A.V.V.M. Sri Pushpam College (Autonomous), Poondi – 613 503

PG & Research Department of Chemistry

M.Sc., Programme in Chemistry

OUTCOME BASED EDUCATION - CHOICE BASED CREDIT SYSTEM

SCHEME OF PROGRAMME AND SYLLABUS

(For the candidates admitted from 2023-2024 onwards)

Vision and Mission of the college

Vision

To provide quality academic programmes and value oriented higher education to the rural community, equip them to encounter current regional, national and global demands upholding moral standards and intellectual competency.

Mission

- To provide conducive environment for quality teaching-learning process and innovative research.
- To bestow substantial educational experience that is intellectually, socially, and personally transformative.
- To strive to bring out the latent potentiality and core competency of the learners
- To foster the culture of research-based learning, independent academic inquiry by encouraging the students to involve in research activities ranging from hands on training, student projects, publications etc.,
- To nurture essential skills, competent minds and compassionate hearts.
- To impart a practical, demanding and overall development of the personality generated by love, consideration and care for the society.
- To serve the society by extending needful outreach programmes to the rural populace.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

- Make the learners realise the transformative power of education.

- Acquire profound disciplinary, applied, integrative knowledge and intellectual competency and domain specific and generic skills.
- Pursue lifelong learning and generate innovative solutions for the problems at individual and social level.
- Create a collaborative and inclusive environment, and serve the betterment of the society with moral integrity.
- Motivate to become a committed professional with necessary ethics as a leader as well as a team player.

PROGRAMME OUTCOMES for Chemistry Programme

On the completion of the programme, the learners will be able to,

PO1: Profound expertise in discipline, interpret advanced and contemporary concepts, principle and theories in the appropriate field to solve real problems.

PO2: Acquire good communication and presentation skills, aid them to become employable.

PO3: Identify and formulate problems critically and integrate resources to reach decisions, make recommendations or carry out action plans.

PO4: Develop and write innovative, scientific research projects on emerging contemporary issues.

PO5: Broaden scientific approach not only with respect to science subjects but also in all aspects related to ethical moral and social values in personal and social life.

PO6: Function effectively in teams to create a collaborative and inclusive environment to achieve goals.

PO7: Expertise in independent and lifelong learning through online courses to fit in an ever-changing world.

PROGRAMME SPECIFIC OUTCOMES for M.Sc Chemistry Programme

On the completion of the programme, the learners would have,

PSO1: gathered comprehensive theoretical and practical knowledge in chemistry

PSO2: acquired knowledge of organic synthesis, inorganic synthesis and medicinal chemistry for employment in research and development in all pharmaceutical fields.

PSO3: equipped themselves to analyze the compounds qualitatively and quantitatively which is useful for placement in quality control and formulation departments in analytical lab.

PSO4: develop the confidence to pursue research in thrust areas of chemistry

PSO5: acquired skill to understand chemistry related social, ethical, global and environmental responsibility for the benefit of the society

PSO6: adopted the principles of green chemistry and phytochemistry for designing experimental techniques to mitigate environmental pollution.

PSO7: confidently appear for competitive examinations such as NET, GATE, SET, UPSC, TNPSC, BARC, ONGC etc, and also to become entrepreneur

Curriculum Structure for PG Programmes (OBE- CBCS) - 2023

	Nature of Course	Total No. of Courses	Total marks	Total credits	Total credits for the Programme
Part – A	Core Course	13	1300	51	80 (CGPA)
	Elective Course	05	500	15	
	Extra Disciplinary Course	01	100	3	
	Core Industry Module (CIM)	01	100	3	
Part – B (i)	Skill Enhancement Course (SEC)	04	400	8	
Part – B (ii)	Ability Enhancement Compulsory Course (AECC)	04	400	8	10 (Non CGPA)
	Internship / Industrial Activity	--	--	2	
	Total	**28**	**2800**	**90**	**90**
Value Added Course (VAC)		01	100	--	
Extra Credit Course - **MOOC / Field visit / Hands on Training**		--	--	Max: 4	

Part A component and Part B (i) will be taken into account for CGPA calculation for the postgraduate programme and the other components Part B and Part C have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the PG degree

Course Structure: M.Sc. Chemistry (2023)

S. No.	Semester	Category	Course Code	Title of the Course	Maximum Marks			Minimum Marks for Pass			Hours/ Week	Credits
					CIA	EE	Total	CIA	EE	Total		
1	I	Core	23P1CHC1	Organic Reaction Mechanism-I	25	75	100	10	30	50	6	4
2		Core	23P1CHC2	Structure and Bonding in Inorganic Compounds	25	75	100	10	30	50	5	4
3		Core	23P1CHCP1	Organic Chemistry Practical	25	75	100	10	30	50	5	4
4		Elective	23P1CHEL1A/ 23P1CHEL1B	Material Science / Nanomaterials and Nanotechnology	25	75	100	10	30	50	5	3
5		Elective	23P1CHEL2A/ 23P1CHEL2B	Electrochemistry/ Molecular Spectroscopy	25	75	100	10	30	50	5	3
6		SEC1	23P1CHSEC1	Computational Chemistry	25	75	100	10	30	50	2	2
7		AECC1	23P1CHAECC1	Communicative Skill and Personality Development	25	75	100	10	30	50	2	2
		Extra Credit	Field visit / Hands on Training		-	-	-	-	-	-	-	-
8	II	Core	23P2CHC3	Organic reaction mechanism-II	25	75	100	10	30	50	6	4
9		Core	23P2CHC4	Physical Chemistry-I	25	75	100	10	30	50	5	4
10		Core	23P2CHCP2	Inorganic Chemistry Practical	25	75	100	10	30	50	5	4
11		Elective	23P2CHEL3A/ 23P2CHEL3B	Medicinal Chemistry/ Green Chemistry	25	75	100	10	30	50	5	3
12		Elective	23P2CHEL4A/ 23P2CHEL4B	Bio Inorganic Chemistry/ Cheminformatics	25	75	100	10	30	50	5	3
13		SEC 2	23P2CHSEC2	Domestic Chemicals Preparation	25	75	100	10	30	50	2	2
14		AECC 2	23P2CHAECC2	Language Lab	25	75	100	10	30	50	2	2

S. No.	Semester	Category	Course Code	Title of the Course	Maximum Marks			Minimum Marks for Pass			Hours/ Week	Credits
					CIA	EE	Total	CIA	EE	Total		
15	III	Core	23P3CHC5	Organic synthesis and Photochemistry	25	75	100	10	30	50	6	4
16		Core	23P3CHC6	Coordination Chemistry – I	25	75	100	10	30	50	6	4
17		Core	23P3CHCP3	Physical Chemistry Practical	25	75	100	10	30	50	5	4
18		EDC	23P3CHEDC	Chemistry in Every Day Life	25	75	100	10	30	50	4	3
19		CIM	23P3CHCIM	Industrial Chemistry	25	75	100	10	30	50	5	3
20		SEC 3	23P3CHSEC3	Dye chemistry	25	75	100	10	30	50	2	2
21		AECC 3	23P3CHAECC3	Research Methodology	25	75	100	10	30	50	2	2
		Internship / Industrial Activity (Carried out in summer vacation at the end of I Year – 30 hours)									-	2
		Extra Credit MOOC(Massive open online course)			-	-	-	-	-	-	-	-
22	IV	Core	23P4CHC7	Coordination Chemistry-II	25	75	100	10	30	50	6	4
23		Core	23P4CHC8	Physical Chemistry-II	25	75	100	10	30	50	5	4
24		Core	23P4CHCP4	Analytical Instrumentation technique Practicals	25	75	100	10	30	50	5	4
25		Elective	23P4CHEL5A/ 23P4CHEL5B	Chemistry of Natural products/ Polymer Chemistry	25	75	100	10	30	50	5	3
26		Core	23P4CHC9PR	Project with Viva Voce	25	75	100	10	30	50	5	3
27		SEC4	23P4CHSEC4	Paint chemistry	25	75	100	10	30	50	2	2
28		AECC4	23P4CHAECC4	Comprehensive Knowledge	-	100	100	-	-	50	2	2
				Total			**2800**					**90**
		Value Add Course		Food additives & Preservation	-	100	100	-	50	50	SS	-
		Extra Credit MOOC(Massive open online course)			-	-	-	-	-	-	-	-

Internship/ Industrial Activity:

Students must complete in-plant training in any industry or organization where a programme-related procedure is being used, and this training must be done during the summer vacation at the end of I Year. A minimum of 30 hours should be spent on training. Students must submit a report on their training together with a certificate from the relevant industry or organization authority.

Ability Enhancement Compulsory Course (AECC): (Communicative Skill and Personality Development, Language Lab, Research Methodology and Comprehensive Knowledge)

Mode of Assessment for these courses is Viva-Voce examination.

Components of Evaluation:

Internal Marks : 25

External Marks: 75

Total : 100

Field visit / Hands on Training:

In order to achieve experiential learning, these programmes with a minimum of 15 hours of contact time are offered as Extra Credit Courses in the I Semester.

Evaluation of visit report will be held at the end of II Semester.

Components of Evaluation:

Internal Marks : 25

External Marks : 75

Total : 100

MOOC:

Massive Open Online Course is offered in the III and IV Semester as an Extra Credit Course. Students can avail any one or more of the courses available in MOOC to equip their skill and knowledge themselves. To receive the extra credit, students must provide their MOOC course completion certificate at the end of the second year.

Skill Enhancement courses (SEC) offered by the Chemistry Department

1. Computational Chemistry 2. Domestic Chemicals Preparation 3. Dye chemistry 4. Paint chemistry

Extra Disciplinary Course (EDC) offered by the Chemistry Department

Chemistry in every Day Life

Value Added Course offered by the Chemistry Department:

"**Food additives & Preservation"** will be conducted for II PG students as a certificate Course.

A.VEERIYA VANDAYAR MEMORIAL SRI PUSHPAM COLLEGE (AUTONOMOUS),POONDI, THANJAVUR DIST.
(NAAC Re-Accredited with A grade in 4th cycle)
Question Pattern for UG and PG Programmes
(For the students admitted from 2023 – 2024 onwards)

Bloom's Taxonomy based Assessment pattern

Bloom's category	Section	Choice	Marks	Total
K1 to K6	A	Compulsory	10 x 2 = 20	75
	B	Either / Or	5 x 5 = 25	
	C	3 out of 5	3 x 10 = 30	

OBE QUESTION PATTERN

Total Marks: 75

CO	K Level	Q. No.	Questions
			SECTION – A (10 x 2 = 20) **Answer All the questions** (Two Questions from each units)
		1.	
		2.	
		3.	
		4.	
		5.	
		6.	
		7.	
		8.	
		9.	
		10.	
			SECTION – B (5 x 5 = 25) **Answer All the questions** (One Question from each unit)
		11(a).	
			(OR)
		11(b).	
		12(a).	
			(OR)
		12(b).	
		13(a).	
			(OR)
		13(b).	
		14(a).	
			(OR)
		14(b).	
		15(a).	
			(OR)
		15(b).	
			SECTION – C (3 x 10 = 30) **Answer ANY THREE questions** (One Question from each unit)
		16.	
		17.	
		18.	
		19.	
		20.	

Bloom's Taxonomy Action Verbs

K1 Remember	K2 Understand	K3 Apply	K4 Analyze	K5 Evaluate	K6 Create
• Choose • Copy • Define • Describe • Discover • Duplicate • Enumerate • Examine • Find • How • Identify • Label • List • Locate • Match • Memorize • Name • Omit • Recall • Recognize • Relate • Select • Show • Spell • State • Tabulate • Tell • What • When • Where • Which • Who • Why	• Associate • Classify • Compare • Contrast • Convert • Demonstrate • Describe • Differentiate • Discuss • Distinguish • Estimate • Explain • Express • Extend • Identify • Illustrate • Indicate • Infer • Interpret • Outline • Paraphrase • Predict • Relate • Rephrase • Show • Summarize • Translate	• Apply • Build • Calculate • Change • Choose • Complete • Construct • Demonstrate • Develop • Discover • Dramatize • Experiment • Identify • Interview • Interpret • Illustrate • Make use of • Manipulate • Model • Modify • Organize • Paint • Plan • Prepare • Produce • Relate • Select • Show • Sketch • Solve • Use • Utilize	• Advertise • Appraise • Analyze • Assume • Break down • Categorize • Classify • Compare • Conclusion • Connect • Contrast • Differentiate • Discover • Dissect • Distinguish • Discriminate • Divide • Examine • Explain • Function • Inference • Inspect • List • Motive • Order • Point out • Prioritize • Relationships • Select • Separate • Simplify • Subdivide • Survey • Takepartin • Testfor • Theme	• Agree • Appraise • Assess • Award • Choose • Compare • Conclude • Convince • Criteria • Criticize • Decide • Deduct • Defend • Determine • Discriminate • Estimate • Evaluate • Explain • Find errors • Grade • Importance • Influence • Interpret • Judge • Justify • Mark • Measure • Order • Predict • Prioritize • Prove • Rank • Rate • Recommend • Reframe • Select • Summarize • Support • Value	• Adapt • Build • Change • Choose • Combine • Compile • Compose • Construct • Create • Design • Develop • Discuss • Elaborate • Estimate • Formulate • Generalize • Hypothesize • Imagine • Improve • Integrate • Invent • Make up • Maximize • Minimize • Modify • Originate • Organize • Plan • Predict • Prepare • Produce • Propose • Rearrange • Rewrite • Role-play • Solution • Solve • Substitute • Write

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
I	23P1CHC1	ORGANIC REACTION MECHANISM - I	6	4

Objective of the course	• To understand the feasibility and the mechanism of various organicreactions. • To comprehend the techniques in the determination of reactionmechanisms. • To understand the concept of stereochemistry involved in organiccompounds. • 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 labelling, isotope effects and stereo chemical evidences. Kinetic methods - relation of rate and mechanism. 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: (4n+2) HNuckel's rule, aromatic of benzenoid compounds. 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 theconfiguration. Racemic modifications: Racemization by thermal, anion, cation, reversible formation, epimerization, mutarotation. D, L system, Cram's and Prelog's rules: R, S- notations, proR, proS, side phase and re phase Cahn-Ingold-Prelog rules, absolute and relative configurations. Configurations of allenes, spiranes, biphenyls, cyclooctene, helicene, binaphthyls, ansa and cyclophanic compounds, exo-cyclic alkylidene-cycloalkanes. Topicity and prostereoisomerism, chiral shift reagents and chiral solvating reagents. 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. 5. I. L. Finar, Organic chemistry, Vol-1 & 2, 6th edition, Pearson Education Asia, 2004.
Website and e-learning source	1.https://sites.google.com/site/chemistryebookscollection02/home/organic-chemistry/organic 2. https://www.organic-chemistry.org/

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	To recall the basic principles of organic chemistry.	**K1**
CO2	To understand the formation and detection of reaction intermediates of organicreactions.	**K2,K3**
CO3	To predict the reaction mechanism of organic reactions and stereochemistry oforganic compounds.	**K4**
CO4	To apply the principles of kinetic and non-kinetic methods to determine the mechanismof reactions.	**K5**
CO5	To design and synthesize new organic compounds by correlating the stereochemistry of organic compounds.	**K6**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong M – Medium L – Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
I	23P1CHC2	STRUCTURE AND BONDING IN INORGANIC COMPOUNDS	5	4

Objectives of the course	• To determine the structural properties of main group compounds and clusters. • To gain fundamental knowledge on the structural aspects of ioniccrystals. • 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 ofPaulings 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 Bravis 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 andexamples.
	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) and their effect on the electrical and optical property, laser and phosphors; Linear defects and its effects due to dislocations.
RecommendedText	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. Saunderscompany: 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 andModels 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 StateChemistry, 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; InorganicChemistry; 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 Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	Predict the geometry of main group compounds and clusters.	**K1**
CO2	Explain about the packing of ions in crystals and apply the radius ratio rule to predictthe coordination number of cations.	**K2**
CO3	Understand the various types of ionic crystal systems and analyze their structuralfeatures.	**K3**
CO4	Explain the crystal growth methods.	**K5**
CO5	To understand the principles of diffraction techniques and microscopic techniques.	**K6**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
I	23P1CHCP1	ORGANIC CHEMISTRY PRACTICAL	5	4

Objectives of the course	• To understand the concept of separation, qualitative analysis and preparation of organic compounds. • To develop analytical skill in the handling of chemical reagents for separation of binary and ternary organic mixtures. • To analyze the separated organic components systematically and derivative them suitably. • To construct suitable experimental setup for the organic preparations involving two stages. • To experiment different purification and drying techniques for the compound processing.
Course Outline	**UNIT-I: Separation and analysis:** A. Two component mixtures. B. Three component mixtures.
	UNIT-II: Estimations: a) Estimation of Phenol (bromination) b) Estimation of Aniline (bromination) c) Estimation of Ethyl methyl ketone (iodimetry) d) Estimation of Glucose (redox) e) Estimation of Ascorbic acid (iodimetry) f) Estimation of Aromatic nitro groups (reduction) g) Estimation of Glycine (acidimetry) h) Estimation of Formalin (iodimetry) i) Estimation of Acetyl group in ester (alkalimetry) j) Estimation of Hydroxyl group (acetylation) k) Estimation of Amino group (acetylation)
	UNIT-III: Two stage preparations: a) *p*-Bromoacetanilide from aniline b) *p*-Nitroaniline from acetanilide c) 1,3,5-Tribromobenzene from aniline d) Acetyl salicyclic acid from methyl salicylate e) Benzilic acid from benzoin f) *m*-Nitroaniline from nitrobenzene *m*-Nitrobenzoic acid from methyl benzoate
Recommended Text	1. A R West, Solid state Chemistry and its applications, 2nd Edition (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.
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.
Website and e-learning source	https://ocw.mit.edu/courses/3-091-introduction-to-solid-state- chemistry-fall-2018/video_galleries/lecture-videos/

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	To recall the basic principles of organic separation, qualitative analysis and preparation.	**K1**
CO2	To explain the method of separation and analysis of separated organic mixtures and convert them as derivatives by suitable preparation method.	**K3**
CO3	To determine the characteristics of separation of organic compounds by various chemical reactions.	**K2**
CO4	To develop strategies to separate, analyze and prepare organic compounds.	**K5**
CO5	To formulate a method of separation, analysis of organic mixtures and design suitable procedure for organic preparations.	**K6**

Cognitive Level: K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
I	23P1CHEL1A	Major Elective – I MATERIAL SCIENCE	5	3

Objectives of the course	• To understand the crystal structure, growth methods and X-ray scattering. • To explain the optical, dielectric and diffusion properties of crystals. • To recognize the basis of semiconductors, superconductivity materials and magnets. • To study the synthesis, classification and applications of nanomaterials. • To learn about the importance of materials used for renewable energy conversion.
Course Outline	**UNIT-I: Crystallography:** symmetry - unit cell and Miller indices - crystal systems - Bravais lattices - point groups and space groups - X-ray diffraction-Laue equations-Bragg's law-reciprocal lattice and its application to geometrical crystallography. Crystal structure–powder and single crystal applications. Electron charge density maps, neutron diffraction-method and applications.
	UNIT-II: Crystal growth methods: Nucleation–equilibrium stability and metastable state. Single crystal –Low and high temperature, solution growth–Gel and sol-gel. Crystal growth methods- nucleation– equilibrium stability and metastable state. Single crystal–Low and high temperature, solution growth–Gel and sol-gel. Melt growth - Bridgeman-Stockbarger,Czochralski methods. Flux technique, physical and chemical vapour transport. Lorentz and polarization factor - primary and secondary extinctions.
	UNIT-III: Properties of crystals: Optical studies - Electromagnetic spectrum (qualitative) refractive index – reflectance – transparency, translucency and opacity. Types of luminescence – photo-, electro-, and injection luminescence, LEDs – organic, Inorganic and polymer LED materials - Applications. Dielectric studies- Polarisation - electronic, ionic, orientation, and space charge polarisation. Effect of temperature. dielectric constant, dielectric loss. Types of dielectric breakdown– intrinsic, thermal, discharge, electrochemical and defect breakdown.
	UNIT-IV: Special Materials: Superconductivity: Meissner effect, Critical temperature and critical magnetic Field, Type I and II superconductors, BCS theory-Cooper pair, Applications. Soft and hard magnets – Domain theory Hysteresis Loop-Applications. Magneto and gian magneto resistance. Ferro, ferri and antiferromagnetic materials- applications, magnetic parameters for recording applications. Ferro-, Piezo-, and pyro electric materials – properties and applications. Shape memory Alloys-characteristics and applications, Non-linear optics- Second Harmonic Generators, mixing of Laser wavelengths by quartz, ruby and $LiNbO_3$.

	UNIT-V: Materials for Renewable Energy Conversion: Solar Cells: Organic, bilayer, bulk heterojunction, polymer, perovskite based. Solar energy conversion: lamellar solids and thin films, dye-sensitized photo voltaic cells, coordination compounds anchored onto semiconductor surfaces - Ru(II) and Os(II) polypyridyl complexes. Photochemical activation and splitting of water, CO2 and N2. Manganese based photo systems for water-splitting. Complexes of Rh, Ru, Pd and Pt - photochemical generation of hydrogen from alcohol.
Recommended Text	1. S. Mohan and V. Arjunan, Principles of Materials Science, MJP Publishers, 2016. 2. Arumugam, Materials Science, Anuradha Publications, 2007. 3. Giacavazzo et. al., Fundamentals of Crystallography, International Union of Crystallography. Oxford Science Publications, 2010 4. Woolfson, An Introduction to Crystallography, Cambridge University Press, 2012. 5. James F. Shackelford and Madanapalli K. Muralidhara, Introduction to Materials Science for Engineers. 6th ed., PEARSON Press, 2007.
Reference Books	1. Suggested Readings 1. M.G. Arora, Solid State Chemistry, Anmol Publications, New Delhi, 2001. 2. R.K. Puri and V.K. Babbar, Solid State Physics, S Chand and Company Ltd, 2001. 3. C. Kittel, Solid State Physics, John-Wiley and sons, NY, 1966. 4. H.P. Meyers, Introductory Solid State Physics, Viva Books Private Limited, 1998. 5. A.R. West, Solid State Chemistry and Applications, John-Wiley and sons, 1987.
Website and e-learning source	1. http://xrayweb.chem.ou.edu/notes/symmetry.html. 2. http://www.uptti.ac.in/classroom-content/data/unit%20cell.pdf. 1. https://bit.ly/3QyVg2R

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	To understand and recall the synthesis and characteristics of crystal structures, semiconductors, magnets, nanomaterials and renewable energy materials.	**K1**
CO2	To integrate and assess the structure of different materials and their properties.	**K2**
CO3	To analyse and identify new materials for energy applications.	**K3**
CO4	To explain the importance of crystal structures, piezoelectric and pyroelectric materials, nanomaterials, hard and soft magnets, superconductors, solar cells, electrodes, LED uses, structures and synthesis.	**K5**
CO5	To design and develop new materials with improved property for energy applications.	**K6**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
I	23P1CHEL1B	Major Elective – I NANO MATERIALS AND NANO TECHNOLOGY	5	3

Objectives ofthe course	• To understand the concept of nano materials and nano technology. • To understand the various types of nano materials and their properties. • To understand the applications of synthetically important nano materials. • To correlate the characteristics of various nano materials synthesized bynew technologies. • To design synthetic routes for synthetically used new nano materials.
Course Outline	**UNIT-I:** Introduction of nanomaterials and nanotechnologies, Introduction-role of size, classification-0D, 1D, 2D, 3D. Synthesis- Bottom –Up, Top–Down, consolidation of Nano powders. Features of nanostructures, Background of nanostructures. Techniques of synthesis of nanomaterials, Tools of the nanoscience. Applications of nanomaterials and technologies.
	UNIT-II: Bonding and structure of the nanomaterials, Predicting the Type of Bonding in a Substance crystal structure. Metallic nanoparticles, Surfaces of Materials, Nanoparticle Size and Properties. Synthesis- Physical and chemical methods - inert gas condensation, arc discharge, laser ablation, sol-gel, solvothermal and hydrothermal-CVD-types, metallo organic, plasma enhanced, and low-pressure CVD. Microwave assisted and electrochemical synthesis.
	UNIT-III: Mechanical properties of materials, theories relevant to mechanical properties. Techniques to study mechanical properties of nanomaterials, adhesion and friction, thermal properties of nanomaterials Nanoparticles: gold and silver, metal oxides: silica, iron oxide and alumina - synthesis and properties.
	UNIT-IV: Electrical properties, Conductivity and Resistivity, Classification of Materials based on Conductivity, magnetic properties,electronic properties of materials. Classification of magneticphenomena. Semiconductor materials – classification-Ge, Si, GaAs, SiC, GaN, GaP, CdS,PbS. Identification of materials as p and n –type semiconductor-Hall effect - quantum and anomalous, Hall voltage - interpretation of charge carrier density. Applications of semiconductors: p-n junction as transistors and rectifiers, photovoltaic and photogalvanic cell.

	UNIT-V: Nano thin films, nanocomposites. Application of nanoparticles in different fields. Core-shell nanoparticles - types, synthesis, and properties. Nanocomposites - metal-, ceramic- and polymer-matrix composites-applications. Characterization – SEM, TEM and AFM - principle, instrumentation and applications.
Recommended Text	1. S.Mohan and V. Arjunan, Principles of Materials Science, MJP Publishers, 2016. 2. Arumugam, Materials Science, Anuradha Publications,2007. 3. Giacavazzo et. al., Fundamentals of Crystallography, International Union of Crystallography. Oxford Science Publications, 2010 4. Woolfson, An Introduction to Crystallography, Cambridge University Press, 2012. 5. James F. Shackelford and Madanapalli K. Muralidhara, Introduction to Materials Science for Engineers. 6th ed., PEARSON Press, 2007.
Reference Books	1. S.Mohan and V. Arjunan, Principles of Materials Science, MJP Publishers, 2016. 2. Arumugam, Materials Science, Anuradha Publications,2007. 3. Giacavazzo et. al., Fundamentals of Crystallography, International Union of Crystallography. Oxford Science Publications, 2010 4. Woolfson, An Introduction to Crystallography, Cambridge University Press, 2012. 5. James F. Shackelford and Madanapalli K. Muralidhara, Introduction to Materials Science for Engineers. 6th ed., PEARSON Press, 2007.
Website and e-learning source	1. http://xrayweb.chem.ou.edu/notes/symmetry.html. 2. http://www.uptti.ac.in/classroom-content/data/unit%20cell.pdf.

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	To explain methods of fabricating nanostructures.	**K1**
CO2	To relate the unique properties of nanomaterials to reduce dimensionality of thematerial.	**K3**
CO3	To describe tools for properties of nanostructures.	**K2**
CO4	To discuss applications of nanomaterials.	**K5**
CO5	To understand the health and safety related to nanomaterial.	**K6**

Cognitive Level: K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
I	23P1CHEL2A	Major Elective – II ELECTROCHEMISTRY	5	3

Objectives ofthe course	• To understand the behavior of electrolytes in terms of conductance, ionicatmosphere, interactions. • To familiarize the structure of the electrical double layer of differentmodels. • To compare electrodes between current density and over potential. • To discuss the mechanism of electrochemical reactions. • To highlight the different types of over voltages and its applications inelectro analytical techniques.
Course Outline	**UNIT-I: Ionics**: Arrhenius theory -limitations, van't Hoff factor and its relation to colligative properties. Deviation from ideal behavior. Ionic activity, mean ionic activity and mean ionic activity coefficient-concept of ionic strength, Debye Huckel theory of strong electrolytes, activity coefficient of strong electrolytes Determination of activity coefficient ion solvent and ion-ion interactions. Born equation. Debye-Huckel Bjerrum model. Derivation of Debye-Huckel limiting law at appreciableconcentration of electrolytes modifications and applications. Electrolyticconduction-Debye-Huckel Onsager treatment of strong electrolyte- qualitative and quantitative verification and limitations. Evidence for ionic atmosphere. Ion association and triple ion formations.
	UNIT-II: Electrode-electrolyte interface: Interfacial phenomena - Evidences for electrical double layer, polarizable and non-polarizable interfaces, Electrocapillary phenomena - Lippmann equation electrocapillary curves. Electro-kinetic phenomena electro-osmosis, electrophoresis, streaming and sedimentation potentials, colloidal and poly electrolytes. Structure of double layer: Helmholtz -Perrin, Guoy- Chapman and Stern models of electrical double layer. Zeta potential andpotential at zero charge. Applications and limitations.
	UNIT-III: Electrodics of Elementary Electrode Reactions: Behavior of electrodes: Standard electrodes and electrodes at equilibrium. Anodic and Cathodic currents, condition for the discharge of ions. Nernst equation, polarizable and non-polarizable electrodes. Model of three electrode system, over potential. Rate of electro chemical reactions: Ratesof simple elementary reactions. Butler-Volmer equation-significance of exchange current density, net current density and symmetry factor. Low and high field approximations. symmetry factor and transfer coefficient Tafel equations and Tafel plots.

	UNIT-IV: Electrodics of Multistep Multi Electron System: Rates of multi-step electrode reactions, Butler - Volmer equation for a multi-step reaction. Rate determining step, electrode polarization and depolarization. Transfer coefficients, its significance and determination, Stoichiometric number. Electro-chemical reaction mechanisms-rate expressions, order, and surface coverage. Reduction of I^{3-}, Fe^{2+}, and dissolution of Fe to Fe^{2+}. Overvoltage - Chemical and electro chemical, Phase, activation and concentration over potentials. Evolution of oxygen and hydrogen at different pH. Pourbiax and Evan's diagrams.
	UNIT-V: Concentration Polarization, Batteries and Fuel cells: Modes of Transport of electro active species - Diffusion, migration and hydrodynamic modes. Role of supporting electrolytes. Polarography- principle and applications. Principle of square wave polarography. Cyclic voltammetry-anodic and cathodic stripping voltammetry and differentialpulse voltammetry. Sodium and lithium-ion batteries and redox flow batteries. Mechanism of charge storage: conversion and alloying. Capacitors- mechanism of energy storage, charging at constant current and constant voltage. Energy production systems: Fuel Cells: classification, alkaline fuel cells, phosphoric acid fuel cells, high temperature fuel cells.
Recommended Text	1. D. R. Crow, Principles and applications of electrochemistry, 4thedition, Chapman & Hall/CRC, 2014. 2. J. Rajaram and J.C. Kuriakose, Kinetics and Mechanism of chemical transformations Macmillan India Ltd., New Delhi, 2011. 3. S. Glasstone, Electro chemistry, Affiliated East-West Press, Pvt.,Ltd., New Delhi, 2008. 4. B. Viswanathan, S. Sundaram, R. Venkataraman, K. Rengarajan and P.S. Raghavan, Electrochemistry-Principles and applications, S. Viswanathan Printers, Chennai,2007. 5. Joseph Wang, Analytical Electrochemistry, 2nd edition, Wiley, 2004.
Reference Books	1. J.O.M. Bockris and A.K.N. Reddy, Modern Electro chemistry, vol.1and 2B, Springer, Plenum Press, New York, 2008. 2. J.O.M. Bockris, A.K.N. Reddy and M.G. Aldeco Morden Electro chemistry, vol. 2A, Springer, Plenum Press, New York, 2008. 3. Philip H. Rieger, Electrochemistry, 2nd edition, Springer, New York, 2010. 4. L.I. Antropov, Theoretical electrochemistry, Mir Publishers, 1977. 5. K.L. Kapoor, A Text book of Physical chemistry, volume-3, Macmillan, 2001.
Website and e-learning source	1. https://www.pdfdrive.com/modern-electrochemistry-e34333229.

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	To understand the behaviour of electrolytes in solution and compare the structures ofelectrical double layer of different models.	**K1**
CO2	To predict the kinetics of electrode reactions applying Butler-Volmer and Tafel equations.	**K2**
CO3	To study different thermodynamic mechanism of corrosion.	**K4**
CO4	To discuss the theories of electrolytes, electrical double layer, electronics and activitycoefficient of electrolytes.	**K3**
CO5	To have knowledge on storage devices and electrochemical reaction mechanism.	**K6**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
I	23P1CHEL2B	Major Elective – II MOLECULAR SPECTROSCOPY	5	3

Objectives ofthe 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 theselection 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.
Cou rse Outl ine	**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 theoryof 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: Vibrational Spectroscopy: Vibrations of molecules, harmonic and anharmonic oscillators- vibrational energy expression, energy level diagram, vibrational wave functions and their symmetry, selection rules, expression for the energies of spectral lines, computation of intensities, hot bands, effect of isotopic substitution. Diatomic vibrating rotor, vibrational-rotational spectra of diatomic molecules, P, R branches, breakdown of the Born-Oppenheimer approximation. Vibrations of polyatomic molecules – symmetry properties, overtone and combination frequencies. Influence of rotation on vibrational spectra of polyatomic molecule, P, Q, R branches, parallel and perpendicular vibrations of linear and symmetric top molecules.
	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 and ESR 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. 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 spectra of magnetically dilute samples.
	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. Structural elucidation of organic compounds by combined spectral techniques. Principle of Mossbauer spectroscopy: Doppler shift, recoil energy. Isomer shift, quadrupole splitting, magnetic interactions. Applications: Mossbauer spectra of high and low-spin Fe and Sn compounds.
Recommended Text	1. 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.
Reference 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 Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	To understand the importance of rotational and Raman spectroscopy.	**K1**
CO2	To apply the vibrational spectroscopic techniques to diatomic and polyatomic molecules.	**K3**
CO3	To evaluate different electronic spectra of simple molecules using electronic spectroscopy.	**K3**
CO4	To outline the NMR, ^{13}C NMR, 2D NMR – COSY, NOESY, Introduction to ^{31}P, ^{19}FNMR and ESR spectroscopic techniques.	**K4**
CO5	To develop the knowledge on principle, instrumentation and structural elucidation of simple molecules using Mass Spectrometry, EPR and Mossbauer Spectroscopy techniques.	**K5**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
I	23P1CHSEC1	Skill Enhancement Course - Computational Chemistry	2	2

Objectives ofthe course	The main objectives of this course are to: • Understand the various types of databases and their utility to solve various quarries. • learn how to build new chemical structures. • understand how to derive, represent and manipulate the structures and reactions of molecules.
Course Outline	**Unit I: Basics of Cheminformatics (5 hours)** Chemical-biological databases and data sources; (Pubchem& PDB) Chemical fileformats; (MOL, SDF, PDB formats), File format conversion using OPEN BABEL. **Computer assisted drug design (7 hours)** Drug Likeness Prediction - Properties of small molecules, structural features, ADMEprediction, Bioavailability, Toxicity studies, Pharmacokinetics and Pharmacodynamics ofdrugs (Swiss ADME &PreADMET servers). **Computational quantum chemistry (3 hours)** Potential energy surface- stationary point, saddle point or transition state, local andglobal minima, Basis sets, Quantum mechanical computational methods-Ab initio methods,Semi empirical methods, DFT methods. Non-quantum mechanical computational methods.
	Unit II: Software Training (8 hours) Chemistry related softwares - Structure drawing softwares, molecular modelling softwares,Molecular visualization and docking tools (Avogadro,Chemdraw, Chem-3D,Pymol& Discovery Studio). Retrieving chemical and biological information from online data bases (Swiss prot, NCI,PDB and CCDC), online compound collection data bases (molinspiration), Regression analysis of the given set of data (MS-Excel) and Prediction of UV-Spectra of the given molecules using Argus Lab. **Computational Chemistry Experiments (7 hours)** 1. Single point energy and vibrational frequency calculation of simple molecules 2. Calculation of energy of HOMO and LUMO of simple organic molecules 3. Ionisation energy and electron affinity calculations. 4. Calculation of ADMET properties of some drugs using DruLiTo (Drug likeliness toxicity). 5. Calculation of the topological and molecular parameters from chemdraw and Chem-3D. 6. Retrieving chemical and biological information from online data bases (Swiss Prot, NCI, PDB and CCDC).

	7. Use of online compound collection data bases (molinspiration). 8. Analyse the hydrogen bonding interaction in the given host guest molecules using HBAT. 9. Regression analysis of the given set of data (MS-Excel). 10. Docking: Small molecule docking using Chemdraw. 11. QSAR : a) Calculation of Clog P values b) Effect of functional group on activity c) Drawing QSAR plot based on the QSAR results. 12. Molecular visualization and interconversion using JMOL, chemissian. Prediction of UV-Spectra of the given molecules using ArgusLab.

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	understand the Chemical-biological databases and data sources	**K2**
CO2	predict and understand the various Drug Likeness properties	**K2**
CO3	understand the spatial structures of molecules	**K2**
CO4	drawing, analyzing and retrieving the chemical information from chemistry related software and online databases.	**K5**
CO5	evaluate how two or more molecular structures fit together	**K5**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO2	**M**	**S**	**S**	**S**	**S**	**M**	**S**
CO3	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO4	**M**	**S**	**S**	**S**	**S**	**M**	**S**
CO5	**M**	**S**	**M**	**S**	**S**	**M**	**S**

S– Strong **M– Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
I	23P1CHAECC1	**Ability Enhancement Compulsory Course - Communication Skill and Personality Development**	2	2

Objectives ofthe course	• To cultivate positive personality traits for successful life. • To groom Winning Attitude among the learns. • To assist the learners to identify their own potential and realize their aspirations. • To enable a holistic development. • To facilitate optimum means of improving personal performance.
Course Outline	**UNIT-I:** 1. Personality – Definition. 2. Determinants of Personality 3. Perceptual process 4. Personality Traits 5. Developing Effective Habits 6. Self esteem (freud and Erikson) 7. Self Appraisal and self development 8. Dos and Don'ts to develop positive self esteem 9. Interpersonal Relationship 10. Difference between Aggressive, Submissive and Assertive behavior 11. Mind Mapping, Competence mapping 360 degree assessment 12. Presentation skills – opening, ending, handling nerves, handling audience, power storytelling, visual aids, Question and answer session
	UNIT-II: 1. Projecting positive body language 2. Confilict management 3. Change management 4. Stress management 5. Time management 6. Goal setting 7. Assertiveness and negotiating skill 8. Problem solving skill 9. Decision making skills 10. Leadership qualities of a successful leader 11. Attitude – positive attitudes 12. Public speaking – Engaging, connecting and influencing the audiences. 13. Employability skill – group discuss, interview questions, psychometric analysis.

Reference Books	1. Hurlock.E.B (2006) : Personality Development, 28th Reprint, New Delhi : Tata McCraw Hill. 2. Stephen .P.Robbiuns and Timothy. A.Judge (2014): Organisation Behaviour . 16th Edition. Prentice Hall

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	Gain self confidence and proden perception of life	**K1**
CO2	**Maximize their potential and steer that into their career choice.**	**K2, K3**
CO3	**Enhance one's self image & self esteem**	**K3**
CO4	**Find a means to achieve excellence and derive fulfilment**	**K4**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
II	23P2CHC3	ORGANIC REACTION MECHANISM-II	6	4

Objectives ofthe course	• To understand the oxidation and reduction reactions. • To understand the mechanism involved in various types of organic reactionswith 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, andE1cB 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, aromatic substrates, reactivity in the attacking radical, effect of solvent.
	UNIT-II: Oxidation and Reduction Reactions: Mechanisms: Direct electrontransfer, 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, DMSO-Oxalyl chloride (Swern oxidation) and Corey-Kim oxidation, dimethyl sulphoxide-dicyclohexyl carbodiimide (DMSO-DCCD). 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: Wagner-Meerwein, Demjanov, Baker-Venkataraman, Benzilic acid and Wolff rearrangements. Schmidt, Lossen, Baeyer-Villiger oxidation and Dakin rearrangements. Favorskii, Quasi-Favorskii, Stevens, [1,2]-Wittig and [2,3]-Wittig rearrangements. Fries and Photo Fries rearrangement. Claisen, Cope, oxy-Cope rearrangements. Payne and Brook rearrangement
	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. Addition to 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 di-isopropylamide (LDA), Azobisisobutyronitrile (AIBN), Sodium cyanoborohydride ($NaBH_3CN$), *meta*-Chloroperbenzoic acid (m-CPBA), Dimethyl aminiopyridine (DMAP), n-Bu_3SnH, Triethylamine (TEA), Diazobicyclo[5.4.0]undec-7-ene (DBU), Diethylazodicarboxylate (DEAD), Trifluoroacetic acid (TFA), Tetramethyl piperiridin-1-oxyl (TEMPO), $TiCl_3$, $NaIO_4$, OsO_4, Pyridinium chlorochromate (PCC), Pyridinium dichromate (PDC), Suzuki coupling, Heck reaction, Baylis-Hillman reaction. Phase transfer catalysis, crown ethers. DDQ, 1,3-dithane, birch reduction
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*, 4th ed., 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 Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	To recall the basic principles of aromaticity of organic and heterocyclic compounds.	**K1**
CO2	To understand the mechanism of various types of organic reactions.	**K2, K3**
CO3	To predict the suitable reagents for the conversion of selective organic compounds.	**K3**
CO4	To correlate the principles of substitution, elimination, and addition reactions.	**K4**
CO5	To design new routes to synthesis organic compounds.	**K6**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
II	23P2CHC4	PHYSICAL CHEMISTRY-I	5	4

Objectives ofthe 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. Heat capacity of mono and di atomic gases-ortho and para hydrogen. Heat capacity of solids- Einstein and Debye models.
	UNIT-III: Irreversible Thermodynamics: Theories of conservation ofmass 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. Factors determine the reaction rates in solution - primary salt effect and secondary salt effect, 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, cationic, anionic polymerization - Polycondensation.
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 Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	To explain the classical and statistical concepts of thermodynamics.	**K2**
CO2	To compare and correlate the thermodynamic concepts to study the kinetics of chemicalreactions.	**K1**
CO3	To discuss the various thermodynamic and kinetic determination.	**K4**
CO4	To evaluate the thermodynamic methods for real gases ad mixtures.	**K5**
CO5	To compare the theories of reactions rates and fast reactions.	**K6**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
II	23P2CHCP2	INORGANIC CHEMISTRY PRACTICAL	5	4

Objectives ofthe course	• To understand and enhance the visual observation as an analytical toolfor the quantitative estimation of ions. • To recall the principle and theory in preparing standard solutions. • To train the students for improving their skill in estimating the amount ofion accurately present in the solution • To estimate metal ions, present in the given solution accurately withoutusing instruments. • To determine the amount of ions, present in a binary mixture accurately.
Course Outline	**UNIT-I: Analysis of mixture of cations:** Analysis of a mixture of four cations containing two common cations and two rare cations. Cations to be tested. Group-I : W, Tl and Pb. Group-II : Se, Te, Mo, Cu, Bi and Cd. Group-III : Tl, Ce, Th, Zr, V, Cr, Fe, Ti and U. Group-IV : Zn, Ni, Co and Mn. Group-V : Ca, Ba and Sr.Group-VI : Li and Mg.
	UNIT-II: Preparation of metal complexes: Preparation of inorganic complexes: a. Preparation of tristhioureacopper(I)sulphate b. Preparation of potassium trioxalate chromate(III) c. Preparation of tetramminecopper(II) sulphate d. Preparation of Reineck's salt e. Preparation of hexathioureacopper(I) chloridedihydrate f. Preparation of *cis*-Potassium tri oxalate diaquachromate(III) g. Preparation of sodium trioxalatoferrate(III) Preparation of hexathiourealead(II) nitrate
	UNIT-III: Complexometric Titration: 1. Estimation of zinc, nickel, magnesium, and calcium. 2. Estimation of mixture of metal ions-pH control, masking and demasking agents. 3. Determination of calcium and lead in a mixture (pH control). 4. Determination of manganese in the presence of iron. 5. Determination of nickel in the presence of iron.

Recommended Text	1. A. JeyaRajendran, Microanalytical Techniques in Chemistry: Inorganic Qualitative Analysis, United global publishers, 2021. 2. V. V. Ramanujam, *Inorganic Semimicro Qualitative Analysis*; 3rded., The National Publishing Company, Chennai, 1974. 3. *Vogel's Text book of Inorganic Qualitative Analysis,* 4thed., ELBS, London.
Reference Books	1. G. Pass, and H. Sutcliffe, *Practical Inorganic Chemistry*; ChapmanHall, 1965. 2. W. G. Palmer, Experimental *Inorganic Chemistry*; Cambridge University Press, 1954.

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	To identify the anions and cations present in a mixture of salts.	**K1**
CO2	To apply the principles of semi micro qualitative analysis to categorize acid radicals andbasic radicals.	**K2**
CO3	To acquire the qualitative analytical skills by selecting suitable confirmatory tests andspot tests.	**K4**
CO4	To choose the appropriate chemical reagents for the detection of anions and cations.	**K5**
CO5	To synthesize coordination compounds in good quality.	**K6**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
II	23P2CHEL3A	Major Elective - III MEDICINAL CHEMISTRY	5	3

Objectives ofthe course	• To study the chemistry behind the development of pharmaceutical materials. • To gain knowledge on mechanism and action of drugs. • To understand the need of antibiotics and usage of drugs. • To familiarize with the mode of action of diabetic agents and treatmentof diabetes. • To identify and apply the action of various antibiotics.
Course Outline	**UNIT-I: Introduction to receptors:** Introduction, targets, Agonist, antagonist, partial agonist. Receptors, Receptor types, Theories of Drug – receptor interaction, Drug synergism, Drug resistance, physicochemical factors influencing drug action.
	UNIT-II: Antibiotics: Introduction, Targets of antibiotics action, classification of antibiotics, enzyme-based mechanism of action, SAR of penicllins and tetracyclins, clinical application of penicillins, cephalosporin.Current trends in antibiotic therapy.
	UNIT-III: Antihypertensive agents and diuretics: Classification of cardiovascular agents, introduction to hypertension, etiology, types, classification of antihypertensive agents, classification and mechanism of action of diuretics, Furosemide, Hydrochlorothiazide, Amiloride.
	UNIT-IV: Anesthetics: Ideal anaesthetic agent-classification according to mode of action, General Anaesthetics – volatile ether, vinyl ether, halothane, trichloro ethylene – structure, advantages and disadvantages, non-volatile-thopental sodium- properties, structure, advantage and disadvantages, local anaesthetics – requisties, cocainie – structure and advantages. **Antiseptics and Disinfectants:** Distinction between disinfectants and antiseptics, phenol-coefficient. **Psychedelic drugs:** Lysergic acid diethylamide (LSD) – Pharmacological action of LSD – mechanism of action – therapeutic uses adverse effects. Marijuana – Pharmacological action and therapeutic uses.
	UNIT-V: Analgesics, Antipyretics and Anti-inflammatory Drugs: Introduction, Mechanism of inflammation, classification and mechanism of action and paracetamol, Ibuprofen, Diclofenac, naproxen, indomethacin, phenylbutazone and meperidine. Medicinal Chemistry ofAntidiabetic Agents Introduction, Types of diabetics, Drugs used for the treatment, chemical classification, Mechanism of action, Treatment of diabetic mellitus. Chemistry of insulin, sulfonyl urea.

Recommended Text	1. Wilson and Gisvold's textbook of organic medicinal and pharmaceutical chemistry, 2. Wilson, Charles Owens: Beale, John Marlowe; Block, John H, Lipincott William, 12th edition, 2011. 3. Graham L. Patrick, An Introduction to Medicinal Chemistry, 5th edition, Oxford University Press, 2013. Jayashree Ghosh, A text book of Pharmaceutical Chemistry, S. Chand and Co. Ltd, 1999,1999 edn. 4. O. LeRoy, Natural and synthetic organic medicinal compounds, Ealemi, 1976. 5. S. Ashutosh Kar, Medicinal Chemistry, Wiley Eastern Limited, New Delhi, 1993, New edn.
Reference Books	1. Foye's Princles of Medicinal Chemistry, Lipincott Williams, Seventh Edition, 2012 2. Burger's Medicinal Chemistry, Drug Discovery and Development, Donald J. Abraham, David P. Rotella, Alfred Burger, Academic press, 2010. 3. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, John M. Beale Jr and John M. Block, Wolters Kluwer, 2011, 12th edn. 4. P. Parimoo, A Textbook of Medical Chemistry, New Delhi: CBS Publishers.1995. 5. S. Ramakrishnan, K. G. Prasannan and R. Rajan, Textbook of Medical Biochemistry,Hyderabad: Orient Longman. 3rd edition, 2001.
Website and e-learning source	1. https://www.ncbi.nlm.nih.gov/books/NBK482447/ 2. https://training.seer.cancer.gov/treatment/chemotherapy/types.html 3. https://www.classcentral.com/course/swayam-medicinal-chemistry-12908

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	Predict a drugs properties based on its structure.	**K2**
CO2	Describe the factors that affect its absorption, distribution, metabolism, and excretion,and hence the considerations to be made in drug design.	**K3**
CO3	Explain the relationship between drug's chemical structure and its therapeutic properties.	**K4**
CO4	Designed to give the knowledge of different theories of drug actions at molecularlevel.	**K5**
CO5	To identify different targets for the development of new drugs for the treatment ofinfectious and GIT.	**K6**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
II	23P2CHEL3B	Major Elective - III GREEN CHEMISTRY	5	3

Objectives ofthe 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, Organicand inorganic chemicals.
Course Outline	**UNIT-I:** Introduction- Need for Green Chemistry. Goals of Green Chemistry.Limitations/ of Green Chemistry. Chemical accidents, terminologies, Internationall green chemistry organizations and Twelve principles ofGreen 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 $scCO_2$. Green synthesis-adipic acid and catechol.
	UNIT-III: Environmental pollution, 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 – Instrumentation, Cavitation theory - Ultra sound assisted green synthesis and 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	1. https://www.organic-chemistry.org/ 2. https://www.studyorgo.com/summary.php

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	To recall the basic chemical techniques used in conventional industrial preparations andin green innovations.	**K1**
CO2	To understand the various techniques used in chemical industries and in laboratory.	**K2**
CO3	To compare the advantages of organic reactions assisted by renewable energy sourcesand non-renewable energy sources.	**K3**
CO4	To apply the principles of PTC, ionic liquid, microwave and ultrasonic assisted organicsynthesis.	**K4**
CO5	To design and synthesize new organic compounds by green methods.	**K5**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
II	23P2CHEL4A	Major Elective – IV BIO-INORGANIC CHEMISTRY	5	3

Objectives ofthe course	• To understand the role of trace elements. • To understand the biological significance of iron, sulpur. • To study the toxicity of metals in medicines. • To have knowledge on diagnostic agents. • To discuss on various metalloenzymes properties.
Course Outline	**UNIT-I: Essential trace elements:** Selective transport and storage of metal ions: Ferritin, Transferrin and sidorphores; Sodium and potassium transport, Calcium signalling proteins. Metalloenzymes: Zinc enzymes– carboxypeptidase and carbonic anhydrase. Iron enzymes–catalase, peroxidase. Copper enzymes – superoxide dismutase, Plast ocyanin, Ceruloplasmin, Tyrosinase. Coenzymes - Vitamin-B12 coenzymes.
	UNIT-II: Transport Proteins: Oxygen carriers -Hemoglobin and myoglobin - Structure and oxygenation Bohr Effect. Binding of CO, NO,CN– to Myoglobin and Hemoglobin. Biological redox system: Cytochromes-Classification, cytochrome a, b and c. Cytochrome P-450. Non-heme oxygen carriers-Hemerythrin and hemocyanin. Iron-sulphur proteins- Rubredoxin and Ferredoxin- Structure and classification.
	UNIT-III: Nitrogen fixation-Introduction, types of nitrogen fixing microorganisms. Nitrogenase enzyme - Metal clusters in nitrogenase- redox property - Dinitrogen complexes transition metal complexes of dinitrogen - nitrogen fixation via nitride formation and reduction of dinitrogen to ammonia. Photosynthesis: photosystem-I and photosystem- II-chlorophylls structure and function.
	UNIT-IV: Metals in medicine: Metal Toxicity of Hg, Cd, Zn, Pb, As, Sb. Therapeutic Compounds: Vanadium-Based Diabetes Drugs; Platinum-Containing Anticancer Agents.Chelation therapy; Cancer treatment. Diagnostic Agents: Technetium Imaging Agents; Gadolinium MRI Imaging Agents. temperature and critical magnetic Field.
	UNIT-V: Enzymes -Introduction and properties -nomenclature and classification. Enzyme kinetics, free energy of activation and the effects of catalysis. Michelis - Menton equation - Effect of pH, temperature on enzyme reactions. Factors contributing to the efficiency of enzyme.

Recommended Text	1. Williams,D.R. –Introdution to Bioinorganic chemistry. 2. F.M. Fiabre and D.R. Williams– The Principles of Bioinorganic Chemistry,RoyolSoceity of Chemistry, Monograph for Teachers-31 3. K.F. Purcell and Kotz., Inorganic chemistry, WB Saunders Co.,USA. 4. G.N. Mugherjea and Arabinda Das, Elements of BioinorganicChemistry - 1993. 5. R. Gopalan, V. Ramalingam, *Concise Coordination Chemistry*, S. Chand, **2001**.
Reference Books	1. M.Satake and Y.Mido, Bioinorganic Chemistry- Discovery Publishing House, New Delhi (1996) 2. M.N. Hughes, 1982, The Inorganic Chemistry of Biological processes,II Edition, Wiley London. 3. R. W. Hay, Bio Inorganic Chemistry, Ellis Horwood, 1987. 4. R. M. Roat-Malone, Bio Inorganic Chemistry, John Wiley, 2002. 5. T. M. Loehr, Iron carriers and Iron proteins, VCH, 1989.
Website and e-learning source	2. https://www.pdfdrive.com/instant-notes-in-inorganic-chemistry-the-instant-notes-chemistry-series-d162097454.html 3. https://www.pdfdrive.com/shriver-and-atkins-inorganic-chemistry-5th-edition-d161563417.html

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	The students will be able to analyses trace elements.	**K1**
CO2	Students will be able to explain the biological redox systems.	**K2**
CO3	Students will gain skill in analyzing the toxicity in metals.	**K4**
CO4	Students will have experience in diagnosis.	**K5**
CO5	Learn about the nitrogen fixation and photosynthetic mechanism.	**K6**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Subject code	Title of the paper	Hours of Teaching/ Week	No. of Credits
II	**20P2CHEL4B**	**Major Elective – IV Cheminformatics**	**5**	**3**

Objectives ofthe course	➢ Students learn about the information of cheminformatics and its applications ➢ Students know about the Representation of Molecules and Chemical Reactions ➢ Studentsidentify about the Searching Chemical Structure ➢ Students understand about the Computer Assisted Virtual screening design: ➢ Students learn about theApplication of Cheminformatics in Drug Design.
Course Outline	**Unit I** **Introduction to Cheminformatics:** Introduction to cheminformatics, History and Evolution of cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Molecular Modeling and Structure Elucidation
	Unit II **Representation of Molecules and Chemical Reactions:** Nomenclature; Different types of Notations; SMILES coding; Matrix Representations; Structure of Molfiles and Sdfiles; Libraries and toolkits; Different electronic effects; Reaction classification
	Unit III **Searching Chemical Structure:** Full structure search; sub structure search; basic ideas; similarity search; Three dimensional search methods; Basics of Computation of Physical and Chemical Data and structure descriptors; Data visualization.
	Unit IV **Computer Assisted Virtual screening design**: Structure Based Virtual Screening- Protein Ligand Docking, Scoring Functions for Protein Ligand docking, Practical aspects of structure based Virtual Screening; Prediction of ADMET Properties, 2 D and 3D data searching, Chemical databases, Role of computers in Chemical Research.
	Unit V **Self Study** **Application of Cheminformatics in Drug Design:** Quantitative Structure-Property Relations; Descriptor Analysis; Computer Assisted Structure elucidations; Target Identification and Validation; Lead Finding and Optimization; Analysis of HTS data; Design of Combinatorial Libraries; LigandBased and Structure Based Drug design.
Recommend edText	1 Andrew R. Leach, Valerie J. Gillet, Cluwer , Introduction to Cheminformatics, Academic Publisher, Netherlands, 2003

Reference Books	1. Lisa B. English (Editor), Combinatorial Library Methods and Protocols, Humana Press Inc, Volume:201, 2002 2. Frank Jensen, Introduction to Computational Chemistry, Wiley Publisher, Second Edition, 2006

Course Outcomes(for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	Understand the Cheminformatics	**K2**
CO2	understand the representation of Molecules and Chemical Reactions	**K2**
CO3	Analyse the Searching Chemical Structure	**K4**
CO4	tounderstand about theComputer Assisted Virtual screening design	**K2**
CO5	To evaluate the Cheminformatics tools in Drug Design	**K5**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping(Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	S	S	S	S	M	S	S
CO2	M	S	S	S	S	M	S
CO3	S	S	M	S	S	S	S
CO4	M	S	S	S	S	M	S
CO5	M	S	M	S	S	M	S

S– Strong **M– Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
II	**23P2CHSEC2**	**Skill Enhancement Course - Domestic Chemicals Preparation**	**2**	**2**

Objectives ofthe course	The main objectives of this course are to: • Know about classification of food and their functions • Understand the Composition of milk • Know the Preparation of soap and detergents • Know the Classification of polymers • Gain practical knowledge on Preparation of domestic products
Course Outline	**UNIT-I: Food**: Nutritional classification of food (carbohydrate, proteins and amino acids, lipids, vitamins, minerals and water) and their functions in the body – examples for each class - rancidity of oil – anti oxidants. **Milk**: composition– some commercial milk products **Soap**: Definition, Preparation of soap by cold process and hot process - properties of soap. **Detergent**: Types, preparation, comparison of the properties of detergent with soap. **Preparation of some food products**: Tooth paste, Jam & Jelly, Garam masala powder, Tomato paste, tomato sauce and tomato soup
	UNIT-II: Polymers: Classification (based on physical property, composition & reaction mode of polymerization). **Adhesive**: Introduction, advantages of adhesive, limitation of adhesive, bonding mechanism of adhesive action. **Preparation of some domestic products:** Nail polish, hand cream, perfumes, rose water, sandal wood powder, shampoo, Mosquito coil, candle, chalk and ink (Formulation and Procedure). (Note: Chemical structures/chemical equation s are not needed in any part)
Recommended Text	1. Bagavathi Sundari K, Applied Chemistry, MJP publishers, Chennai (2006).
Reference Books	2. Sivasankar B, Food Processing and Preservation, PHI Learning Private Limited, New Delhi, (2010)

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	Students should able to learn about the classification of food and their functions	**K1**
CO2	able to understand the Composition of milk	**K2**
CO3	able to know the Preparation of soap and detergents	**K3**
CO4	able to know the Classification of polymers	**K4**
CO5	Should able to gain practical knowledge on Preparation of domestic products	**K5**

Cognitive Level: K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
II	**23P2CHAECC2**	**Ability Enhancement Compulsory Course - Language Lab**	**2**	**2**

Nature of the course

Employability Oriented	√	Relevant to Local need	√	Addresses Gender Sensitization	
Entrepreneurship Oriented	√	Relevant to national need	√	Addresses Environment and Sustainability	
Skill development Oriented	√	Relevant to regional need	√	Addresses Human Values	√
		Relevant to Global development need	√	Addresses Professional Ethics	√

Course Objectives

The main objectives of this course are to:

1. To facilitate computer-assisted multi-media instruction enabling individualized and independent language learning
2. To sensitize students to the nuances of English speech sounds, word accent, intonation and rhythm
3. To bring about a consistent accent and intelligibility in students' pronunciation of English by providing an opportunity for practice in speaking
4. To improve the fluency of students in spoken English and neutralize their mother tongue influence
5. To train students to use language appropriately for public speaking and Interviews

Unit – I LSRW

Listening Skills: Introduction to Phonetics – Speech Sounds – Vowels and Consonants, Listen to News, poem, songs, Motivational speech, stories, movies, interesting facts, sign of zodiac, dialogues, idioms, dictation – Common errors

Speaking Skills: Stress, Intonation, Homophone, Silent Letters, Greetings, Small Talk, Telephone English, Role Play, Tongue Twisters, Welcome Speech & Vote of Thanks, Compering, Declamation, Sing Along, Brain Storming, JAM (Just A Minute)

Reading Skills: Reading test, Skit, Proof Reading, Oral Reading Fluency, Reading Stories,

Writing Skills: learn English Grammar through Tamil Translation, Reading Comprehension-short stories, informational passages, Advanced Critical reading – Intelligence Augmentation, Dialogues, Sentence Completion, Word Definition, Classic Analogy Bridges, Sentence Analogies, Same Sound, Divided Syllables, Finish the Story, Answering the questions, Practical Writing, Making a formal Argument, Free Writing, Using Precise Language

Unit – II Career and Soft Skills

Career Skills: Body Language (BL) : BL Interview, BL Model, BL Tips, Business English, Communication skills, GD, Interview Skills

Soft Skills: Assertiveness, Creativity, Critical Thinking and Problem Solving, Empathy, Enthusiasm and attitude, Goal Setting, Great interviews, Negotiation Skills, Personality Development, Professionalism, Self Esteem, Stress Management, Team Building, Time Management, Motivation and Attitude, Interpersonal relationship and skills, Networking,

Reference:

1. Materials prepared by the Department of English for Writing skills
2. Soft Skills – Know Yourself and know the world, Dr.K.Alex, Chand Publications, 3rd revised edition 2014
3. Software : Express Pro Lite

The Language Lab focuses on the production and practice of sounds of language and familiarizes the students with the use of English in everyday situations both in formal and informal contexts.

Learning Outcomes:

Students will be able to attain

1. Better understanding of nuances of English language through audio- visual experience and group activities
2. Neutralization of accent for intelligibility
3. Speaking skills with clarity and confidence which in turn enhances their employability skills

Minimum Requirement of infrastructural facilities for Language Lab:

1. Computer Assisted Language Learning (CALL) Lab:

The Computer Assisted Language Learning Lab has to accommodate 40 students with 40 systems, with one Master Console, LAN facility and English language learning software for self-study by students.

System Requirement (Hardware component):

Computer network with LAN facility (minimum 40 systems with multimedia) with the following specifications:

i) Computers with Suitable Configuration
ii)High Fidelity Headphones

2. Interactive Communication Skills (ICS) Lab:

The Interactive Communication Skills Lab: A Spacious room with movable chairs and audio-visual aids with a Public-Address System, a LCD and a projector etc

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
III	23P3CHC5	ORGANIC SYNTHESIS AND PHOTOCHEMISTRY	6	4

Objectives ofthe 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 toeffect successful organic synthesis. • To learn the concepts of pericyclic reaction mechanisms. • To gain the knowledge of photochemical organic reactions.
Course Outline	**UNIT-I: Retro Synthetic Analysis:** defintion, terminology, - target molecule (TM), synthon, functional group interconvention (FGI), disconnection - Guidelines to good disconnection, designing a synthesis - calculation of yield, Consecutive verses convergent synthesis - List of Nucleophilic reagents and electrophilic reagents- Retro synthetic analysis of monocyclic compounds, bifunctional target molecules and one group C-X disconnection. Synthesis based on umpolung concepts of Seebach. Functional group inter conversion involving aldehyde, ketone, ester, acids, acid derivatives, amine and nitro compounds. Selectivity: stereo selective, region selective and chemo selective reactions. Protecting groups in organic synthesis: protection and deprotection of alcohol, amine, aldehyde, ketone and carboxylic acids.
	UNIT-II: Aromaticity Aromatic character: Five - Six, seven-, and eight-membered rings - Other systems with aromatic sextets – Huckel's theory of aromaticity, Concept of homo aromaticity and anti aromaticity, Electron occupancy in MO's and aromaticity - NMR concept of aromaticity and anti aromaticity, systems with 2,4,8,10 electrons and more than 10 electrons, alternant and non-alternant hydrocarbons. Bonding properties of systems. Heteroaromatic molecules. Annulenes ,sydnones and fullerenes.

	UNIT-III: Pericyclic Reactions: Woodward Hoffmann rules; The Mobius and Huckel concept, FMO, PMO 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), (1,5), (3,3) and (5,5)-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. 6. Badger, ***Aromatic*** Character and ***Aromaticity***. ***B***. Cambridge University, 1969
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. 6. Organic synthesis: The Disconnection Approach by Staurt Warren, John wiley & sons.

Website and e-learning source	**1**. https://rushim.ru/books/praktikum/Monson.pdf

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	To recall the basic principles of organic chemistry and to understand the various reactions of organic compounds with reaction mechanisms.	**K2**
CO2	To understand the versatility of various special reagents and to correlate their reactivity with various reaction conditions.	**K4**
CO3	To implement the synthetic strategies in the preparation of various organic compounds.	**K3**
CO4	To predict the suitability of reaction conditions in the preparation of tailor-made organiccompounds.	**K5**
CO5	To design and synthesize novel organic compounds with the methodologies learnt during the course.	**K6**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
III	23P3CHC6	COORDINATION CHEMISTRY – I	5	4

Objectives ofthe course	• To gain insights into the modern theories of bonding in coordination compounds. • To learn various methods to determine the stability constants of complexes. • To understand and construct correlation diagrams and predict the 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:** Crystal field theory • splitting of d orbitals in octahedral, tetrahedral and square planar symmetries • measurement of 10Dq • factors affecting 10Dq • spectrochemical series • crystal field stabilisation energy for high spin and low spin complexes• evidences for crystal field splitting • site selections in spinels and antispinels • Jahn Teller distortions and its consequences. Molecular Orbital Theory and energy level diagrams concept of Weak and strong fields, Sigma and pi bonding in octahedral, square planar and tetrahedral 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, Ion exchange method, Polorographic method and Continuous variation method (Job'smethod) Magnetic property of complexes: Spin-orbit coupling, effect ofspin-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; Kurnakov test.
	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 and their applications.
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 Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	Understand and comprehend various theories of coordination compounds.	**K1**
CO2	Understand the spectroscopic and magnetic properties of coordination complexes.	**K2**
CO3	Explain the stability of complexes and various experimental methods to determine thestability of complexes.	**K3**
CO4	Predict the electronic transitions in a complex based on correlation diagrams and UV-visible spectral details.	**K4**
CO5	Comprehend the kinetics and mechanism of substitution reactions in octahedral andsquare planar complexes.	**K6**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
III	23P3CHCP3	PHYSICAL CHEMISTRY PRACTICAL	5	4

Objectives ofthe course	• To evaluate the order of the reaction, temperature coefficient, and activation energy of the reaction by following pseudo first order kinetics. • To construct the phase diagram of two component system forming congruent melting solid and find its eutectic temperatures and compositions. • To determine the kinetics of adsorption of oxalic acid on charcoal. • To develop the potential energy diagram of hydrogen ion, charge densitydistribution and Maxwell's speed distribution by computational calculation.
Course Outline	1. Determination of CST and study of the effect of impurity on CST 2. Determination of distribution coefficient and determination of equilibrium Constant for the formation of KI_3(Demonstration only) 3. Determination of the rate constant for Persulphate oxidation both by titrimetry and Colorimetry. 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 & determination of surface area(Freundlich isotherm only). **11.** Determination of molecular weight by Transition Temperature
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 Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	To recall the principles associated with various physical chemistry experiments.	**K1**
CO2	To scientifically plan and perform all the experiments.	**K2**
CO3	To observe and record systematically the readings in all the experiments.	**K3**
CO4	To calculate and process the experimentally measured values and compare withgraphical data.	**K4**
CO5	To interpret the experimental data scientifically to improve students' efficiency forsocietal developments.	**K5**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Subject Code	Title of the Paper	Hours of Teaching / Week	No. of Credit
III	**23P3CHCIM**	**Industry Module - Industrial chemistry**	**5**	**3**

Objectives of the course	➢ Students learn about the industrial products like cement and glass, manufacturing processes and their uses in day today life ➢ Students learn about the techniques of studying battery and fuel cell and their uses ➢ Students understand about the renewable and non – renewable energy. ➢ Students shall know the principle and process of refining petroleum. ➢ Students learn about the concept of dyes, pigments, paints, preparation and uses.
Course Outline	**Unit – I: Silicate Industries** **Glass:** Glassy state and its properties. Classification (silicate and non silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.**Ceramics** : Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, super conducting and semi conducting oxides, fullerenes carbon nanotubes and carbon fiber. **Cements:** Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.
	Unit – II: Battery and Chemical explosive Primary and Secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pbaci, Li – Battery, Solid state electrolyte battery. Fuel Cells, Solar cell and polymer cell.Orgin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction of rocket propellant.
	Unit – III: Fuel Chemistry Review of energy spurces (renewable and non – renewable). Classification of fuels and their calorific value.**Coal:** Uses of coal (fuel and non fuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas – composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisties of a good metallurgical coke, Coal gasification (Hydro Gasification and catalytic gasification), Coal liquefaction and solvent Refining. **Petroleum and Petrochemical Industry**: Composition of crude petroleum, Refining and different types of pertroleum products and their applications. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non – petroleum fuels (LPG, CNG, LNG, bio – gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. **Petrochemicals:** Vinyl acetate, propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene. **Lubricants:** Classification of lubricants, lubricating oils (conducting and non – conducting) Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, clud point, pore point) and their

	determination.
	Unit –IV :Dye Chemistry **Textile fibre :** Classification of fibres – properties. Such count, denier, tex, staple length, spinning properties. Strength, elasticity and creep, general characterstics of cotton, silk, wool, viscose Nylon polyster.**Pretreatment of fibre:** Techniques, sizing &Desizing (enzymatic desing) scouring – kier boiling bleaching (hyphochlorite, peroxide and bleaching powder)
	Unit –V : **Dyeing classification of dyes:** According to structure and application. Technical term in dyeing MLR, % of shade, % of exhaustion, equilibrium absorption.**Dyebath assistant and mechanism:**Exhausting agent, wetting agent leveling agent.**Technology of Textile finishing** : Define textile finishing, classification of textile finishing, water repellent finishes, flame retardant finishes moth proof finish, antistatic finishes, anti microbial finish, moth proof finish.
Recommended Text	**1.** Norrish Shreve. R. and Joseph A. Brink Jr Chemical Process Industries, McGraw Hill, Industrial Book Company London. **2.** Mohapatra – elements of Industrial chemistry 1988 in Delhi – Kalyani publications. **3.** B.K.Sharma Industrial Chemistry Ist edition – Goel publications – Meerat 1983.
Reference Books	1. Norrish Shreve. R. and Joseph A. Brink Jr Chemical Process Industries, McGraw Hill, Industrial Book Company London. 2.Mohapatra – elements of Industrial chemistry 1988 in Delhi – Kalyani publications. 3. B.K.Sharma Industrial Chemistry Ist edition – Goel publications – Meerat 1983.

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	Students should able to learn about the industrial products like cement and glass, manufacturing processes and their uses in day today life	**K1,K2**
CO2	Students could know about the techniques of studying battery and fuel cell and their uses	**K3**
CO3	Students understood about the renewable and non – renewable energy.	**K4**
CO4	Students should know the principles and process of refining petroleum. prevention. Classifications, importance, uses, fastness and applications of dyes.	**K4**
CO5	Students have an exposure on the concept of dyes, pigments, paints, preparation and use	**K5**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze;
K5 – Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
III	23P3CHEDC	Extra Disciplinary Course - CHEMISTRY IN EVERY DAY LIFE	5	3

Objectives of the course	• Learn the manufacture and uses of cleaning agents. Various nature and characteristics of water • Learn about importance and preservation of food. • To enable the students to acquire knowledge about the green chemistry and nanotechnology. • Know and learn the various uses and constituents of cosmetic. • Study the various classification, importance and classifications of polymers and dyes.
Course Outline	UNIT-I: **Cleaning agents:** manufacture and uses of soaps, detergents, baking powder, shampoo, washing powder and bleaching powder: **Water:** Characteristics' of water, soft water and hard water - types **-** removal of hardness – ion exchange method. Reverse osmosis method, Water pollution, causes and prevention.
	UNIT-II: Food: Importance – spoilages – causes, preservation – additives – colouring flavouring agents, beverages. **Soft drinks** aerated water – manufacturing – mineral water. Fruits, vegetables, dairy product – storage, preservation. Minerals in food and anti-oxidants. Preparation of fruit Jam and pickle.
	UNIT-III: Cosmetics: Face powder – constituents, uses – side – effects. Nail polish, hair dye – composition and side effects. Tooth powder – composition and manufacturing – lotions.
	UNIT-IV: Green chemistry: Basic concepts of Green chemistry and its significance in day to day life. **Polymers:** Classification – Types of polymerization – plastics – classification – types of plastics – PVC, Teflon, PET, Bakelite – Rubber – Natural and synthetic – Bunas rubber, Butyl Rubber. Vulcanization of rubber, neoprene rubber, Plastic pollution and prevention.
	UNIT-V: Nano Technology: Basic concepts of Nano Technology and its importance in day to day life. **Dyes:** Importance of food colours – PFA (Prevention of Food Adulteration Act) Natural dyes – Classification - importance – Uses of the following Synthetic dyes - Direct dyes, acid dye, Basic dye, mordant dye, Reactive dye, Disperse dye.Fastness – Light and Washing. Application of dyes in food, paper, plastic and lather.
Recommended Text	**1.** Dr. GokulanandaMohapatra, Elements of Industrial Chemistry, Kalyani Publishers. New edition 1998. **2.** Ramani,V.Alex,Food Chemistry(2009),MJP publishers.

Reference Books	1. Brain A.C.S. Reinhold, Production and properties of Industrial chemicals — New York. 2. Burgh, A. Fermentation Industries, Inter science, New York.
Website and e-learning source	**1.** https://www.vedantu.com/chemistry/green-chemistry **2.** https://byjus.com/free-ias-prep/nanotechnology/ 3. https://byjus.com/jee/polymers/

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	know basic concepts of Nano Technology and its importance in day to day life. Basic concepts of Green chemistry and its significance in day to day life.	**K1,K2**
CO2	Enrich knowledge on Manufacturing & uses of cleaning agents, characteristics of water. Importance, causes and prevention of additives, storage & preservation of food.	**K3**
CO3	Understood the Cosmetics constituents, uses and side effects	**K4**
CO4	Classify the types of plastic, vulcanization of rubber and Plastic pollution and prevention. Classifications, importance, uses, fastness and applications of dyes.	**K4**
CO5	Analyse the hardness, pollutions and prevention of water.	**K5**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
III	**23P3CHSEC3**	**Skill Enhancement Course - Dye chemistry**	**2**	**2**

Objectives ofthe course are to	• learn about the main purpose of dyeing and how fabrics are dyed in industry. • understand the dyeing is the application of pigments on textile materials. • know about dyes may require a mordant to improve the fastness of the dye on the fiber. • learn that pretreatment is a heart of processing of textile.
Course Outline	**Unit - I** **Basic concepts of colour chemistry**: Colour and sensation - theories of colour and chemical constitution – Witt's theory - chromophore - auxochrome – chromogen – batho chromic and hypsochromic shifts – resonance and valence bond theories – requirements of a dye - classification of dyes based on their their structures and use. **Synthesis of few dyes**: Bismark brown, Congo red, Malachite green, Crystal violet, Magenda (Rosaniline), Alizarin, Indigo dyes and fluorescein.
	Unit - II **Pretreatment of fibers :** Singing – Singing techniques - sizing & desizing - hydrolytic and enzymatic desizing methods - scouring - Kier boiling method - bleaching methods (with hypochlorite, peroxide, and bleaching powder) – mercerization . **Technical terms in dyeing**: M.L.ratio – % of shade – % of exhaustion – equilibrium absorption. **Dyeing processes :** *Vat dyeing*: Vatting, dyeing, oxidation and after treatment steps. *Reactive dyeing*: Hot and cold brand reactive dyes – principles involved in the dyeing process. *Dyeing of polyester:* principle – carrier dyeing – functions of carrier – functions of dispersing agents - high temperature dyeing. *Ingrain dyes*: azoic colours with one example.
Recommended Text	1. V.A.Shenai, An introduction to dyes stuff and intermediate–Sevak publication, Mumbai. 2. V.A.Shenai , vol. IV, Technology of textile processing, Sevak publication , Mumbai. 3. V.A.Shenai, vol. I, Textile fibres, Sevak publication , Mumbai. 4. V.A.Shenai, vol.III , Techniques of bleaching, Sevak publication ,Mumbai. 5. V.A.Shenai , vol.II, Principle of dyeing , Sevak publication, Mumbai.
Reference Books	1. Jain M.K.,Sharma S.C., Modern Organic chemistry,Vishal Publishing Co., Jalandar, (2012)

Website and e-learning source	1. http://en.wikipedia.org/wiki/Hair_coloring 2. http://www.pbm.com/~lindahl/articles/food_coloring_agents.html

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	Students should able to learn about the main purpose of dyeing and how fabrics are dyed in industry.	**K1**
CO2	Students should able to understand the dyeing is the application of pigments on textile materials.	**K2, k3**
CO3	Students should able to know about dyes may require a mordant to improve the fastness of the dye on the fiber.	**K4**
CO4	Students should able to learn that pretreatment is a heart of processing of textile.	**K5**
CO5	Students should able to learn about reactive dyeing	**K6**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
III	23P3CHAECC3	Ability Enhancement Compulsory Course - RESEARCH METHODOLOGY	2	2

Objectives ofthe course are to	• learn about various journals • preparation of manuscript • internet and electronic media to prepare review • types of errors • estimations of errors
Course Outline	**UNIT I** **1. Literature Survey** Source of Information - Primary, Secondary, Tertiary source - Journals - abstracts - current titles - Review Monographs - Dictionaries - Information retrievals using Internet and other electronic medias (preparing a review article related to problem of research of the student). 2. E-Journals, Search engines- Google, Yahoo Search, Wikipedia. 3. Reports of research work- laboratory observation - preparation of records - Manuscripts - Research paper formats in Indian J. Chemistyr., J. Indian Chem. Soc., J. AM. Chem. Soc., Tetrahedran. Ana., Chem. J. Chem. Education, Etc., Writing of the project reports of thesis.
	UNIT II **2. Error Analysis** Types of Error - Minimization of error - Accuracy, Precision, significant figures, use of calculus in the estimation of errors - Frequency distributions, the binomial distribution and normal distribution - mean, and standard deviation varcence Q-test, t-test - chi-square test - F-test- Analysis of variance (ANOVA) - Correlation and Regression - Curve fitting
Recommended Text	1. D.B. Hibbert and J.J. Gooding, Data Analysis for chemistry, Oxford University Press, 2006. 2. J. Topping, Errors of Observation and Their Treatment, Fourth Edn., Chapman Hall, London, 1984. 3. S.C. Gupta, Fundamentals of Statistics, Sixth Edn., Himalaya Publ. House, Delhi, 2006. 4. H.E.Solbers, Inaccuracies in Computer Calculation of Standard Deviation, Anal. Chem. 55, 1611 (1983).
Reference Books	1. P.M.Wanek et al., Inaccuracies in the calculation of standard Deviation with Electronic calculators, Anal. Chem. 54, 1877 (1982).

Website and e-learning source	1. http://www.virtualref.com/govdocs/s189.htm 2. http://www.inflibnet.ac.in 3. http://www.springerlink.com 4. http://rsc.org 5. http://www.pubs.acs.org 6. http://dspace.org 7. http://dspace.bdu.ac.in

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	learn about various journals	**K1**
CO2	preparation of manuscript	**K2**
CO3	internet and electronic media to prepare review	**K3**
CO4	understand types of errors	**K4**
CO5	acquire the knowledge on estimations of errors	**K5**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
IV	23P4CHC7	COORDINATION CHEMISTRY – II	6	4

Objectives ofthe 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:** Classification of organometallic compounds based on M-C bond – 18 and 16 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; 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); 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 and metathesis 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, Monsonto process.
	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 1H, 15N, 19F, 31P-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 V(II), Mn(II), Fe(II), Co(II), Ni(II), Cu(II) complexes, bis(salicylaldimine)copper(II) and $[(NH_3)_5Co\text{-}O_2\text{-}Co(NH_3)_5]^{5+}$ Mossbauer spectroscopy – Mossbauer effect, Recoil energy, 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, CH_4, NH_3) – evaluation of vibrational constants of the above molecules. Koopman's theorem- applications and limitations. Optical Rotatory Dispersion – Principle of CD and ORD; Δ and λ isomers in complexes, 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 Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	Understand and apply 18 and 16 electron rule for organometallic compounds.	**K2**
CO2	Understand the structure and bonding in olefin, allyl, cyclopentadienyl and carbonyl containing organometallic compounds	**K1**
CO3	Understand the reactions of organometallic compounds and apply them in	**K3**
CO4	understanding the catalytic cycles	**K4**
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.	**K5**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
IV	23P4CHC8	PHYSICAL CHEMISTRY-II	5	4

Objectives ofthe course	• To understand the essential characteristics of wave functions and needfor the quantum mechanics. • To know the importance of quantum mechanical models of particle in abox, 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 ofgroup 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, hydrogen spectrum. Need for quantum mechanics, Postulates of Quantum Mechanics, Schrodinger wave equation, Time independent andtime 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, anharmonicity, 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. Hatrefock self-consistent field method, Hohenberg-Kohn theorem and Kohn-Sham equation, Helium atom-electron spin, paulis exclusion principle and Slater determination.

	UNIT-IV: Group theory **Principles –** Elements of group theory –properties of a group and subgroup-classes- group multiplication tables – symmetry elements and operations – inter relations among symmetry operation -point groups of molecules Comparison of crystal symmetry with molecular symmetry. - Matrix representations theory– reducible and irreducible representations – Great orthogonality theorem and its consequences –construction of character table C_{2V}, C_2h electronic spectra of ethylene.and $C_{3V.}$
	UNIT-V: Applications of group theory: Hybridization schemes for atoms in molecules of different geometry - AB_4 tetrahedral, AB_3trigonal planar - Symmetry selection rules for IR and Raman Spectra. -Mutual exclusion rule -Symmetries of vibrational modes in non-linear molecules (H_2O, NH_3 and BF_3 only) and IR & Raman active - Vibration modes - 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. 6. S.Jayanthi and M.Pramesh, Group theory and statistical thermodynamics, saratha pathippagam,2008
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 Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	To discuss the characteristics of wave functions and symmetry functions.	**K2**
CO2	To classify the symmetry operation and wave equations.	**K3**
CO3	To apply the concept of quantum mechanics and group theory to predict the electronicstructure.	**K4**
CO4	To specify the appropriate irreducible representations for theoretical applications.	**K5**
CO5	To develop skills in evaluating the energies of molecular spectra.	**K6**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
IV	23P4CHCP4	ANALYTICAL INSTRUMENTATION TECHNIQUES	5	4

Objectives ofthe course are to	• study the principles associated with physical chemistry electrical experiments • scientifically plan and perform all the experiments • observe and record systematically the readings in all the experiments • calculate and process the experimentally measured values and compare withgraphical data • interpret the experimental data scientifically to improve students efficiency for societaldevelopments.
Course Outline	**Unit I: CONDUCTOMETRIC TITRATIONS** **I. acid – base titrations** i) Strong acid Vs strong base ii) Weak acid Vs strong base iii) Mixture of acids Vs strong base iv) Mixture of bases Vs strong acid **II. precipitation titrations** i) Kl Vs $AgNO_3$ ii) Mixture of halides (KCl + KI) Vs $AgNO_3$ iii) K_2SO_4 Vs $BaCl_2$ **III.** verification of ostwald's dilution law **IV.** Verification of Debye Huckel Onsagar equation **V.** determination of solubility of sparingly soluble salt.
	Unit II **POTENTIOMETER TITRATIONS** **I. acid – base titrations** i) Strong acid Vs strong base ii) Weak acid Vs strong base iii) Mixture of acids Vs strong base **II. precipitationtitrations** i) Kl Vs $AgNO_3$ ii) Mixture of halides (KCl + KI) Vs $AgNO_3$ **III .Rredox titrations** i) $KMnO_4$ Vs KI, FAS ii) K_2Cr2O_7 Vs KI, FAS IV. Determination of pH of buffer solutions V. Determination of activity coefficient VI. Determination of dissociation constant of an organic acid VII. Determination of Redox potential of Fe^{3+} / Fe^{2+} system

	UNIT-III: 1. Estimation of Fe, Cu and Ni by colorimetric method... 2. Determination of the amount (mol/L) of ferricyanide present in the given solution using cyclic voltammetry. 3. Determination of the diffusion coefficient of ferricyanide using cyclic voltammetry. 4. Determination of the standard redox potential of ferri-ferrocyanide redox couple using cyclic voltammetry. 8. Analysis of water quality through COD, DO, BOD measurements. 9. Separation of (a) mixture of Azo dyes by TLC (b) mixture of metal ions by Paper chromatography 10. Estimation of chlorophyll in leaves and phosphate in wastewater by colorimetry.
	UNIT-III: Interpretation and identification of the given spectra of various organic compounds arrived at from the following instruments 1.UV-Visible 2.IR 3.Raman 4.NMR 5. ESR
Recommended Text	*1.* Vogel's Text book of Practical Organic Chemistry, 5th Ed, ELBS/Longman, England, 2003. *2.* B. Viswanathan and P.S.Raghavan, Practical Physical Chemistry, Viva Books, New Delhi, 2009. *3.* Sundaram, Krishnan, Raghavan, Practical Chemistry (Part II), S. Viswanathan Co. Pvt., 1996.
Reference Books	1. J. N. Gurtu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 2011. 2. J. B. Yadav, Advanced Practical Physical Chemistry, Gobel Publishing House, 2001. 3. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th edition, McGraw Hill, 2009. 4. 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 Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	To recall the principles associated with physical chemistry electrical experiments	**K1**
CO2	To scientifically plan and perform all the experiments	**K2**
CO3	To observe and record systematically the readings in all the experiments	**K3**
CO4	To calculate and process the experimentally measured values and compare withgraphical data.	**K4**
CO5	To interpret the experimental data scientifically to improve students efficiency for societaldevelopments.	**K6**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
IV	23P4CHEL5A	**Major Elective – V** **CHEMISTRY OF NATURAL PRODUCTS**	5	3

Objectives ofthe course	• To learn the basic concepts and biological importance of biomolecules andnatural products. • To explain various of functions of carbohydrates, proteins, nucleic acids,steroids and hormones. • To understand the functions of alkaloids and terpenoids. • To elucidate the structure determination of biomolecules and natural products. • To extract and construct the structure of new alkaloids and terpenoids fromdifferent methods.
Course Outline	**UNIT-I: Alkaloids:** Introduction, occurrence, classification, isolation and functions of alkaloids. Classification, general methods of structural elucidation. Chemical methods of structure determination of Coniine, Piperine, Nicotine, Papaverine. Atropine, Quinine, Belladine, Cocaine, Heptaphylline, Papaverine and Morphine.
	UNIT-II: Terpenoids: Introduction, occurrence, Isoprene rule, classification. General methods of determining structure.. Structure determination of Camphor, Abietic acid, Cadinene, Squalene, Zingiberine. **Carotenoids:** Introduction, geometrical isomerism, Structure, functions and synthesis of β-carotene and vitamin-A.
	UNIT-III: Anthocyanines and flavones: Anthocyanines: Introduction to anthocyanines. Structure and general methods of synthesis ofanthocyanines. Cyanidine chloride: structure and determination. Flavones: Biological importance of flavones. Structure and determination of flavone and flavonoids. Quercetin: Structure determination and importance.
	UNIT-IV: Purines and Steroids: Purines: Introduction, occurrence and isolation of purines. Classification and spectral properties of steroids. biological importance, Structure and synthesis of Uric acid and Caffeine. Steroids: Steroids-Introduction, occurrence, nomenclature, configuration of substituents, Diels' hydrocarbon, stereochemistry, classification, Diels' hydrocarbon, biological importance, colour reactions of sterols, cholesterol-occurrence, tests, physiological activity, biosynthesis of cholesterol from squalene.
	UNIT-V: Natural Dyes: Occurrence, classification, isolation, purification, properties, colour and constitution. Structural determination and synthesis of indigoitin and alizarin.

Recommended Text	1. G. K. Chatwal, Organic Chemistry on Natural Products, Vol. 1, Himalaya Publishing House, Mumbai, 2009. 2. G. K. Chatwal, Organic Chemistry on Natural Products, Vol. 2, Himalaya Publishing House, Mumbai,2009. 3. O. P. Agarwal, Chemistry of Organic Natural Products, Vol. 1, Goel Publishing House, Meerut,1997. 4. O. P. Agarwal, Chemistry of Organic Natural Products, Vol. 2, Goel Publishing House, Meerut,1997. 5. I. L. Finar, Organic Chemistry Vol-2, 5thedition, Pearson Education Asia, 1975.
Reference Books	1. I. L. Finar, Organic Chemistry Vol-1, 6thedition, Pearson Education Asia,2004. 2. Pelletier, Chemistry of Alkaloids, Van Nostrand Reinhold Co,2000. 3. Shoppe, Chemistry of the steroids, Butterworthes,1994. 4. I. A. Khan, and A. Khanum. Role of Biotechnology in medicinal & aromatic plants, Vol 1 and Vol 10, Ukkaz Publications,Hyderabad,2004.
Website and e-learning source	https://sites.google.com/site/chemistryebookscollection02/home/organic-chemistry/organic

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	To understand the biological importance of chemistry of natural products.	**K1**
CO2	To scientifically plan and perform the isolation and characterization of synthesizednatural products.	**K3**
CO3	To elucidate the structure of alkaloids, terpenoids, carotenoids, falvanoids andanthocyanins.	**K2**
CO4	To determine the structure of phytochemical constituents by chemical and physicalmethods.	**K5**
CO5	To interpret the experimental data scientifically to improve biological activity ofactive components.	**K6**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong M – Medium L – Low

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
IV	23P4CHEL5B	Major elective – V POLYMER CHEMISTRY	5	3

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 synthetic rubber - Buna - N, Buna-S and neoprene. Conducting Polymers: Elementary ideas; examples: poly sulphur nitriles, polyphenylene, poly pyrrole and poly acetylene. Polymethylmethacrylate, polyimides, polyamides, polyurethanes, polyureas, polyethylene and polypropylene glycols.

	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.
Recommended Text	**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 Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	To understand the bonding in polymers.	**K2**
CO2	To scientifically plan and perform the various polymerization reactions.	**K3**
CO3	To observe and record the processing of polymers.	**K4**
CO4	To calculate the molecular weight by physical and chemical methods.	**K5**
CO5	To interpret the experimental data scientifically to improve the quality of syntheticpolymers.	**K6**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
IV	23P4CHSEC4	Skill Enhancement Course - Paint Chemistry	2	2

Objectives ofthe course are to	• have knowledge about the ingredient of paints and their functions. • have the knowledge about different types additives and the polymers used in paint • understand the different types of paints
Course Outline	**UNIT – I** **Paint ingredients : –** Classification of paints – according to drying mechanism – under coats – Technical terms , Sag, Skin Irreversible gel, shelf life, Pot life, Solids, vehicle – consistency of thixotrophy – Dry film properties – Adhesion – gloss – flexibility –repair and renovation – Pigments – function (opacity, protective and Reinforcing) – classification – properties – optical – particle size and shape – refractive index – Tinting strength – Chemical reactivity – Bleeding characteristic Hiding power – Examples of pigments – zinc oxide – chrome greens – Lithophone selection of pigments – dispersion – color matching.
	UNIT – II Classification of solvents – facts and theory – solvent – properties – boiling point and evaporation rate – uses of solvents –toxicity. Paint additives wetting and dispersing agents. Anti setting – anti – sag and bodying agents – Aluminum soaps – hydrogenated castor oil, modified clays – anti skinning agents – examples – anti flood and anti- float additives - factors influencing flooding and floating – Mildew – inhibitors – dispersing agents (anionic) stabilizing agents (Non ionic) Anti foam agents – thickening agents – preservatives – freezer stabilizers.
Recommended Text	1. G.P.A. Turner –Principles of Paint Chemistry and Introduction to paint Technology Oxford & IBH Publishing & Co 2. Paint Film Defects by HESS's 3. Modern technology of surface coating & Varnishes by SSP
Reference Books	1. Paint, Lacquers, Enamels, Powder coating & Varnishes by SSP consultants.

Course Outcomes (for Mapping with POs and PSOs)

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

CO Number	CO Statement	Cognitive Level
CO1	gain knowledge about the ingredient of paints and their functions	**K1**
CO2	gain knowledge about different types additives and the polymers used in paint	**K2**
CO3	understand the different types of paints	**K3**
CO4	chemical reactivity of paints	**K4**
CO5	applications of various solvents	**K5**

Cognitive Level:K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; **K6 –** Create

CO-PO Mapping (Course Articulation Matrix)

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

S – Strong **M – Medium** **L – Low**

Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3