanisms. • To gain the knowledge of photochemical organic reactions.	
Course Outline	**UNIT-I: Planning an Organic Synthesis and Control elements:** Preliminary Planning – knowns and unknowns of the synthetic system studied, analysis of the complex and interrelated carbon framework into simple rational precursors, retrosynthetic analysis, alternate synthetic routes, key intermediates that would be formed, available starting materials and resulting yield of alternative methods. Use of protective groups, activating groups and bridging elements. Examples on retrosynthetic approach, calculation of yield, advantages of convergent synthesis, synthesis of stereochemistry-controlled products.	
	UNIT-II: Organic Synthetic Methodology: Retrosynthetic analysis; Alternate synthetic routes. Synthesis of organic mono and bifunctional compounds via disconnection approach. Key intermediates, available starting materials and resulting yields of alternative methods. Illustration of protection and deprotection in synthesis. Control elements: Regiospecific control elements. Use of protective groups, activating groups, and bridging elements. Stereospecific control elements. Functional group alterations and transposition.	
	UNIT-III: Pericyclic Reactions: Woodward Hoffmann rules; The Mobius and Huckel concept, FMO, method and correlation diagrams. Cycloaddition and retrocycloaddition reactions; [2+2], [2+4], [4+4, Cationic, anionic, and 1,3-dipolar cycloadditions. Cheletropic reactions. Electrocyclization and ring opening reactions of conjugated dienes and trienes. Sigmatropic rearrangements: (1,3) and (1,5) carbon migrations, degenerate rearrangements. Ionic sigmatropic rearrangements. Group transfer reactions. Regioselectivity, stereoselectivity and periselectivity in pericyclic reactions.	

	UNIT-IV: Organic Photochemistry-I: Photochemical excitation: Experimental techniques; electronic transitions; Jablonskii diagrams; intersystem crossings; energy transfer processes; Stern Volmer equation. Reactions of electronically excited ketones; $\pi \rightarrow \pi^*$ triplets; Norrish type-I and type-II cleavage reactions; photo reductions; Paterno-Buchi reactions;
	UNIT-V: Organic Photochemistry-I: Photochemistry of α,β-unsaturated ketones; cis-trans isomerisation. Photon energy transfer reactions, Photo cycloadditions, Photochemistry of aromatic compounds; photochemical rearrangements; photo-stationery state; di-π-methane rearrangement; Reaction of conjugated cyclohexadienone to 3,4-diphenyl phenols; Barton's reactions.
Recommended Text	1. F. A. Carey and Sundberg, Advanced Organic Chemistry, 5thed, Tata McGraw-Hill, New York, 2003. 2. J. March and M. Smith, Advanced Organic Chemistry, 5th ed., John-Wiley and sons, 2007. 3. R. E. Ireland, Organic synthesis, Prentice Hall India, Goel publishing house, 1990. 4. Clayden, Greeves, Warren, Organic Chemistry, Oxford University Press, Second Edition, 2016. 5. M. B. Smith, Organic Synthesis 3rd edn, McGraw Hill International Edition, 2011.
Reference Books	1. Gill and Wills, Pericyclic Reactions, Chapman Hall, London, 1974. 2. J.A. Joule, G.F. Smith, Heterocyclic Chemistry, Garden City Press, Great Britain, 2004. 3. W. Caruthers, Some Modern Methods of Organic Synthesis 4thedn, Cambridge University Press, Cambridge, 2007. 4. H. O. House. Modern Synthetic reactions, W.A. Benjamin Inc, 1972. 5. Jagdamba Singh and Jaya Singh, Photochemistry and Pericyclic Reactions, New Age International Publishers, New Delhi, 2012.
Website and e-learning source	**1. https://rushim.ru/books/praktikum/Monson.pdf**

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: To recall the basic principles of organic chemistry and to understand the various reactions of organic compounds with reaction mechanisms.

CO2: To understand the versatility of various special reagents and to correlate their reactivity with various reaction conditions.

CO3: To implement the synthetic strategies in the preparation of various organic compounds.

CO4: To predict the suitability of reaction conditions in the preparation of tailor-made organic compounds.

CO5: To design and synthesize novel organic compounds with the methodologies learnt during the course

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-II/ Skill Enhancement Course I	SEC I-CHEMISTRY IN EVERYDAY LIFE	Course Code:
Instruction Hours : 2	Credits: 2	Exam Hours: 3
Internal Marks: 25	External Marks: 75	Total Marks: 100
Cognitive Level	**K1 – Recalling** **K2 – Understanding** **K3 - Applying** **K4 – Analyzing** **K5 – Evaluating** **K6 - Creating**	
Objectives of the course	1. To understand the chemistry of Water. 2. To learn the importance of fertilizer, manure, fungicide etc., 3. To gain knowledge about additives and flavouring agents in food. 4. To learn manufacture and uses of cement, rubber and rocket propellent. 5. To know the difference between dye and fibre.	
Course outline	**UNIT-1:WATER CHEMISTRY** Water pollution: Sources and effects of water pollution (Domestic, Industrial,Agricultural) Eutrophication. Heavy metals such as Hg, Cr, Cd, Zn, Cu and metals like Pb, As, Ba, Temperature, Radio activity, synthetic detergents etc**.**	
	UNIT-2: AGRICULTURAL CHEMISTRY Difference between fertilizer and manure – Superiority of manure over fertilizer - Biofertilizers: Rhizobium, Azatobacter, Cyano bacteria. Pesticides: Classification on the basis of mode of action, types of pests and Chemical nature with examples – safety measures while using pesticides. Fungicides, Herbicides, Acaricides, Rodenticides, Repellants, Fumigants, Defoliants (Definitions and Examples).	
	UNIT-3: FOOD CHEMISTRY Food additives – colouring (Natural and synthetic colours)-List of permitted colours (Curcumin, Riboflavin, Betacarotene, Plain Caramel and amaranth)-description and uses. Flavouring agents – Anti oxidants – Emulsifiers- Acidulants and beverages. Soft drinks aerated water (ingredients and side effects).	
	UNIT-4: INDUSTRIAL CHEMISTRY Cement – Raw materials – Manufacture of Portland cement and Setting of Cement. Rubber – Vulcanization and users of rubber. Rocket propellant – Soild, liquid and gas propellants.	
	UNIT-5: DYE A N D PIGMENT CHEMISTRY Dyes and Dyeing process: Difference between dye and pigment -Witt's colour theory, classification of dyes based on application (Direct, Vat, Acid, Reactive, Mordant and Disperse).	
Recommended Text	**1.** K. Kumarasamy, A. Alagappa Moses and M. Vasanthy, "Environmental studies", Bharathidasan University, Thiruchirappalli. **2.** A Thankamma Jacob, A Text Book of Applied Chemistry, 1st edition, McMillan India Ltd (1979).	

Reference Books	1. AlexRamani, "Food Chemistry", MJP publishers (2009), Chennai. 2. Jayashree Gosh, "Text book of Pharmaceutical Chemistry" New Delhi, S. Chand & Company Ltd.,(2003). 3 .K. BagavathiSundari , "Applied Chemistry" MJP Publishers, (2006) Chennai. 4. Hesse P.R,"A text book of soil chemical analysis" John Murray, New York, 1971. 5. Buchel K.H, Chemistry of Pesticides, John Wiley & Sons New York 1983.
Web site and e-learning source	https://www.topfreebooks.org. https://bookboon.com.

Course Learning Outcomes(for Mapping with POs and PSOs)

Students will be able:

CO 1:Identify and understand the unit operations involved in a process

CO 2: Differentiate fertilizer and manure

CO 3: Understand about Food additives – colouring agents, natural and synthetic colours.

CO 4: To gain knowledge about Industrial and Material Chemistry

CO-PO Mapping(Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	S	S	S	S	M
CO2	M	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	S	S

S– Strong **M– Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
Weightage	12	12	12	12	12
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-II/ Value Added Course I	VAC I - CHEMISTRY IN CONSUMER PRODUCTS (Self Learning)	Course Code:
Instruction Hours : -	Credits: 2	Exam Hours: 3
Internal Marks:-	External Marks: -	Total Marks: 100
Cognitive Level	K1 – Recalling K2 – Understanding K3 - Applying K4 – Analyzing K5 – Evaluating K6 - Creating	
Objectives of the course	• To know the preparation and applications of different types of soap. • To learn about the composition of Shampoos, Conditioners, Powder, Nail polish and Lip stick. • To gain knowledge about constituents and functions of Paint and Varnish. • To learn about preparation and applications of various dyes. • To know the preparation and uses of synthetic plastics, Resins and Rubber.	
Course Outline	**UNIT I:SOAPS AND DETERGENTS** Manufacture of soaps, formulation of toilet soaps – different ingredients used-Soft soaps, shaving soaps and creams. Anionic detergents – manufacture and applications – cationic detergents–manufacture and applications.	
	UNIT II:COSMETICS Shampoos – different kinds of shampoos – anti – dandruff, anti – lice, herbal and baby shampoos hair dye – manufacture of conditioners - skin preparation – skin powder, nail polish, lip sticks.	
	UNIT III-PAINTS AND VARNISHES Constituents and their function – types and applications.	
	UNIT IV: DYES Classification – preparation and uses of alizarin, Indigo, Methyl orange, Phenolphthalein and Malachite green.	
	UNIT V: PLASTICS– RESINS AND RUBBER Synthetic resins and plastics, synthetic polymers–important basic plastics and uses -rubber, vulcanization.	
Recommended Text	1. Thangamma Jacob,A Text Book of Applied Chemistry for Home Science and Allied Sciences. 2. B.K.Sharma, Industrial Chemistry Goel Publishing House(1995).	
Reference Books	1. R.Norris Shreve, Chemical process Industries. 2. Jayashree Ghosh, Fundamental Concept of Applied Chemistry, 1stEdition (2006) S.Chand Company Ltd., New Delhi.	
Website and e-learning source	1. https://www.topfreebooks.org. 2. https://bookboon.com.	

Course Learning Outcomes (for Mapping with POs and PSOs)
Students will be able:

CO1 : To learn depth knowledge about soap and detergent. To make plastics and know about the properties and applications of plastics
CO2 : To acquire the basic knowledge of classification, preparation and uses of dyes.
CO3: To know the applications of paint and varnishes.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
Weight age	09	09	09	09	09
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

SEMESTER- III

Semester-III/ Core Course -VII	CC VII- ORGANIC REACTION MECHANISM-II	Course Code:
Instruction Hours : 6	Credits: 5	Exam Hours: 3
Internal Marks: 25	External Marks: 75	Total Marks: 100
Cognitive Level	K1 – Recalling K2 – Understanding K3 - Applying K4 – Analyzing K5 – Evaluating K6 - Creating	
Objectives ofthe course	• To understand the concept of aromaticity in benzenoid, non-benzenoid, heterocyclic and annulene compounds. • To understand the mechanism involved in various types of organic reactions with evidences. • To understand the applications of synthetically important reagents. • To correlate the reactivity between aliphatic and aromatic compounds. • To design synthetic routes for synthetically used organic reactions.	
Course Outline	**UNIT-I: Elimination and Free Radical Reactions:** Mechanisms: E2, E1, and E1cB mechanisms. Syn- and anti-eliminations. Orientation of the double bond: Hoffmann and Saytzeff rules, Reactivity: Effect of substrate, attacking bases, leaving group and medium. Stereochemistry of eliminations in acyclic and cyclic systems, pyrolytic elimination. Long lived and short-lived radicals – Production of radicals by thermal and photochemical reactions, Detection and stability of radicals, characteristics of free radical reactions and free radical, reactions of radicals; polymerization, addition, halogenations, aromatic substitutions, rearrangements. Reactivity: Reactivity on aliphatic, aromaticsubstrates, reactivity in the attacking radical, effect of solvent.	
	UNIT-II: Oxidation and Reduction Reactions: Mechanisms: Direct electron transfer, hydride transfer, hydrogen transfer, displacement, addition-elimination, oxidative and reductive coupling reactions. Mechanism of oxidation reactions: Dehydrogenation by quinones, selenium dioxides, ferricyanide, mercuric acetate lead tetraacetate, permanganate, manganese dioxide, osmium tetroxide, oxidation of saturated hydrocarbons, alkyl groups, alcohols, halides and amines. Reactions involving cleavage of C-C bonds - cleavage of double bonds, oxidative decarboxylation, allylic oxidation, oxidation by chromium trioxide-pyridine, Mechanism of reduction reactions: Wolff- Kishner, Clemmenson, Rosenmund, reduction with Trialkyl and triphenyltin hydrides, McFadyen-Steven's reduction, Homogeneous hydrogenation, Hydroboration with cyclic systems, MPV and Bouveault-Blanc Reduction	

	UNIT-III: Rearrangements: Rearrangements to electron deficient carbon: Pinacol-pinacolone and semi-pinacolone rearrangements -applications and stereochemistry, Wagner-Meerwein, Demjanov, Dienone-phenol, Baker-Venkataraman, Benzilic acid and Wolff rearrangements. Rearrangements to electron deficient nitrogen: Hofmann, Curtius, Schmidt, Lossen, Beckmann and abnormal Beckmann rearrangements. Rearrangements to electron deficient oxygen: Baeyer-Villiger oxidation and Dakin rearrangements. Rearrangements to electron rich atom: Favorskii, Quasi-Favorskii, Stevens, [1,2]-Wittig and [2,3]-Wittig rearrangements. Fries rearrangement. Intramolecular Rearrangements – Claisen, Cope, Benzidine rearrangements.
	UNIT-IV: Addition to Carbon Multiple Bonds: Mechanisms: (a) Addition to carbon-carbon multiple bonds- Addition reactions involving electrophiles, nucleophiles, free radicals, carbenes and cyclic mechanisms-Orientation and reactivity, hydrogenation of double and triple bonds, Michael reaction, addition of oxygen and Nitrogen; (b) Addition to carbon-hetero atom multiple bonds: Mannich reaction, acids, esters, nitrites, addition of Grignard reagents, Wittig reaction, Prins reaction. Stereochemical aspects of addition reactions. Additionto Carbon-Hetero atom Multiplebonds: Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Mechanism of condensation reactions involving enolates –Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.
	UNIT-V: Reagents and Modern Synthetic Reactions: Lithium diisopropylamine (LDA), Azobisisobutyronitrile (AIBN), Sodium cyanoborohydride ($NaBH_3CN$), *meta*-Chloroperbenzoic acid (m-CPBA), Dimethyl aminiopyridine (DMAP), n-Bu_3SnD, Triethylamine (TEA), Diazobicyclo[5.4.0]undec-7-ene (DBU), , *N*-bromosuccinimide (NBS), Trifluoroacetic acid (TFA), Tetramethyl piperiridin-1-oxyl (TEMPO), Phenyltrimethylammonium tribromide (PTAB). Diazomethane and Zn-Cu, Diethyl maleate (DEM), Copper diacetylacetonate ($Cu(acac)_2$), $TiCl_3$, $NaIO_4$, Pyridinium chlorochromate (PCC), Pyridinium dichromate (PDC), Meisenheimer complex**.** Suzuki coupling, Heck reaction, Negishi reaction, Baylis-Hillman reaction.
Recommended Text	1. J. March and M. Smith, *Advanced Organic Chemistry*, 5th ed., John-Wiley and Sons. 2001. 2. E. S. Gould, *Mechanism and Structure in Organic Chemistry*, Holt, Rinehart and Winston Inc., 1959. 3. P. S. Kalsi, *Stereochemistry of carbon compounds*, 8thedn, New Age International Publishers, 2015. 4. P. Y.Bruice, *Organic Chemistry*, 7thedn.,Prentice Hall, 2013. 5. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee*Organic Chemistry*, 7th edn., Pearson Education, 2010.

Reference Books	1. S. H. Pine, *Organic Chemistry*, 5thedn, McGraw Hill International Editionn, 1987. 2. L. F. Fieser and M. Fieser, *Organic Chemistry*, Asia Publishing House, Bombay, 2000. 3. E.S. Gould, *Mechanism and Structure in Organic Chemistry*, Holt, Rinehart and Winston Inc., 1959. 4. T. L. Gilchrist, *Heterocyclic Chemistry*, Longman Press, 1989. 5. J. A. Joule and K. Mills, *Heterocyclic Chemistry*, 4thed., John-Wiley, 2010.
Website and e-learning source	1. https://sites.google.com/site/chemistryebookscollection02/home/organic-chemistry/organic 2. https://www.organic-chemistry.org/

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:
CO1: To recall the basic principles of aromaticity of organic and heterocyclic compounds.
CO2: To understand the mechanism of various types of organic reactions.
CO3: To predict the suitable reagents for the conversion of selective organic compounds.
CO4: To correlate the principles of substitution, elimination, and addition reactions.
CO5: To design new routes to synthesis organic compounds.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-III/ Core Course -VIII	CC VIII - COORDINATION CHEMISTRY – I	Course Code:
Instruction Hours : 6	Credits: 5	Exam Hours: 3
Internal Marks: 25	External Marks: 75	Total Marks: 100
Cognitive Level	K1 – Recalling K2 – Understanding K3 - Applying K4 – Analyzing K5 – Evaluating K6 - Creating	
Objectives of the course	• To gain insights into the modern theories of bonding incoordination compounds. • To learn various methods to determine the stability constantsof complexes. • To understand and construct correlation diagrams and predictthe electronic transitions that are taking place in the complexes. • To describe various substitution and electron transfer mechanistic pathways of reactions in complexes. • To evaluate the reactions of octahedral and square planar complexes.	
Course Outline	**UNIT-I: Modern theories of coordination compounds:** Introduction of Coordination compounds -Crystal field theory - splitting of d orbitals in octahedral, tetrahedral and square planar symmetries – measurement of 10Dq - factors affecting 10Dq - spectrochemical series - crystal field stabilization energy for high spin and low spin complexes - evidences for crystal field splitting - site selections in spinels and Anti spinels - Jahn Teller distortions and its consequences. **Advanced theories**-Molecular Orbital theory and energy level diagrams concept of weak and strong fields, Sigma and pi bonding in octahedral and square planar complexes.	
	UNIT-II: Spectral characteristics of complexes: Term states for d ions -characteristics of d-d transitions - charge transfer spectra – selection rules for electronic spectra - Orgel correlation diagrams - Sugano-Tanabe energy level diagrams - Nephelauxetic series - Racha parameter and calculation of inter-electronic repulsion parameter.	
	UNIT-III: Stability and Magnetic property of the complexes: Stability of complexes: Factors affecting stability of complexes, Thermodynamic aspects of complex formation, Stepwise and overall formation constants, Stability correlations, statistical factors and chelate effect, Determination of stability constant and composition of the complexes: Formation curves and Bjerrum's half method, Potentiometric method, Spectrophotometric method. Magnetic property of complexes: Spin-orbit coupling, effect of spin-orbit coupling on magnetic moments, quenching of orbital magnetic moments.	

	UNIT-IV: Kinetics and mechanisms of substitution reactions of octahedral and square planar complexes: Inert and Labile complexes; Associative, Dissociative and SNCB mechanistic pathways for substitution reactions; acid and base hydrolysis of octahedral complexes; Classification of metal ions based on the rate of water replacement reaction and their correlation to Crystal Field Activation Energy; Substitution reactions in square planar complexes: Trans effect, theories of trans effect and applications of trans effect in synthesis of square planar compounds.
	UNIT-V: Electron Transfer reactions in octahedral complexes: Outer sphere electron transfer reactions and Marcus-Hush theory; inner sphere electron transfer reactions; nature of the bridging ligand in inner sphere electron transfer reactions. Photo-redox, photo-substitution and photo-isomerisation reactions in complexes.
Recommended Text	1. J E Huheey, EA Keiter, RL Keiter and OK Medhi, Inorganic Chemistry – Principles of structure and reactivity, 4th Edition, Pearson Education Inc., 2006 2. G L Meissler and D ATarr, Inorganic Chemistry, 3rd Edition, Pearson Education Inc., 2008 3. D. Bannerjea, Co-ordination Chemistry, TATA Mcgraw Hill, 1993. 4. B. N. Figgis, Introduction to Ligand Fields, Wiley Eastern Ltd, 1976. 5. F. A. Cotton, G. Wilkinson.; C. A. Murillo; M. Bochmann, Advanced Inorganic Chemistry, 6th ed.; Wiley Inter-science: New York, 1988.
Reference Books	1. Keith F. Purcell and John C. Kotz, Inorganic Chemistry, Saunders Publications, USA, 1977. 2. Peter Atkins and Tina Overton, Shriver and Atkins' Inorganic Chemistry, 5th Edition, Oxford University Press, 2010. 3. Basic Inorganic Chemistry, F. A. Cotton, G. Wilkinson, P. L. Guas, John Wiley, 2002, 3rd edn. 4. Concepts and Models of Inorganic Chemistry, B. Douglas, D. McDaniel, J. Alexander, John Wiley, 1994, 3rd edn. 5. Inorganic Chemistry, D. F. Shriver, P. W. Atkins, W. H. Freeman and Co, London, 2010.
Website and e-learning source	https://ocw.mit.edu/courses/5-04-principles-of-inorganic-chemistry-ii-fall-2008/pages/syllabus/

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: Understand and comprehend various theories of coordination compounds.

CO2: Understand the spectroscopic and magnetic properties of coordination complexes.

CO3: Explain the stability of complexes and various experimental methods to determine the stability of complexes

CO4: Predict the electronic transitions in a complex based on correlation diagrams and UV-visible spectral details.

CO5: Comprehend the kinetics and mechamism of substitution reactions in octahedral and square planar complexes.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-III/ Core Course -IX	CC XI -PHYSICAL CHEMISTRY PRACTICAL-I	Course Code:
Instruction Hours :6	Credits: 4	Exam Hours: 6
Internal Marks: 25	External Marks: 75	Total Marks: 100
Cognitive Level	K1 – Recalling K2 – Understanding K3 - Applying K4 – Analyzing K5 – Evaluating K6 - Creating	
Objectives of the course	• To perform the various techniques of physical chemistry experiments. • To evaluate the activation energy of the reaction by following first order kinetics. • To construct the phase diagram of two component system formingcongruent melting solid and find its eutectic temperatures andcompositions. • To determine the kinetics of adsorption of oxalic acid on charcoal.	
Course Outline	1. Determination of CST and study of the effect of impurity to CST. 2. Determination of distribution coefficient and determination of equilibrium constant for theformation of KI_3. 3. Determination of the rate Constant for Persulphate Oxidation, both by titrimetry and clockreaction. 4. Comparison of acid strengths by Kinetics. 5. Determination of the energy of activation and frequency factor. 6. Association factor of benzoic acid between benzene and water. 7. Determination of molecular weight by Rast macro method. 8. Phase diagram – simple eutectic system. 9. Phase diagram – three component system. 10. Adsorption of oxalic acid on charcoal.	

Recommended Text	1. B. Viswanathan and P.S.Raghavan, Practical Physical Chemistry, Viva Books, New Delhi, 2009. 2. Sundaram, Krishnan, Raghavan, Practical Chemistry (Part II), S. Viswanathan Co. Pvt., 1996. 3. V.D. Athawale and Parul Mathur, Experimental Physical Chemistry,New Age International (P) Ltd., New Delhi, 2008. 4. E.G. Lewers, Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics, 2nd Ed., Springer, New York, 2011.
Reference Books	1. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001. 2. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th edition, McGraw Hill, 2009. 3. J. N. Gurthu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 1987. 4. Shailendra K Sinha, Physical Chemistry: A laboratory Manual, Narosa Publishing House Pvt, Ltd., New Delhi, 2014. 5. F. Jensen, Introduction to Computational Chemistry, 3rd Ed., Wiley-Blackwell.
Website and e-learning source	https://web.iitd.ac.in/~nkurur/2015-16/Isem/cmp511/lab_handout_new.pdf

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO 1: Draw the phase diagram 3 component systems and analyze it
CO 2: Determine the kinetics of the reactions
CO 3: Predict the concentration of two analytes in a mixture

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S

S – Strong **M-Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
Weightage	09	09	09	09	09
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-III/ Core Choice Course -III	CCC III- NON – CONVENTIONAL ENERGY SOURCES	Course Code:
Instruction Hours : 6	Credits: 4	Exam Hours: 3
Internal Marks: 25	External Marks: 75	Total Marks: 100
Cognitive Level	K1 – Recalling K2 – Understanding K3 - Applying K4 – Analyzing K5 – Evaluating K6 - Creating	
Objectives of the course	• Understand the various types of energy sources. • Learn about the solar energy • Introduce the importance of wind energy & fuel cells. • Acquire knowledge about bio energy. • Know the differential power plants	
Course Outline	**UNIT: I ENERGY SOURCES** Introduction to energy - Different forms of energy - Primary & Secondary Energysources - Various types of Conventional Energy Sources- Fossil fuel energy, Hydraulic energy & Nuclear energy - Various types of Non-Conventional Energy Sources - Wind energy, Tidal energy & Solar energy.	
	UNIT: II SOLAR ENERGY Introduction - Solar Constant - Solar Radiation at the Earth's Surface - Solar Energy applications - Solar Cooker - Design principle , constructional details and limitations of Solar Cooker - Solar Water heater - Solar distillation - Solar Pumping - Electricity from Solar Energy - Street lighting system.	
	UNIT: III WIND ENERGY AND FUEL CELLS Wind energy - Classification of wind mills - Horizontal Wind mills, Vertical WindMills – Advantages & Disadvantage of Wind energy. Fuel cells – Introduction - Working of Fuel Cell - Advantages of Fuel Cells	
	UNIT: IV BIO ENERGY Introduction - Bio Gas and its Compositions - Process of Bio gas, generation – Wet Process, dry Process - Raw Materials available for Bio gas Fermentation - Constructional Details of Biogas Plant - Utilization and benefits of Biogas Technology - Economical, social environmental and health benefits of bio gas - Utilization - KVIC Bio gas Plant - Advantagesof Bio Gas technology.	
	UNIT: V TIDAL POWER PLANTS Introduction to Tidal Power Plants - Classification of tidal Power Plants - Working of Different Tidal Power Plants - Factors affecting the suitability of the site for tidal power plant- Advantages and disadvantages of Tidal Power Plants - Components of Tidal Power plants.	

Recommended Text	1. G.D Raj, Non– Conventional Energy Sources,Khanna Publisher,1998. 2. G.S. Sawhney ,Non –Conventional Energy Sources, PHIL earning, 2005. 3. N.K Bansal, Non–Conventional Energy Source, Vikas Publishing house. 4. B.H. Khan, Non Conventional Energy Sources, McGraw Hill Publications,3rdEdition
Reference Books	1. Roger H.Charlier, Charles W. "Ocean Energy- Tide and Tidal Power" ISBN: Library of Congress Control Number :2008929624_c Springer-Verlag Brerlin Heidelberg 2009. 2. John F.Walker& N.Jenkins, "Wind Energy Technology", John Willey and Sons Chichester,U.K– 1997. 3. T.H. Taylor Alternate Energy Sourcesby. Adam Hilger Ltd,Bristol

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO 1: To ensure the students understand the basic concept of energy.

CO 2: Understand the solar devices such as solar cooker, solar water heater.

CO 3: Get awareness about the wind energy and conversion to the generation of power.

CO 4: An introduction of composition of biogas and generation of power.

CO 5: Study about the principles of tidal power plant

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	S	S	S	S	S	M
CO 2	S	M	S	S	S	S	S	S	S	S
CO 3	S	M	S	S	S	S	S	S	S	S
CO 4	S	S	S	S	S	S	S	S	S	S
CO 5	S	S	S	S	S	S	S	S	S	S

S – Strong L – Low

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-III/ Industry Based Course -I	IBC-I Chemometrics and Quality control in Industry	Course Code:
Instruction Hours : 4	**Credits: 3**	**Exam Hours: 3**
Internal Marks: 25	**External Marks: 75**	**Total Marks: 100**
Cognitive Level	**K1 – Recalling** **K2 – Understanding** **K3 - Applying** **K4 – Analyzing** **K5 – Evaluating** **K6 - Creating**	
Objectives of the course	1. Provides essential theoretical background of chemometrics 2. Students will have exposure on a variety of quality control measures	
Course outline	**UNIT-1:Chemometrics:** Introduction,-various techniques- Partial least squares (PLS), Soft independent modeling of class Analogy (SIMCA), Methods based on factor analysis : Principle component regression (PCR), Target Fourier Analysis (TFA)	
	UNIT-2:Statistical Quality Control: Statistical Quality Control Techniques: Statistical treatment of data. Control charts, Performance Evaluation uncertainties in measurement.	
	UNIT-3: Pharmaceutical Quality Control: In-process quality control on various dosage forms, Sterile and non- sterile operations. Factors affecting stability of formulations and shelf - life prediction, techniques to determine and improve shelf life	
	UNIT-4: Quality control of packaging materials: Types of plastics, primary and secondary packaging materials (glass, closures, cartons, blister and their control)	
	UNIT-5:Quality control standards for pesticides: Structure-responsabilities and authority of individuals in the laboratory-Document and data recording-Internal quality audits	
Recommended Text	1. D.C. Montgomery, Statistical Quality Control, John Wiley & Sons, 5th edition, 2005. 2. Quality control of pesticide products-Guidelines for National laboratories	
Reference Books	1. Quality Assurance of Aseptic Preparation Services: Standards Part A | Fifth edition, Alison M Beaney, Royal Pharmaceutical Society and the NHS Pharmaceutical Quality Assurance Committee,2016. 2. Manging for quality and performance excellence ninth edition James R.Every, William M.Lindsay South-western Cengage learning 2014 3. Massart,D.L., et al.,(1997) Data handling in Science and Technology 20A:Hand book of Chemometrics and Qualimetrics Part A.	
Website and e-learning source	https://www.topfreebooks.org. https://bookboon.com.	

Course Learning Outcomes (for Mapping with POs and PSOs)
Students will be able :

CO1 :Identify and understand the unit operations involved in a process

CO2: To understand the various techniques involved in chemometrics

CO3: To gain knowledge about Quality Control in Pharmaceutical

CO4: To know about Quality control of packaging materials and pesticides

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	S	S	S	S	M
CO2	M	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	S	S

S– Strong **M– Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
Weight age	12	12	12	12	12
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-III/ Skill Enhancement Course -II	SEC-II : INDUSTRIAL CHEMISTRY	Course Code:
Instruction Hours : 2	Credits: 2	Exam Hours: 3
Internal Marks: 25	External Marks: 75	Total Marks: 100
Cognitive Level	K1 – Recalling K2 – Understanding K3 - Applying K4 – Analyzing K5 – Evaluating K6 - Creating	
Objectives of the course	• Understand and develop efficacy in planning, designing, production processing and marketing • Study water testing treatment and petroleum refining. • Acquire in depth knowledge of basic and applied area of industrial chemistry. • Know the industrial production of soaps, detergents and perfumes. • Learn the process of photography.	
Course outline	**UNIT-1: BASIC IDEAS ABOUT UNIT OPERATION** Basic ideas about unit operation – Flowcharts – Chemical conversion – Batch versus continuous processing – chemical process selection – design – chemical process control – chemical process economics – market evaluation – plant location –management in productivity and creativity.	
	UNIT-2: PETROLEUM AND DETERGENTS Petroleum: Origin, refining, cracking, reforming, knocking and octane number, LPG, synthetic gas, synthetic petrol. Detergents – raw materials – manufacture – Biodegradability of surfactants – methods.	
	UNIT-3: PULP, PAPER AND PLASTICS Pulp and paper industries – Sulphite, Sulphate, Soda, Ground wood pulp for paper manufacture – speciality paper– paper stock– structural boards. Plastics – manufacture – resin – manufacturing processes–condensation polymerization –Hexamethylenetetramine plastics. Wood conversions – Hydrolytic wood – Phenolic treatment wood – chip wood and their manufacture & advantages	
	UNIT-4: PERFUMES Introduction – Definition - uses and economics -.production of natural and synthetic perfumes – Flower perfumes – Fruit flavours – artificial flavours.	
	UNIT-5: SUGAR CHEMISTRY AND PHOTOGRAPHY Sugar manufacture – starch and related products –Manufacture of industrial alcohol – Butanol - acetone – vinegar – acetic acid – citric acid – lactic acid by fermentation. Industrial and military explosives – manufacture of safety matches. Colour photography – theory – material sand process–special applications of photography.	

Recommended Text	1. Charkarbharthy BN, Industrial Chemistry, Oxford and IBH Publishing.Co.1st Edition.NewDelhi. 2. Danielsetal., Experimental Physical chemistry, 7th Ed, NewYork,McGrawHill,1970. 3. Sharma BK, Industrial Chemistry, geol Publishing House, Meerut.
Reference Books	1. Norris Shreve.R. andJoseph.A.BrinkJr-Chemical process Industries–.McGrawHill, I International Book Company,London. 2. BrainA.C.S.Remhold-Production and properties of Industrial Chemicals – NewYork 3. Burgh, A Fermentation industries – Interscience, New York. 4. Gilbert .J. Handbook of Technology and Engineering–,VanNostr and Reinhold, London. 5. Guthrie. V-Petroleum products Handbook. McGrawHill, Tokyo.
Website and e-learning source	https://www.essentialchemicalindustry.org. https://www.tandfonline.com

Course Learning Outcomes (for Mapping with POs and PSOs)
Students will be able :

CO1:Identify and understand the unit operations involved in a process

CO2: Design common heat exchangers like double pipe and shell & tube to determine relevant design parameters

CO 3: Understand the commercial processes used for their fining and processing of natural gas and crude petroleum

CO 4: Solve materials and energy balances alone and simultaneously on chemical process system

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	S	S	S	S	M
CO2	M	S	S	S	S	M	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	S	S

S– Strong **M– Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
Weightage	12	12	12	12	12
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-III/ Value Added Course -II	VAC II ANALYTICAL TECHNIQUES (Self Learning Course)	Course Code:
Instruction Hours : -	Credits: 2	Exam Hours: 3
Internal Marks: -	External Marks:-	Total Marks: 100
Cognitive Level	K1 – Recalling K2 – Understanding K3 - Applying K4 – Analyzing K5 – Evaluating K6 - Creating	
Objectives of the course	• To study thermo analytical techniques forchemical analysis. • To understand electro analytical techniques. • To learn the nature of errors and their types. • To gain sound knowledge on methods of crystalgrowth. • To learn diffraction studies and its applications.	
Course Outline	**UNIT 1: THERMO ANALYTICAL METHODS** Thermogravimetry : Principle, factors affecting thermogram, instrumentation and thermal decomposition of $CaC_2O_4H_2O$ and $CuSO_4.5H_2O$ Differential Techniques : Instrumentation, experimental, instrumental factors of DTA and D Thermal studies of $CuSO_4.5H_2O$ by DTA and determination of purity of pharmaceutical an transition studies by DSC-evaluation of thermodynamic parameters.	
	UNIT 2: ELECTROANALYTICAL METHODS Electro gravimetry : Principle, instrumentation, deposition and separation Electrolysis at constant current and estimation of copper. Coulometry : Principle, controlled potential coulometry and separation of nickel and cobalt, coulometric titration, instrumentation – estimation of Sb(III)Potentiometry : Principle, potentiometric titration, equivalence point potential for (i)Fe^{2+}- Ce^{4+} system (ii) Fe^{2+} $MnO_4^-/H+$ system. Colorimetry Beer- lambert's law and spectrophotometric method of estimation, principle and methods of visual colorimetry. Estimation of iron and nickel by visual colorimetry.	
	UNIT 3: DATA ANALYSIS **ERRORS** : Various types of errors – precision and accuracy – significant figures – various statistical test on accuracy of results, positive & negative deviation from accurate results – the binomial distribution, the Gaussian distribution – the normal distribution of random errors, mean value, variation and standard deviation, reliability interval, deviation from the Gaussian law of error distribution. Student's t-distribution & t-tests, comparison of the mean with the expected value, comparison of the results of two different methods, comparison of precision of two methods by F-tests, gross errors and elimination of outlying	

	results.Graphical methods Linear regression, regression line, standard deviation, correlationco-efficient.
	UNIT 4: CRYSTALLOGRAPHY Single crystal growth – low and high temperature, solution growth technique – gel and sol- gel methods. Melt growth – Bridgeman – stockberger method, Czochralski methods. Flux technique, physical and chemical vapour transport methods. Characterization – TGA/DTA/DSC methods, SEM/TEM analysis. Determination of hardness. Applications of single crystals.
	UNIT 5: DIFFRACTION STUDIES X-ray Diffraction -Powder and single crystal method, advantages over neutron diffraction methods, applications of x-ray diffraction method. Neutron diffraction, advantages over Electron diffraction, limitations. Electron diffraction studies -limitations and applications.
Recommended Text	1. A.K.Srivastava, P.C.Jain Chemical Analysis: An Instrumental Approachfor B.Sc. Hons.& M.Sc classes, S. Chand Company Ltd. 2.D. C. Harris, Quantitative Chemical Analysis; 4t^{h}Ed.,W.H.Freeman Publications,NewYork,1995. 3.A. K. Srivastava, P. C Jain. Instrumental Methods of ChemicalAnalysis4.S.Gopalan. Analytical Chemistry 5..Clegg,W, Crystal structure determination, Oxford University press , New York.
Reference Books	1.D.B.Hibbert and J.J.Gooding, Data Analysis for Chemistry; Oxford University Press, UK,2006 2. J. Topping, Errors of Observation and Their Treatment;4thEd.,ChapmanHall, London,1984. 3. Mahinder Singh. Text Book of Analytical ChemistryInstrumental Techniques
Website and e-learning source	https://edu.rsc.org

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: Explain the theoretical aspects of key analytical techniques and instruments

CO2: Strategically plan analytical campaigns to apply to different types of samples and research objectives, including selection of the most appropriate technique/instrumentation for the students' research project.

CO3: Undertake the correct sample preparation and characterization prior to analysis by the chosen techniques or instruments.

CO4: Design an analytical work-flow to acquire data

CO5: Process data from the chosen instruments and demonstrate understanding of the limitations and quality of the data. Justify the approach taken to data processing.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	S	S	S	S	S	S
CO 2	S	S	S	S	S	S	S	S	S	S
CO 3	S	S	S	S	S	S	S	S	S	S
CO 4	S	S	S	S	S	S	S	S	S	S
CO 5	S	S	S	S	S	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-IV/ Core Course -X	CC X- COORDINATION CHEMISTRY – II	Course Code:
Instruction Hours : 6	**Credits: 5**	**Exam Hours: 3**
Internal Marks: 25	**External Marks: 75**	**Total Marks: 100**
Cognitive Level	**K1 – Recalling** **K2 – Understanding** **K3 - Applying** **K4 – Analyzing** **K5 – Evaluating** **K6 - Creating**	
Objectives of the course	• To recognize the fundamental concepts and structural aspects of organometallic compounds. • To learn reactions of organometallic compounds and their catalytic behaviour. • To identify or predict the structure of coordination compounds usingspectroscopic tools. • To understand the structure and bonding in coordination complexes. To evaluate the spectral characteristics of selected complexes.	
Course Outline	**UNIT-I: Chemistry of organometallic compounds:** Introduction of organometallic compounds, Structure and bonding − bonding modes, MO approach of M-CO bonding, π- acceptor nature of carbonyl group, synergistic effect (stabilization of lower oxidation states of metals); Classification of Organometallic compounds based on M-C bond – 18 electron rule; Bonding in metal – olefin complexes (example: Ziese's salt), metal- acetylene and metal-allyl complexes; Metal-cyclopentadienyl complexes – Examples and MO approach to bonding in metallocenes; fluxional isomerism. Metal – carbonyl complexes: MO diagram of CO; **Carbonyl clusters**: Low nuclearity and high nuclearity carbonyl clusters – Structures based on polyhedral skeleton electron pair theory or Wade's rule.	
	UNIT-II: Reactions and catalysis of organometallic compounds: Reactions of organometallic compounds: Oxidative addition, reductive elimination (α and β eliminations), migratory insertion reaction. Organo-metallic catalysis: Hydrogenation of olefins (Wilkinson's catalyst), hydroformylation of olefins using cobalt or rhodium catalysts (oxo process), oxidation of olefin (Wacker process), olefin isomerisation, water gas shift reaction, cyclo-oligomerisation of acetylenes using Reppe's catalysts..	
	UNIT-III: Inorganic spectroscopy -I: IR spectroscopy: Effect of coordination on the stretching frequency-sulphato, carbonato, sulphito, aqua, nitro, thiocyanato, cyano, thiourea, DMSO complexes; IR spectroscopy of carbonyl compounds. NMR spectroscopy- Introduction, applications of ^{1}H -NMR spectroscopy in structural identification of inorganic complexes, fluxional molecules, quadrupolar nuclei- effect in NMR spectroscopy.	

	UNIT-IV: Inorganic spectroscopy-II: Introductory terminologies: g and A parameters-definition, explanation and factors affecting g and A; Applications of ESR to coordination compounds with one and more than one unpaired electrons – hyperfine and secondary hyperfine splitting and Kramer's doublets; ESR spectra of Fe(II), Ni(II) complexes, Mossbauer spectroscopy – Mossbauer effect, Mossbauer active nuclei, Doppler shift, Isomer shift, quadrupole splitting and magnetic interactions. Applications of Mössbauer spectra to Fe and Sn compounds.
	UNIT-V: Photo Electron Spectroscopy: Theory, Types, origin of fine structures - shapes of vibrational fine structures – adiabatic and vertical transitions, PES of homonuclear diatomic molecules (N_2, O_2) and heteronuclear diatomic molecules (CO, HCl) and polyatomic molecules (H_2O, CO_2) – evaluation of vibrational constants of the above molecules. Koopman's theorem- applications and limitations. Optical Rotatory Dispersion – Principle of CD and ORD, Assignment of absolute configuration using CD and ORD techniques.
Recommended Text	1. J E Huheey, EA Keiter, RL Keiter and OK Medhi, Inorganic Chemistry – Principles of structure and reactivity, 4th Edition, Pearson Education Inc., 2006 2. G L Meissler and D ATarr, Inorganic Chemistry, 3rd Edition, Pearson Education Inc., 2008 3. D. Bannerjea, Co-ordination Chemistry, TATA Mcgraw Hill, 1993. 4. B D Gupta and A K Elias, Basic Organometallic Chemistry: Concepts, Syntheses and Applications, University Press, 2013. 5. F. A. Cotton, G. Wilkinson.; C. A. Murillo; M. Bochmann, Advanced Inorganic Chemistry, 6th ed.; Wiley Inter-science: New York, 1988.
Reference Books	1.Crabtree, Robert H. The Organometallic Chemistry of the Transition Metals. 3rd ed. New York, NY: John Wiley, 2000. 2. P Gütlich, E Bill, A X Trautwein, Mossbauer Spectroscopy and Transition Metal Chemistry: Fundamentals and Applications, 1st edition, Springer-Verlag Berlin Heidelberg, 2011. 3. Concepts and Models of Inorganic Chemistry, B. Douglas, D. McDaniel, J. Alexander, John Wiley, 1994, 3rd edn. 4. K. F. Purcell, J. C. Kotz, Inorganic Chemistry; Saunders: Philadelphia, 1976. 5. R. S. Drago, PhysicaI Methods in Chemistry; Saunders: Philadelphia, 1977.
Website and e-learning source	https://archive.nptel.ac.in/courses/104/101/104101100/

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: Understand and apply 18 and 16 electron rule for organometallic compounds

CO2: Understand the structure and bonding in olefin, allyl, cyclopentadienyl and carbonyl containing organometallic compounds

CO3: Understand the reactions of organometallic compounds and apply them in

CO4:Understanding the catalytic cycles

CO5: Identify / predict the structure of coordination complexes using spectroscopic tools such as IR, NMR, ESR, Mossbauer and optical rotatory dispersion studies to interpret the structure of molecules by various spectral techniques.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-IV/ Core Course -XI	CC XI- PHYSICAL CHEMISTRY-II	Course Code:
Instruction Hours :6	Credits: 5	Exam Hours: 3
Internal Marks: 25	External Marks: 75	Total Marks: 100
Cognitive Level	K1 – Recalling K2 – Understanding K3 - Applying K4 – Analyzing K5 – Evaluating K6 - Creating	
Objectives of the course	• To understand the essential characteristics of wave functions and need for the quantum mechanics. • To know the importance of quantum mechanical models of particle in a box, rigid rotor and harmonic oscillator. • To apply the quantum mechanics to hydrogen and polyelectronic systems. • To familiarize the symmetry in molecules and predict the point groups. • To predict the vibrational modes, hybridization using he concepts of group theory.	
Course Outline	**UNIT-I:** Wave particle duality, Uncertainty principle, Particle wave and Schrodinger wave equation, wave function, properties of wave function. Properties of wave function, Normalized, Orthogonal, orthonormal, Eigen values, Eigen functions, Hermitian properties of operators. Introduction to quantum mechanics-black body radiation, photoelectric effect. Need for quantum mechanics, Postulates of Quantum Mechanics, Schrodinger wave equation, Time independent and time dependent	
	UNIT-II: Quantum models: Particle in a box-1D, two dimensional and three-dimensional, degeneracy, application to linear conjugated molecular system, free particles, ring systems. Harmonic Oscillator-wave equation and solution, force constant and its significance. Rigid Rotor-wave equation and solution, calculation of rotational constants and bond length of diatomic molecules.	
	UNIT-III: Applications to Hydrogen and Poly electron atoms: Hydrogen atom and hydrogen like ions, Hamiltonian-wave equation and solutions, radial and angular functions, representation of radial distribution functions. Approximation methods –variation methods: trial wave function, variation integral and application to particle in 1D box. Perturbation method - first order applications. Hohenberg-Kohn theorem and Kohn-Sham equation, Helium atom-electron spin, paulis exclusion principle and Slater determination.	

	UNIT-IV: Group theory: Groups, sub groups, symmetry elements, operations, classification-axial and non-axial. Dihedral point groups- C_n, C_{nh}, D_n, D_{nh}. Matrix representation and classes of symmetry operations, reducible irreducible and direct product representation. The Great orthogonality theorem – irreducible representation and reduction formula, construction of character table for C_{2v}, C_{2h}, C_{3v} and D_{2h} point groups.
	UNIT-V: Applications of quantum and group theory: Hydrogen Molecule-Molecular orbital theory and Heitler London (VB) treatment, Energy level diagram, Hydrogen molecule ion; Use of linear variation function and LCAO methods. Electronic conjugated system:Huckel method to Ethylene butadiene, cyclopropenyl, cyclo butadiene and Benzene. Applications of group theory to molecular vibrations, electronic spectra of ethylene.
Recommended Text	1. R.K. Prasad, Quantum Chemistry, New Age International Publishers, New Delhi, 2010, 4th revised edition. 2. F. A. Cotton, Chemical Applications of Group Theory, John Wiley & Sons, 2003, 2nd edition. 3. A. Vincent, Molecular Symmetry and Group Theory. A Programmed Introduction to Chemical Applications, John and Willy & Sons Ltd., 2013, 2nd Edition. 4. T. Engel & Philip Reid, Quantum Chemistry and Spectroscopy, Pearson, New Delhi, 2018, 4th edition. 5. G. K. Vemulapalli, Physical Chemistry, Prentice Hall of India Pvt. Ltd. 2001. 6. D.A. McQuarrie, Quantum Chemistry, Viva Books PW. Ltd, 2013, 2nd edition.
Reference Books	1. N. Levine, Quantum Chemistry, Allyn& Bacon Inc, 1983, 4th edition. 2. D.A. McQuarrie and J. D. Simon, Physical Chemistry, A Molecular Approach, Viva Books Pvt. Ltd, New Delhi, 2012. 3. R. P. Rastogi & V. K. Srivastava, An Introduction to Quantum Mechanics of Chemical Systems, Oxford & IBH Publishing Co., New Delhi, 1999. 4. R.L. Flurry. Jr, Symmetry Group Theory and Chemical applications, Prentice Hall. Inc, 1980 5. J. M. Hollas, Symmetry in Molecules, Chapman and Hall, London, 2011, Reprint.
Website and e-learning source	1. https://nptel.ac.in/courses/104101124 2. https://ipc.iisc.ac.in/~kls/teaching.html

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: To discuss the characteristics of wave functions and symmetry functions.

CO2: To classify the symmetry operation and wave equations.

CO3: To apply the concept of quantum mechanics and group theory to predict the electronic structure.

CO4: To specify the appropriate irreducible representations for theoretical applications.

CO5: To develop skills in evaluating the energies of molecular spectra.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO 4	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 5	**M**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**	**S**

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-IV/ Core Course -XII	CC XII- PHYSICAL CHEMISTRY PRACTICAL - II	Course Code:
Instruction Hours : 6	**Credits: 4**	**Exam Hours: 6**
Internal Marks: 40	**External Marks: 60**	**Total Marks: 100**
Cognitive Level	**K1 – Recalling** **K2 – Understanding** **K3 - Applying** **K4 – Analyzing** **K5 – Evaluating** **K6 - Creating**	
Objectives of the course	• To perform the various techniques of physical chemistry experiments. • To understand the principle of conductivity experiments through conductometric titrations.	
Course Outline	Any **ten** experiments (to be decided by the course teacher) out of thef Following experiments. ***I. Conductometric Titrations*** 1. Estimation of strong acids. 2. Estimation of mixture of acids 3. Estimation of mixture of bases 4. Estimation of halides 5. Verification of Ostwald's dilution law 6. Determination of solubility of sparingly solute salt. ***II. EMF Measurements*** 7. Estimation of KI [$KMno_4$Vs KI] 8. Estimation of KI [$K_2Cr_2O_7$ Vs KI] 9. Estimation of mixture of halides [KCl + KI] 10. Estimation of strong acid [NaoH Vs HCl] 11. Estimation of Acetic acid [NaoH Vs CH_3 COOH] 12. Estimation of mixture of acids [NaoH Vs HCl + CH_3 COOH] 13. Determination of dissociation constant of organic acid. 14. Determination of solubility of sparingly soluble salt. 15. Determination of p^H of buffer solutions.	

Recommended Text	*1.* Vogel's Text book of Practical Organic Chemistry, 5th Ed, ELBS/Longman, England, 2003. *2.* G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denney, *Vogel's Textbook of Quantitative Chemical Analysis*; 6th ed., ELBS, 1989. *3.* J. D. Woollins, *Inorganic Experiments*; VCH: Weinheim, 1995. *4.* B. Viswanathan and P.S.Raghavan, Practical Physical Chemistry, Viva Books, New Delhi, 2009. *5.* Sundaram, Krishnan, Raghavan, Practical Chemistry (Part II), S. Viswanathan Co. Pvt., 1996.
Reference Books	1. N. S. Gnanapragasam and G. Ramamurthy, Organic Chemistry – Labmanual, S. Viswanathan Co. Pvt. Ltd, 2009. 2. J. N. Gurtu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 2011. 3. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001. 4. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th edition, McGraw Hill, 2009. 5. J. N. Gurthu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 1987.
Website and e-learning source	1. https://bit.ly/3QESF7t 2. https://bit.ly/3QANOnX
Course Learning Outcomes (for Mapping with POs and PSOs) Students will be able: CO1: To scientifically plan and perform all the experiments CO2: To observe and record systematically the readings in all the experiments CO3: To calculate and process the experimentally measured values and compare with graphical data.	

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**
CO 2	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**S**	**S**

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
Weight age	09	09	09	09	09
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-IV/ Core Course -XIII	PROJECT	Course Code:
Instruction Hours : 6	Credits: 4	Exam Hours: 3
Internal Marks: 25	External Marks: 75	Total Marks: 100

Semester-IV/ Elective Course - III	EC III- POLYMER CHEMISTRY	Course Code:
Instruction Hours : 6	Credits: 4	Exam Hours: 3
Internal Marks: 25	External Marks: 75	Total Marks: 100
Cognitive Level	K1 – Recalling K2 – Understanding K3 - Applying K4 – Analyzing K5 – Evaluating K6 - Creating	
Objectives ofthe course	• To learn the basic concepts and bonding in polymers. • To explain various types of polymerization reactions and kinetics. • To understand the importance of industrial polymers and their syntheticuses. • To determine the molecular weight of polymers. • To predict the degradation of polymers and conductivities.	
Course Outline	**UNIT-I: Characterization, Molecular weight and its Determination:** Primary and secondary bond forces in polymers; cohesive energy, molecular structure, chemical tests, thermal methods, Tg, molecular distribution, stability. Determination of Molecular mass of polymers: Number Average molecular mass (M_n) and Weight average molecular mass (M_w) of polymers. Molecular weight determination of high polymers by physical and methods.	
	UNIT-II: Mechanism and kinetics of Polymerization: Chain growth polymerization: Cationic, anionic, free radical polymerization, Stereo regular polymers: Ziegler Natta polymerization. Reaction kinetics. Step growth polymerization, Degree of polymerization.	
	UNIT-III: Techniques of Polymerization and Polymer Degradation: Bulk, Solution, Emulsion, Suspension, solid, interfacial and gas phase polymerization. Types of Polymer Degradation, Thermal degradation, mechanical degradation, photodegradation, Photo stabilizers, Solid and gas phase polymerization.	
	UNIT-IV: **Industrial Polymers:** Preparation of fibre forming polymers, elastomeric material. Thermoplastics: Polyethylene, Polypropylene, polystyrene, Polyacrylonitrile, Poly Vinyl Chloride, Poly tetrafluoro ethylene, nylon and polyester. Thermosetting Plastics: Phenol formaldehyde and expoxide resin. Elastomers: Natural rubber and syntheticrubber - Buna - N, Buna-S and neoprene. Conducting Polymers: Elementaryideas; examples: poly pyrrole and polyacetylene. Polymethylmethacrylate, polyimides, polyamides, polyurethanes, polyureas,	

	UNIT-V: Polymer Processing: Compounding: Polymer Additives: Fillers, Plasticizers, antioxidants, thermal stabilizers, fire retardants and colourants. Processing Techniques: Calendaring, die casting, compression moulding, injection moulding, blow moulding and reinforcing. Film casting, Thermofoaming, Foaming. Catalysis and catalysts – Polymerization catalysis, catalyst support, clay compounds, basic catalyst, auto-exhaust catalysis, vanadium, heterogeneous catalysis and active centres.
RecommendedText	**1.** V.R. Gowariker, *Polymer Science*, Wiley Eastern, 1995. **2.** G.S. Misra, *Introductory Polymer Chemistry*, New Age International (Pvt) Limited, 1996. **3.** M.S. Bhatnagar, A Text Book of Polymers, vol-I & II, S.Chand & Company, New Delhi, 2004.
Reference Books	1. F. N. Billmeyer, *Textbook of Polymer Science*, Wiley Interscience,1971. *2.* A. Kumar and S. K. Gupta, *Fundamentals and Polymer Science and Engineering*, Tata McGraw-Hill, 1978.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

CO1: To understand the bonding in polymers.

CO2: To scientifically plan and perform the various polymerization reactions.CO3: To observe and record the processing of polymers.

CO4: To calculate the molecular weight by physical and chemical methods.

CO5: To interpret the experimental data scientifically to improve the quality of syntheticpolymers.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0