M.Sc CHEMISTRY

Course Structure and Syllabus

(For the candidates admitted from the academic year 2023-2024 onwards)

CHOICE BASED CREDIT SYSTEM-LEARNINGOUTCOMESBASEDCURRICULUMFRAMEWORK(CBCS-LOCF)

THANTHAI HANS ROEVER COLLEGE (AUTONOMOUS)

(Nationally Re-Accredited by NAAC with B^{++})

(Affiliated to Bharathidasan University, Tiruchirappalli)

ELAMBALUR, PERAMBALUR – 621 220

Vision

- Strive to be at the forefront of interdisciplinary research, exploring the intersections of chemistry with other scientific disciplines to address complex societal issues such as healthcare, environmental sustainability, and renewable energy.

- Aspire to be recognized globally for our contributions to fundamental scientific understanding and for developing practical applications that positively impact industries and communities worldwide.

- Aim to inspire a passion for chemistry among students and colleagues, fostering a culture of curiosity, collaboration, and continuous learning.

Mission

- Provide a rigorous and comprehensive curriculum that equips students with a deep understanding of core chemical principles, alongside hands-on laboratory experiences and advanced research opportunities.

- Cultivate a supportive and inclusive academic environment that encourages diversity of thought, embraces different perspectives, and fosters an atmosphere of respect, integrity, and professionalism.

- Collaborate with industry partners, governmental organizations, and non-profit institutions to translate research findings into real-world solutions, driving innovation and addressing pressing societal challenges.

- Engage in outreach initiatives to promote scientific literacy, inspire the next generation of chemists, and contribute to the broader community through educational programs, public lectures, and community service projects.

- Foster a culture of responsible and ethical conduct in scientific research, emphasizing the importance of integrity, transparency, and accountability in all aspects of academic and professional endeavors.

Programme Outcomes (POs)

- **PO1: Problem Solving Skill**
  Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.
- **PO2: Decision Making Skill**
  Foster analytical and critical thinking abilities for data-based decision-making.
- **PO3: Ethical Value**
  Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.
- **PO4: Individual and Team Leadership Skill**
  Capability to lead themselves and the team to achieve organizational goals.
- **PO5: Employability Skill**
  Inculcate contemporary business practices to enhance employability skills in the competitive environment.

Program Specific Outcomes (PSOs)

- **PSO1 – Placement**
  To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.
- **PSO 2 - Entrepreneur**
  To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.
- **PSO3 – Research and Development**
  Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.
- **PSO4 – Contribution to Business World**
  To produce employable, ethical and innovative professionals to sustain in the dynamic business world.
- **PSO 5 – Contribution to the Society**
  To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

Thanthai Hans Roever College (Autonomous), Elambalur, Perambalur - 621 220

M.Sc CHEMISTRY

CHOICEBASEDCREDITSYSTEM–LEARNING OUTCOMESBASED CURRICULUM FRAME WORK (CBCS- LOCF)

(For the candidates admitted from the academic year 2023 - 2024 onwards)

Semester	Course Code	Title of the Course	Ins. Hours/ Week	Credits	Exam Hrs	Max. Marks		
						CIA	ESE	Total
I	23PCH1CC1	Organic Reaction Mechanism-I	5	4	3	25	75	100
	23PCH1CC2	Structure and Bonding in Inorganic Compounds	5	4	3	25	75	100
	23PCH1CC3	Molecular Spectroscopy	5	4	3	25	75	100
	23PCH1CC4P	Organic Chemistry Practical	6	4	6	40	60	100
	23PCH1EC11 23PCH1EC12	Nanomaterials and Nanotechnology Instrumentation Techniques	5	3	3	25	75	100
	23PCH1EC21 23PCH1EC22	Industrial Chemistry Concepts and models in chemistry	4	3	3	25	75	100
	23PCHVA1	Environmental Chemistry	-	2*	-	-	-	-
		Total	**30**	**22**	**-**	**-**	**-**	**600**
II	23PCH2CC5	Organic reaction mechanism-II	6	5	3	25	75	100
	23PCH2CC6	Physical Chemistry-I	6	5	3	25	75	100
	23PCH2CC7P	Inorganic Chemistry Practical	6	4	6	40	60	100
	23PCH2EC31 23PCH2EC32	Green Chemistry Medicinal chemistry	5	3	3	25	75	100
	23PCH2EC41 23PCH2EC42	Bio Inorganic Chemistry Material science	5	3	3	25	75	100
	23PCH2NME1	NME-1 Water Technology	2	2	3	25	75	100
	23PCH2OC	SWAYAM/NPTEL Online Course		2**				
		Total	**30**	**22**				**600**
III	23PCH3CC8	Organic synthesis and Photochemistry	6	4	3	25	75	100
	23PCH3CC9	Coordination Chemistry-I	5	4	3	2/5	75	100
	23PCH3CC10	Electro Chemistry	6	4	3	25	75	100
	23PCH3CC11P	Physical Chemistry Practical - I	6	4	6	40	60	100
	23PCH3EC51 23PCH3EC52	Chemistry of natural products Biomolecules and heterocyclic compounds	5	3	5	25	75	100

	23CH3NME2	NME 2- Home care	2	2	3	25	75	100
		Internship/Industrial Activity***	-	2	-	-	-	100
	23PCHVA2	Ecology and waste management *	-	2*	2	50	50	100*
		Total	**30**	**23**	**-**	**-**	**-**	**700**
	23PCH4CC12	Coordination Chemistry-II	5	4	3	25	75	100
	23PCH4CC13	Physical Chemistry-II	5	4	3	25	75	100
	23PCH3CC14P	Physical Chemistry Practical - I	5	4	6	40	60	100
	23PCHA4PW	Project with Viva-Voce	5	4	-	Evaluation 80 Viva-voce 20		100
	23PCH4EC6	Elective- VI (Industry Entrepreneurship) Polymer Chemistry	4	3	3	25	75	100
	23PCH4SE1	Skill Enhancement Course/ Professional Competency Skill Analytical instrumentation techniques	3	2	3	25	75	100
	23PCH4SE2	Soft Skill	3	2	3	25	75	100
		Extension Activity	-	1	-	-	-	-
		Total	**30**	**24**				**700**
		Grand Total	**120**	**91**				**2600**

*** Internship/Industrial Activity-Internship after 2nd semester during summer vacation -30 Hours and 2 credits will be included in the 3rdsemester.

* The value added course credit will not be included in the total CGPA.These courses are extra-credit courses. Instruction hours for these courses is 30 hours

** SWAYAM/NPTEL Online Course -Extra Credit Course. Not considered for grand total &CGPA

SEMESTER-I					
Course Code	**:**	**23PCHICC1**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**5**	**Internal Marks**	**:**	**25**
Credits	**:**	**4**	**External Marks**	**:**	**75**
ORGANIC REACTION MECHANISM- I					

Objectives of the course

- To understand the feasibility and the mechanism of various organic reactions.
- To comprehend the techniques in the determination of reaction mechanisms.
- To understand the concept of stereochemistry involved in organic compounds.
- To correlate and appreciate the differences involved in the various types of organic reaction mechanisms.
- To design feasible synthetic routes for the preparation of organic compounds.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able

- **CLO1**: To recall the basic principles of organic chemistry.
- **CLO2**: To understand the formation and detection of reaction intermediates of organic reactions.
- **CLO3**: To predict the reaction mechanism of organic reactions and stereochemistry of organic compounds.
- **CLO4:** To apply the principles of kinetic and non-kinetic methods to determine the mechanism of reactions.
- **CLO5**: To design and synthesize new organic compounds by correlating the stereochemistry of organic compounds.

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: Aromaticity in benzenoid, non-benzenoid, heterocyclic compounds and annulenes. Aromatic electrophilic

substitution: Orientation and reactivity of di- and polysubstituted phenol, nitrobenzene and halobenzene. Reactions involving nitrogen electrophiles: nitration, nitrosation and diazonium coupling; Sulphur electrophiles: sulphonation; Halogen electrophiles: chlorination and bromination; Carbon electrophiles: Friedel-Crafts alkylation, acylation and arylation reactions. Aliphatic electrophilic substitution Mechanisms: SE2 and SEi, SE1- Mechanism and evidences.

UNIT-III: Aromatic and Aliphatic Nucleophilic Substitution: Aromatic nucleophilic substitution: Mechanisms - SNAr, SN1 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. SN1, ion pair, SN2 mechanisms and evidences. Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon.SN1, SN2, SNi, and SE1 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, 2ndedition, 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. 1.https://sites.google.com/site/chemistryebookscollection02/home/organic-chemistry/organic
2. https://www.organic-chemistry.org/
3. Relationship Matrix for COs, POs and PSOs

Question Pattern			
Section :A	**I. a**	**5 Multiple Chose Questions (One question from each Unit)**	**5x1=5**
	I.b	**5 Fill in the blanks Questions (One question from each Unit)**	**5x1=5**
	II	**5 short answer Questions (One question from each Unit)**	**5x2=10**
Section :B (5 Marks)		**Either OR choice (One set of question from each Unit)**	**5x5=25**
Section :C (10 Marks)		**Ans three out of five (One question from each Unit)**	**3x10=30**
Total Marks			**75**

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits
I	23PCHICC1	ORGANIC REACTION MECHANISM- I	5	4

Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-I					
Course Code	**:**	**23PCHICC2**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**5**	**Internal Marks**	**:**	**25**
Credits	**:**	**4**	**External Marks**	**:**	**75**
STRUCTURE AND BONDING IN INORGANIC COMPOUNDS					

Objectives of the course

- To determine the structural properties of main group compounds and clusters.
- To gain fundamental knowledge on the structural aspects of ionic crystals.
- To familiarize various diffraction and microscopic techniques.
- To study the effect of point defects and line defects in ionic crystals.
- To evaluate the structural aspects of solids.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able

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

UNIT-I: Structure of main group compounds and clusters: VB theory – Effect of lone pair and electronegativity of atoms (Bent's rule) on the geometry of the molecules; Structure of silicates - applications of Paulings rule of electrovalence - isomorphous replacements in silicates – ortho, meta and pyro silicates – one dimensional, two dimensional and three-dimensional silicates. Structure of silicones, Structural and bonding features of B-N, S-N and P-N compounds; Poly acids – types, examples and structures; Borane cluster: Structural features of closo, nido, arachano and klado; carboranes, hetero and metalloboranes; Wade's rule to predict the structure of borane cluster; main group clusters –zintl ions and mno rule.

UNIT-II: Solid state chemistry – I: Ionic crystals: Packing of ions in simple, hexagonal and cubic close packing, voids in crystal lattice, Radius ratio, Crystal systems and 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 and examples.

UNIT-IV: Techniques in solid state chemistry: X-ray diffraction technique: Bragg's law, Powder diffraction method – Principle and Instrumentation; Interpretation of XRD data – JCPDS files, Phase purity, Scherrer formula, lattice constants calculation; Systematic absence of reflections; Electron diffraction technique – principle, instrumentation and application. Electron microscopy – difference between optical and electron microscopy, theory, principle, instrumentation, sampling methods and applications of SEM and TEM.

UNIT-V: Band theory and defects in solids

Band theory – features and its application of conductors, insulators and semiconductors, Intrinsic and extrinsic semiconductors; Defects in crystals – point defects (Schottky, Frenkel, metal excess and metal deficient) and their effect on the electrical and optical property, laser and phosphors; Linear defects and its effects due to dislocations.

Recommended Text

1. A R West, Solid state Chemistry and its applications, 2ndEdition (Students Edition), John Wiley & Sons Ltd., 2014.
2. A K Bhagi and G R Chatwal, A textbook of inorganic polymers, Himalaya Publishing House, 2001.
3. L Smart, E Moore, Solid State Chemistry – An Introduction, 4th Edition, CRC Press, 2012.
4. K. F. Purcell and J. C. Kotz, Inorganic Chemistry; W.B. Saunders company: Philadelphia, 1977.
5. J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry; 4th ed.; Harper and Row: NewYork, 1983.

Reference Books

1. D. E. Douglas, D.H. McDaniel and J. J. Alexander, Concepts and Models in Inorganic Chemistry, 3rd Ed, 1994.
2. R J D Tilley, Understanding Solids - The Science of Materials, 2nd edition, Wiley Publication, 2013.
3. C N R Rao and J Gopalakrishnan, New Directions in Solid State Chemistry, 2nd Edition, Cambridge University Press, 199.
4. T. Moeller, Inorganic Chemistry, A Modern Introduction; John Wiley: New York, 1982.
2. D. F. Shriver, P. W. Atkins and C.H. Langford; Inorganic Chemistry; 3rd ed.; Oxford University Press: London, 2001.

Website and e-learning source

1. https://ocw.mit.edu/courses/3-091-introduction-to-solid-state-chemistry-fall-2018/video_galleries/lecture-videos/

Question Pattern			
Section :A	I. a	5 Multiple Chose Questions (One question from each Unit)	5x1=5
	I.b	5 Fill in the blanks Questions (One question from each Unit)	5x1=5
	II	5 short answer Questions (One question from each Unit)	5x2=10
Section :B (5 Marks)		Either OR choice (One set of question from each Unit)	5x5=25
Section :C (10 Marks)		Ans three out of five (One question from each Unit)	3x10=30
Total Marks			75

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits
I	23PCH1CC2	STRUCTURE AND BONDING IN INORGANIC COMPOUNDS	5	4

Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-I					
Course Code	**:**	**23PCHICC3**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**5**	**Internal Marks**	**:**	**25**
Credits	**:**	**4**	**External Marks**	**:**	**75**
MOLECULAR SPECTROSCOPY					

Objectives of the course

- To understand the influence of rotation and vibrations on the spectra of the polyatomic molecules.
- To study the principle of Raman spectroscopy, ESR spectroscopy, EPR spectroscopy and fragmentation patterns in Mass spectroscopy.
- To highlight the significance of Franck-Condon principle to interpret the selection rule, intensity and types of electronic transitions.
- To interpret the first and second order NMR spectra in terms of splitting and coupling patterns using correlation techniques such as COSY, HETCOR, NOESY.
- To carry out the structural elucidation of molecules using different spectral techniques.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

1. **CO1**: To understand the importance of rotational and Raman spectroscopy.
2. **CO2**: To apply the vibrational spectroscopic techniques to diatomic and polyatomic molecules.
3. **CO3**: To evaluate different electronic spectra of simple molecules using electronic spectroscopy.
4. **CO4**: To outline the NMR, ^{13}C NMR, 2D NMR – COSY, NOESY, Introduction to ^{31}P, ^{19}F NMR and ESR spectroscopic techniques.
5. **CO5**:To develop the knowledge on principle, instrumentation and structural elucidation of simple molecules using Mass Spectrometry, EPR and Mossbauer Spectroscopy techniques.

UNIT-I: Rotational and Raman Spectroscopy: Rotational spectra of diatomic and polyatomic molecules. Intensities of rotational spectral lines, effect of isotopic substitution. Non-rigid rotators. Classical theory of the Raman effect, polarizability as a tensor, polarizability ellipsoids, quantum theory of the Raman effect, Pure rotational Raman spectra of linear and asymmetric top

molecules, Stokes and anti-Stokes lines. Vibrational Raman spectra, Raman activity of vibrations, rule of mutual exclusion, rotational fine structure-O and S branches, Polarization of Raman scattered photons.

UNIT-II: 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. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Ed., Tata McGraw Hill, New Delhi, 2000.
2. R. M. Silverstein and F. X. Webster, Spectroscopic Identification of Organic Compounds, 6th Ed., John Wiley & Sons, New York, 2003.
3. W. Kemp, Applications of Spectroscopy, English Language Book Society, 1987.
4. D. H. Williams and I. Fleming, Spectroscopic Methods in Organic Chemistry, 4th Ed., Tata McGraw-Hill Publishing Company, New Delhi, 1988.
5. R. S. Drago, Physical Methods in Chemistry; Saunders: Philadelphia, 1992.

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

Question Pattern			
Section :A	I. a	5 Multiple Chose Questions (One question from each Unit)	5x1=5
	I.b	5 Fill in the blanks Questions (One question from each Unit)	5x1=5
	II	5 short answer Questions (One question from each Unit)	5x2=10
Section :B (5 Marks)		Either OR choice (One set of question from each Unit)	5x5=25
Section :C (10 Marks)		Ans three out of five (One question from each Unit)	3x10=30
Total Marks			75

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits
I	23PCHICC3	MOLECULAR SPECTROSCOPY	5	3

Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-I					
Course Code	**:**	**23PCHICC4P**	**Exam Hours**	**:**	**6**
Instruction Hours	**:**	**6**	**Internal Marks**	**:**	**40**
Credits	**:**	**4**	**External Marks**	**:**	**60**
ORGANIC CHEMISTRY PRACTICAL					

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 derivatize 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 Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

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

UNIT-I: Separation and analysis:

A. Two component mixtures.

B. Three component mixtures.

UNIT-II: Estimations:

a) Estimati/on 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

g) m-Nitrobenzoic acid from methyl benzoate

Recommended Text

1. A R West, Solid state Chemistry and its applications, 2ndEdition (Students Edition), John Wiley & Sons Ltd., 2014.
2. A K Bhagi and G R Chatwal, A textbook of inorganic polymers, Himalaya Publishing House, 2001.
3. L Smart, E Moore, Solid State Chemistry – An Introduction, 4th Edition, CRC Press, 2012.

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/

Question Pattern			
Section :A	**I. a**	**5 Multiple Chose Questions (One question from each Unit)**	**5x1=5**
	I.b	**5 Fill in the blanks Questions (One question from each Unit)**	**5x1=5**
	II	**5 short answer Questions (One question from each Unit)**	**5x2=10**
Section :B (5 Marks)		**Either OR choice (One set of question from each Unit)**	**5x5=25**
Section :C (10 Marks)		**Ans three out of five (One question from each Unit)**	**3x10=30**
Total Marks			**75**

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**				**Hours**		**Credits**	
I	23PCHICC4P		ORGANIC CHEMISTRY PRACTICAL				5		4	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-I					
Course Code	**:**	**23PCHIEC11**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**5**	**Internal Marks**	**:**	**25**
Credits	**:**	**3**	**External Marks**	**:**	**75**
NANO MATERIALS AND NANO TECHNOLOGY					

Objectives of the 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 by new technologies.
- To design synthetic routes for synthetically used new nano materials.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CO1**: To explain methods of fabricating nanostructures.
- **CO2**: To relate the unique properties of nanomaterials to reduce dimensionality of the material.
- **CO3**: To describe tools for properties of nanostructures.
- **CO4**: To discuss applications of nanomaterials.
- **CO5**:To understand the health and safety related to nanomaterial.

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 magnetic phenomena. 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.

Question Pattern			
Section :A	I. a	5 Multiple Chose Questions (One question from each Unit)	5x1=5
	I.b	5 Fill in the blanks Questions (One question from each Unit)	5x1=5
	II	5 short answer Questions (One question from each Unit)	5x2=10
Section :B (5 Marks)		Either OR choice (One set of question from each Unit)	5x5=25
Section :C (10 Marks)		Ans three out of five (One question from each Unit)	3x10=30
Total Marks			75

Relationship Matrix for COs, POs and PSOs

Semester	Code		Title of the Course				Hours		Credits	
I	23PCHIEC11		NANO MATERIALS AND NANO TECHNOLOGY				5		3	
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-I					
Course Code	**:**	**23PCHIEC12**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**5**	**Internal Marks**	**:**	**25**
Credits	**:**	**3**	**External Marks**	**:**	**75**
INSTRUMENTATION TECHNIQUES					

Objectives of the course

- To improve the technical knowledge about various spectroscopy
- To study the detailed information about conductometry
- To understand the separation of compounds by using chromatography
- To correlate the characteristics of various instruments by new technologies.
- To design synthetic routes for synthetically used instrument materials.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- Learn improve the technical knowledge about various spectroscopy.
- Learn the detailed information about conductometry.
- Learn the separation of compounds by using chromatography.
- Learn the ion fragmentation.
- Learn the prediction of NMR.

UNIT-I : UV- Visible spectroscopy (18 − Hours)

Instrumentation- sources, filters and monochromators, slits grating cuvete, radiation detectors and indicators - photoelectric spectrophotometer types, sources of errors during recording, calibration- presentation of spectral data Infrared Spectroscopy: Dispersive infrared spectrometer- source (Nernst, Globar) monochrometer, detector, double-beam spectrophotometer - rotational spectra of polyatomic molecule-linear and symmetric top molecule- presentation of spectra- sample preparation techniques for IR, FT-–IR- simple diagram of a Fourier transform

infrared spectrometer- working mode -advantages. Raman spectroscopy: Instrumentation- source of light, filters, sample holders, spectrograph, detectors, Sample preparation.

UNIT-II: Nuclear Magnetic Resonance (NMR) (18 − Hours)

Instrumentation -Nuclear spin and nuclear parameters-**chemical shift- spin spin coupling-coupling constant-**mechanism of absorption- calculation of r resonance frequency-magnet, magnetic field sweep, radio frequency source, signal detector and recording system, sample holder, sample probe. Electron Spin Resonance (ESR): Theoretical principles"g' factor,-hyperfine splitting-Illustration and example-Instrumentation - electromagnet, source of micro wave radiation, sample cavity, choice of solvent, crystal detectors and recorder-double resonance spectrometers. Mass Spectrometry: Instrumentation - sample preparation, generation of ions, analyzer, ion collector and measuring system, resolution- representation of mass spectrum - double focusing mass spectrometer.

UNIT III: Conductometry (18 − Hours)

Introduction, laws and definitions of conductance, effects of dilution, conductance measurements, conductometric titrations - apparatus, types and advantages. Potentiometry: electrochemical series, reference electrodes - hydrogen electrode, calomel and silver-silver chloride electrode, measurement of pH - glass indicating electrode, potentiometric titrations, variations in potentiometric titrations, its advantages. Atomic Absorption Spectroscopy: Introduction, principle of AAS, classification of atomic spectroscopic methods, measurement of atomic absorption, instrumentation - application. Atomic **Emission spectroscopy** - Introduction, origin of spectra, principle of emission spectroscopy, Instrumentation, measurement of light intensity and applications.

UNIT IV: Ion exchange Chromatography (18 − Hours)

Electrophoresis : Separation by Adsorption- Affinity techniques, Affinity elution from Ion exchangers and other Adsorbents, Pseudo affinity adsorbents polycrylamide gel electrophorsis-Isoelectic focussing Isotachophoresis, Two dimensional gel electrophoreisis, Capillary electrophoresis in rotation- stabilized media, Electrophoresis in stabilized salts. Applications in Nuclei acids, Clinical and capillary zone electrophoresis of carbohydrates.

UNIT V: Mass Spectroscopy (18 − Hours)

Mass spectrometry principle,condition Instrumentation-Ionization methods - EL, CI, FAB, arc & spark, photoionization, thermal ionization, Fl*& FD, laser induced, Photoelectic ionization,

SIMS, stereochemical activity of lone pair,magnetic interaction-Mass analyzers - Magnetic, Double foucusing, Time of flight, Quadrupolar, Ion cyclotron resonance analyzer. Coupled techniques, GC FTIR, GCMS (Use of stable isotopes) HPLC-MS. Applications of mass spectroscopy.

Text Books:

1. H. Kaur - "Instrumental methods of Chemical Analysis", 6th edition, (2010), Pragati prakasan Publications, Meerut.
2. B.K. Sharma - "Instrumental methods of Analysis", (2000), Goel Publications.
3. R.A. Day and A.L. Underwood - "Quantitative Analysis", (1999), Prentice-Hall of India Pvt., Ltd., New Delhi.

References:

1. Willard, Meeritt, Dean and Settle - "Instrumental Methods of Analysis", 7th Ed.,(2006), CBS Publishers.
2. S.M. Khopkar, "Basic Concepts of Analytical Chemistry", Revised edition (2006) Wiley Eastern Ltd.
3. B.S. Furniss, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell - "Vogel‟s Text book of Practical Organic Chemistry", fifth edition ,2009, Pearson Education Publisher.
4. L. Pavia - "Spectroscopy" cengage CourseIndia Pvt. Ltd - 2010.
5. Harald Guther, "NMR Spectroscopy", Wiley india (p) Ltd, 2nd Edn,2010.
6. G.Aruldhas -"Molecular structure & Spectroscopy ",PHI CoursePvt.Ltd.2nd Edition ,-2008.
7. Colin N.Banwell - "Fundemendals of Molecular structure Spectroscopy " Mc.Grow -Hill publishing company Ltd. 4th edition „1995.

Question Pattern

Section :A	**ia. MCQ Type**	**5x1=5**
	ib. Fill in the blanks	**5x1=5**
	ii . Short answer questions	**5x2=10**
Section : B (5 Marks)	**Either OR choice**	**5x5=25**
Section :C (10 Marks)	**Answer three out of five**	**3x10=30**
Total Marks		**75**

Relationship Matrix for COs, POs and PSOs

Semester	Code		Title of the Course				Hours		Credits	
I	23PCHIEC12		INSTRUMENTATION TECHNIQUES				6		4	
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-I					
Course Code	**:**	**23PCHIEC21**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**4**	**Internal Marks**	**:**	**25**
Credits	**:**	**3**	**External Marks**	**:**	**75**
INDUSTRIAL CHEMISTRY					

Objectives of the course

- To study the information about green methods for industries.
- To understand the non conventional energy sources.
- To know about water pollution and control methods.
- To correlate the characteristics of various Chemical products by new technologies.
- To design synthetic routes for synthetically used instrument materials.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- Learn develop the knowledge about chemical industries
- Learn the fuels and dyes
- Learn about synthesis of dyes and polymer chemistry
- Learn the application of chemistry in quality control measurements.
- Learn about the polymers.

UNIT-I: Green Methods and Industrial Process (18 − Hours)

Basic ideas about unit operation -Flow charts -Chemical conversion -Batch versus continuous processing -Chemical process selection -Design -Chemical process control- Research & Development and its role in chemical industries. Industrial safety measures -Fire extinguisher-Fire retardant materials -Fire retarding wood -Procedures for handling toxic chemicals

UNIT II: Renewable Energy Resources (18 − Hours)

Renewable energy sources: types of renewable energy sources-Solar cells: basic principles-types and their applications. Fuel cells: basic principles-types and their applications. Working principle and applications of Biofuel cells- brief introduction about hydroelectric- biomass-wind power and geothermal power and their applications and limitations-energy from some other natural source.

UNIT III: Polymers (18 − Hours)

Polymers definition types of polymers liquid crystalline polymers. Molecular mass - number and mass average molecular mass - determination of molecular mass (osmometry, viscosity, diffusion, light scattering, and sedimentation methods). viscoelasticity, Rubber elasticity. Kinetics of linear stepwise polymerization - addition polymerization - free radical, cationic and anionic polymerization- Zigler-Natta polymerization-Resin and its types - Unactivated carbon-hydrogen bond: definition,mechanism and synthetic application-synthetic rubber-vulcanization of rubber-Kinetics of copolymerization. Polymerization in homogeneous and heterogeneous systems.

UNIT IV: Commercial Polymers (18 − Hours)

Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins and silicone polymers-Functional polymers-Fire retarding polymers and electrically conducting polymers. Biomedicalpolymers.

UNIT V: Industrial Water Pollution and its Control & Analysis (18 − Hours)

Sources of water pollution -domestic -industrial -agricultural -soil and radioactive wastes as sources of pollution. Water pollutants and their effects. Eutrophication-salt water interation-salinity –blue baby syndrome-Objectives of analysis -parameter for analysis-colour -turbidity -total solids -conductivity -acidity -alkalinity -hardness –chloride -sulphate -fluoride -silica -phosphates, different forms of nitrogen, DO, BOD, COD Heavy metal pollution-public health significance of Cadmium -Chromium -Copper -Lead -Zinc -Manganese. Prevention and control its measures.

Text Books:

1. B. K. Sharma, Industrial Chemistry; 8th Ed., Goel Publishing House, New Delhi, 1997.

2. V.R.Gowariker, N.V. Viswanathan and Jayadev Sreedhar, Polymer Science, New Age Publishers, New Delhi, 1986.
3. B.K. Sharma and H. Kaur, "Environmental chemistry" ,Goel Publishing House, Meerut, 2008

References:

1. Chemical Process Industries - Norrish Shreve, R. and Joseph A. Brink Jr. McGraw Hill, Industrial Book Company, London.
2. Production and Properties of Industrial Chemicals - Brain A.C.S. Reinhold - New York.
3. Petroleum Products Hand Book. Guthrie V., McGraw Hill, Tokyo.
4. Outlines of Chemical Technology - For the 21st Century - M. Gopala Rao & Matshall Sittig (3rd Edition)
5. Charles E. Carraher, Polymer chemistry, 6th edn, Marcel Dckker, Pvt .Ltd, 2003.
6. F.W.Billmeyer, Jr., A Text Book of Polymer Science, Wiley & Sons, New York, 1971.

Question Pattern

Section :A	**ia. MCQ Type**	**5x1=5**
	ib. Fill in the blanks	**5x1=5**
	ii . Short answer questions	**5x2=10**
Section : B (5 Marks)	**Either OR choice**	**5x5=25**
Section :C (10 Marks)	**Answer three out of five**	**3x10=30**
Total Marks		**75**

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**				**Hours**		**Credits**	
IV	**23PCHIEC21**		**INDUSTRIAL CHEMISTRY**				6		5	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-I					
Course Code	**:**	**23PCHIEC22**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**4**	**Internal Marks**	**:**	**25**
Credits	**:**	**3**	**External Marks**	**:**	**75**
CONCEPTS AND MODELS IN CHEMISTRY					

Objectives of the course

- To study the information about bio-organic molecules and metal ions.
- To understand the chemical bonding and chemical thermodynamics.
- To know about chemical kinetics.
- To study the information about new concepts of chemistry.
- To understand the modern biological concepts.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- To learn about polymeric bio-organic molecules such as carbohydrates- proteins and nucleic acids.
- To enable the students to understand the importance of trace elements in biological system
- To enable the students to understand the structure and importance of biomolecules such as proteins- nucleic acids and carbohydrate.
- To identify the bonding types.
- Learn the chemical bonding and chemical thermodynamics. Learn chemical kinetics.

Unit I

Bio-Organic Chemistry: Amino acids and proteins: Structure- classification- nomenclature and function of amino acids- functional groups- isoelectric point - Peptide structure- structural levels of proteins - primary- secondary- tertiary and quaternary- alpha- beta helix - collagen- fibrous and globular proteins.

Nucleic acids: Structures of RNA and DNA.

Enzymes: Co-enzymes Classification , Characteristics- properties-nomenclature-functions-factors affecting enzyme activity: pH- temperature- substrate concentration-Examples for coenzymes and its functions**.**

Unit II

Metal Ions in Biology & Chemotherapy: Metal Ions in Biology - Occurrence and availability of Inorganic elements in Organism-Biological function of inorganic elements - Biological ligands for metal ions - Coordination of Proteins and enzymatic catalysis - Porphyrins and other Macrocycles - Nucleobases- nucleotides and other Nucleic acids as ligands. Metal ion transport and storage - Cobalamines Metals at the Center of Photosynthesis. Dioxygen transport: Oxygen Transport and Storage through Hemoglobin and Myoglobin- Alternative oxygen Transport in some Lower Animals: Hemereythrin - Hemocyanin.

Chemotherapy- Platinum complexes in Cancer therapy - Cisplatin and its mode of action - Cytotoxic compounds of other metals.

Unit III

Chemical Bonding: Atomic structure - Types of chemical bonds, Core and valence electrons - concept of hybridization periodicity, valence shells and chemical reactivity - valence and chemical formulas, covalent, ionic and co-ordinate bonds, hydrogen bonds - non-covalent interactions electronic and molecular structure - σ- π and δ bonds - bond parameters, conformation, configuration, various representations - macromolecules and three dimensional structures.

Unit IV

Chemical Thermodynamics: Energy and the First Law of Thermodynamics- Conservation of energy-principle- work and heat- enthalpy- exothermic and endothermic reactions- C_p & C_v- Hess's law of heat summation- use of standard enthalpies of formation - Entropy and the second law of Thermodynamics- Kelvin and Clausius statements of Second Law- variation of chemical potential with tempreature and pressure -definition of entropy- spontaneity and reversibility- entropy change of the system- molecular basis of entropy- free energy and chemical equilibrium- Factors affecting equilibrium.

Unit V

Chemical Kinetics: Rate of Reaction- order of reaction - derivation of rate equation for first order reaction- Determination of rate equation by isolation method - Effect of temperature on reaction rate -Arrhenius equation-Enzyme Kinetics - Michaelis Menten equation - Salt effect on reaction rate (derivation not needed).

Text Book(s):

1. S. J. Lippard and J. M. Berg- Principles of Bioinorganic Chemistry- Purnima Publishing Company- 1997. (Unit-1)
2. Geoffrey L. Zubay- William W. Parson and Dennis E. Vance- Principles of Biochemistry- McGraw-Hill Education- 1995. (Unit-2)
3. D. E. Douglas- D.H. McDaniel and J. J. Alexander- Concepts and Models in Inorganic Chemistry- 3rd Ed- 1994. (Unit-3)
4. S. Glasstone- Thermodynamics for Chemists- Affiliated East West Press- New Delhi- 1960. (Unit-4)
5. Gordon M. Barrow- Physical Chemistry- Tata McGraw Hill- 1994. (Unit-5)

Reference Book(s):

1. B.H. Mahan- University chemistry- Narosa Publishers.
2. Bruce H. Mahan- University chemistry- Narosa Publishers.
3. David L. Nelson and Michael M. Cox- Leninger Principles of Biochemistry- WH Freeman- 2017.
4. R.T. Morrison and R.N. Boyd- Organic Chemistry- 6th Ed.- Pearson- 1992.
5. I.L. Finar- Organic Chemistry- Vol.II- 5th ed.- ELBS 1975.
6. J.E. Huheey- Inorganic Chemistry- 3rd. Ed.- Harper & Row publisher- 1983.
7. W. Kaim and B. Schewederski- Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life- John Wiley

8.C.H. Snyder- The extra-ordinary chemistry of ordinary things- John Wiley- 1992.

9. P.W. Atkins- Physical Chemistry- ELBS and Oxford University Press- 1998.

Question Pattern

Section :A	**ia. MCQ Type**	**5x1=5**
	ib. Fill in the blanks	**5x1=5**
	ii . Short answer questions	**5x2=10**
Section : B (5 Marks)	**Either OR choice**	**5x5=25**
Section :C (10 Marks)	**Answer three out of five**	**3x10=30**
Total Marks		**75**

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**		**Credits**	
II	**23PCHIEC22**		**CONCEPTS AND MODELS IN CHEMISTRY**			5		4	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-II					
Course Code	**:**	**23PCH2CC5**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**5**	**Internal Marks**	**:**	**25**
Credits	**:**	**5**	**External Marks**	**:**	**75**
ORGANIC REACTION MECHANISM-II					

Objectives of the course

- To understand the concept of aromaticity in benzenoid, non-benzenoid, heterocyclic and annulene compounds.
- To understand the mechanism involved in various types of organic reactions with evidences.
- To understand the applications of synthetically important reagents.
- To correlate the reactivity between aliphatic and aromatic compounds.
- To design synthetic routes for synthetically used organic reactions.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

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

UNIT-I: Elimination and Free Radical Reactions: Mechanisms: E2, E1, and E1cB mechanisms. Syn- and anti-eliminations. Orientation of the double bond: Hoffmann and Saytzeff rules. Reactivity: Effect of substrate, attacking bases, leaving group and medium. Stereochemistry of eliminations in acyclic and cyclic systems, pyrolytic elimination. Long lived and short-lived radicals – Production of radicals by thermal and photochemical reactions, Detection and stability of radicals, characteristics of free radical reactions and free radical, reactions of radicals;

polymerization, addition, halogenations, aromatic substitutions, rearrangements. Reactivity: Reactivity on aliphatic, aromatic substrates, reactivity in the attacking radical, effect of solvent.

UNIT-II: Oxidation and Reduction Reactions: Mechanisms: Direct electron transfer, hydride transfer, hydrogen transfer, displacement, addition-elimination, oxidative and reductive coupling reactions. Mechanism of oxidation reactions: Dehydrogenation by quinones, selenium dioxides, ferricyanide, mercuric acetate lead tetraacetate, permanganate, manganese dioxide, osmium tetroxide, oxidation of saturated hydrocarbons, alkyl groups, alcohols, halides and amines. Reactions involving cleavage of C-C bonds - cleavage of double bonds, oxidative decarboxylation, allylic oxidation, oxidation by chromium trioxide-pyridine, 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: Rearrangements to electron deficient carbon: Pinacol-pinacolone and semi-pinacolone rearrangements -applications and stereochemistry, Wagner-Meerwein, Demjanov, Dienone-phenol, Baker-Venkataraman, Benzilic acid and Wolff rearrangements. Rearrangements to electron deficient nitrogen: Hofmann, Curtius, Schmidt, Lossen, Beckmann and abnormal Beckmann rearrangements. Rearrangements to electron deficient oxygen: Baeyer-Villiger oxidation and Dakin rearrangements. Rearrangements to electron rich atom: Favorskii, Quasi-Favorskii, Stevens, [1,2]-Wittig and [2,3]-Wittig rearrangements. Fries and Photo Fries rearrangement. Intramolecular rearrangements – Claisen, abnormal Claisen, Cope, oxy-Cope Benzidine rearrangements.

UNIT-IV: Addition to Carbon Multiple Bonds: Mechanisms: (a) Addition to carbon-carbon multiple bonds- Addition reactions involving electrophiles, nucleophiles, free radicals, carbenes and cyclic mechanisms-Orientation and reactivity, hydrogenation of double and triple bonds, Michael reaction, addition of oxygen and Nitrogen; (b) Addition to carbon-hetero atom multiple bonds: Mannich reaction, acids, esters, nitrites, addition of Grignard reagents, Wittig reaction, Prins reaction. Stereochemical aspects of addition reactions. 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 diisopropylamine (LDA), Azobisisobutyronitrile (AIBN), Sodium cyanoborohydride (NaBH3CN), meta-Chloroperbenzoic acid (m-CPBA), Dimethyl aminiopyridine (DMAP), n-Bu3SnD, Triethylamine (TEA), Diazobicyclo[5.4.0]undec-7-ene (DBU), Diisopropylazodicarboxylate (DIAD), Diethylazodicarboxylate (DEAD), N-bromosuccinimide (NBS), Trifluoroacetic acid (TFA), Tetramethyl piperiridin-1-oxyl (TEMPO), Phenyltrimethylammonium tribromide (PTAB). Diazomethane and Zn-Cu, Diethyl maleate (DEM), Copper diacetylacetonate (Cu(acac)2), TiCl3, NaIO4, Pyridinium chlorochromate (PCC), Pyridinium dichromate (PDC), Meisenheimer complex. Suzuki coupling, Heck reaction, Negishi reaction, Baylis-Hillman reaction.

Recommended Text

1. J. March and M. Smith, Advanced Organic Chemistry, 5th ed., John-Wiley and Sons. 2001.
2. E. S. Gould, Mechanism and Structure in Organic Chemistry, Holt, Rinehart and Winston Inc., 1959.
3. P. S. Kalsi, Stereochemistry of carbon compounds, 8thedn, New Age International Publishers, 2015.
4. P. Y.Bruice, Organic Chemistry, 7thedn.,Prentice Hall, 2013.
5. R. T. Morrison, R. N. Boyd, S. K. BhattacharjeeOrganic Chemistry, 7th edn., Pearson Education, 2010.

Reference Books

1. S. H. Pine, Organic Chemistry, 5thedn, McGraw Hill International Editionn, 1987.
2. L. F. Fieser and M. Fieser, Organic Chemistry, Asia Publishing House, Bombay, 2000.
3. E.S. Gould, Mechanism and Structure in Organic Chemistry, Holt, Rinehart and Winston Inc., 1959.
4. T. L. Gilchrist, Heterocyclic Chemistry, Longman Press, 1989.
5. J. A. Joule and K. Mills, Heterocyclic Chemistry, 4thed., John-Wiley, 2010.

Website and e-learning source

1. 1.https://sites.google.com/site/chemistryebookscollection02/home/organic-chemistry/organic
2. https://www.organic-chemistry.org/

Question Pattern			
Section :A	I. a	5 Multiple Chose Questions (One question from each Unit)	5x1=5
	I.b	5 Fill in the blanks Questions (One question from each Unit)	5x1=5
	II	5 short answer Questions (One question from each Unit)	5x2=10
Section :B (5 Marks)		Either OR choice (One set of question from each Unit)	5x5=25
Section :C (10 Marks)		Ans three out of five (One question from each Unit)	3x10=30
Total Marks			75

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits
I	23PCH2CC5	ORGANIC REACTION MECHANISM-II	5	4

Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-II					
Course Code	**:**	**23PCH2CC6**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**6**	**Internal Marks**	**:**	**25**
Credits	**:**	**5**	**External Marks**	**:**	**75**
PHYSICAL CHEMISTRY-I					

Objectives of the course

- To recall the fundamentals of thermodynamics and the composition of partial 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 Learning Outcomes (for Mapping with POs and PSOs)
Students will be able:

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

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 of mass and energy entropy production in open systems by heat, matter and current flow, force and flux concepts. Onsager theory-validity and verification- Onsager reciprocal relationships. Electro kinetic and thermo mechanical effects-Application of irreversible thermodynamics to biological systems.

UNIT-IV: Kinetics of Reactions: Theories of reactions-effect of temperature on reaction rates, collision theory of reaction rates, Unimolecular reactions -Lindeman and Christiansen hypothesis- molecular beams, collision cross sections, effectiveness of collisions, Potential energy surfaces. Transition state theory-evaluation of thermodynamic parameters of activation-applications of ARRT to reactions between atoms and molecules, time and true order-kinetic parameter evaluation. 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 H2 – Cl2 & H2 – Br2 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

Question Pattern			
Section :A	I. a	5 Multiple Chose Questions (One question from each Unit)	5x1=5
	I.b	5 Fill in the blanks Questions (One question from each Unit)	5x1=5
	II	5 short answer Questions (One question from each Unit)	5x2=10
Section :B (5 Marks)		Either OR choice (One set of question from each Unit)	5x5=25
Section :C (10 Marks)		Ans three out of five (One question from each Unit)	3x10=30
Total Marks			75

Relationship Matrix for COs, POs and PSOs

Semester	Code		Title of the Course				Hours		Credits	
I	23PCH2CC6		PHYSICAL CHEMISTRY-I				5		4	
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-II					
Course Code	**:**	**23PCH2CC7P**	**Exam Hours**	**:**	**6**
Instruction Hours	**:**	**6**	**Internal Marks**	**:**	**40**
Credits	**:**	**4**	**External Marks**	**:**	**60**
INORGANIC CHEMISTRY PRACTICAL					

Objectives of the course

- To understand and enhance the visual observation as an analytical tool for 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 of ion accurately present in the solution
- To estimate metal ions, present in the given solution accurately without using instruments.
- To determine the amount of ions, present in a binary mixture accurately.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CO1**: To identify the anions and cations present in a mixture of salts.
- **CO2**: To apply the principles of semi micro qualitative analysis to categorize acid radicals and basic radicals.
- **CO3**: To acquire the qualitative analytical skills by selecting suitable confirmatory tests and spot tests.
- **CO4**: To choose the appropriate chemical reagents for the detection of anions and cations.
- **CO5**: To synthesize coordination compounds in good quality.

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)

h. 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. 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

4. G. Pass, and H. Sutcliffe, Practical Inorganic Chemistry; Chapman Hall, 1965.

5. W. G. Palmer, Experimental Inorganic Chemistry; Cambridge University Press, 1954.

Question Pattern			
Section :A	I. a	5 Multiple Chose Questions (One question from each Unit)	5x1=5
	I.b	5 Fill in the blanks Questions (One question from each Unit)	5x1=5
	II	5 short answer Questions (One question from each Unit)	5x2=10
Section :B (5 Marks)		Either OR choice (One set of question from each Unit)	5x5=25
Section :C (10 Marks)		Ans three out of five (One question from each Unit)	3x10=30
Total Marks			75

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits
I	23PCH2CC7P	INORGANIC CHEMISTRY PRACTICAL	5	4

Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-II					
Course Code	**:**	**23PCH2EC31**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**5**	**Internal Marks**	**:**	**25**
Credits	**:**	**3**	**External Marks**	**:**	**75**
GREEN CHEMISTRY					

Objectives of the course

- To discuss the principles of green chemistry.
- To propose green solutions for chemical energy storage and conversion.
- Propose green solutions for industrial production of Petroleum and Petrochemicals.
- Propose solutions for pollution prevention in Industrial chemical and fuel
- production, Automotive industry and Shipping industries.
- Propose green solutions for industrial production of Surfactants, Organic and inorganic chemicals.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CO1**: To recall the basic chemical techniques used in conventional industrial preparations and in green innovations.
- **CO2**: To understand the various techniques used in chemical industries and in laboratory.
- **CO3**: To compare the advantages of organic reactions assisted by renewable energy sources and non-renewable energy sources.
- **CO4**: To apply the principles of PTC, ionic liquid, microwave and ultrasonic assisted organic synthesis.
- **CO5**: To design and synthesize new organic compounds by green methods.

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 of Green Chemistry with examples.

UNIT-II: Choice of starting materials, reagents, catalysts and solvents in detail, Green chemistry in day today life. Designing green synthesis-green reagents: dimethyl carbonate. Green solvents: Water,Ionic liquids-criteria, general methods of preparation, effect on organic reaction. Supercritical carbon dioxide- properties, advantages, drawbacks and a few examples of organic reactions in scCO2. 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, 7thedition, 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

Question Pattern			
Section :A	**I. a**	**5 Multiple Chose Questions (One question from each Unit)**	**5x1=5**
	I.b	**5 Fill in the blanks Questions (One question from each Unit)**	**5x1=5**
	II	**5 short answer Questions (One question from each Unit)**	**5x2=10**
Section :B (5 Marks)		**Either OR choice (One set of question from each Unit)**	**5x5=25**
Section :C (10 Marks)		**Ans three out of five (One question from each Unit)**	**3x10=30**
Total Marks			**75**

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**				**Hours**		**Credits**	
I	23PCH2EC31		GREEN CHEMISTRY				5		3	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-II					
Course Code	**:**	**23PCH2EC32**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**5**	**Internal Marks**	**:**	**25**
Credits	**:**	**3**	**External Marks**	**:**	**75**
MEDICINAL CHEMISTRY					

Objectives of the 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 treatment of diabetes.
- To identify and apply the action of various antibiotics.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CO1**: Predict a drugs properties based on its structure.
- **CO2**: Describe the factors that affect its absorption, distribution, metabolism, and excretion, and hence the considerations to be made in drug design.
- **CO3**: Explain the relationship between drug's chemical structure and its therapeutic properties.
- **CO4**: Designed to give the knowledge of different theories of drug actions at molecular level.
- **CO5**: To identify different targets for the development of new drugs for the treatment of infectious and GIT.

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: 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-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 of Antidiabetic 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

Question Pattern			
Section :A	I. a	5 Multiple Chose Questions (One question from each Unit)	5x1=5
	I.b	5 Fill in the blanks Questions (One question from each Unit)	5x1=5
	II	5 short answer Questions (One question from each Unit)	5x2=10
Section :B (5 Marks)		Either OR choice (One set of question from each Unit)	5x5=25
Section :C (10 Marks)		Ans three out of five (One question from each Unit)	3x10=30
Total Marks			75

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits
I	23PCH2EC32	MEDICINAL CHEMISTRY1	5	3

Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-II					
Course Code	**:**	**23PCH2EC41**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**5**	**Internal Marks**	**:**	**25**
Credits	**:**	**3**	**External Marks**	**:**	**75**
BIO-INORGANIC CHEMISTRY					

Objectives of the 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 Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CO1**: The students will be able to analyses trace elements.
- **CO2**: Students will be able to explain the biological redox systems.
- **CO3**: Students will gain skill in analyzing the toxicity in metals.
- **CO4**: Students will have experience in diagnosis.
- **CO5**: Learn about the nitrogen fixation and photosynthetic mechanism.

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 Bioinorganic Chemistry - 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

1. https://www.pdfdrive.com/instant-notes-in-inorganic-chemistry-the-instant-notes-chemistry-series-d162097454.html
2. https://www.pdfdrive.com/shriver-and-atkins-inorganic-chemistry-5th-edition-d161563417.html

Question Pattern			
Section :A	I. a	5 Multiple Chose Questions (One question from each Unit)	5x1=5
	I.b	5 Fill in the blanks Questions (One question from each Unit)	5x1=5
	II	5 short answer Questions (One question from each Unit)	5x2=10
Section :B (5 Marks)		Either OR choice (One set of question from each Unit)	5x5=25
Section :C (10 Marks)		Ans three out of five (One question from each Unit)	3x10=30
Total Marks			75

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits
I	23PCH2EC41	BIO-INORGANIC CHEMISTRY	5	3

Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-II					
Course Code	**:**	**23PCH2EC42**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**5**	**Internal Marks**	**:**	**25**
Credits	**:**	**3**	**External Marks**	**:**	**75**
MATERIAL SCIENCE					

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 Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CO1**: To understand and recall the synthesis and characteristics of crystal structures, semiconductors, magnets, nanomaterials and renewable energy materials.
- **CO2**: To integrate and assess the structure of different materials and their properties.
- **CO3**: To analyse and identify new materials for energy applications.
- **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.
- **CO5**: To design and develop new materials with improved property for energy applications.

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 LiNbO3.

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. 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.
3. https://bit.ly/3QyVg2R

Question Pattern			
Section :A	I. a	5 Multiple Chose Questions (One question from each Unit)	5x1=5
	I.b	5 Fill in the blanks Questions (One question from each Unit)	5x1=5
	II	5 short answer Questions (One question from each Unit)	5x2=10
Section :B (5 Marks)		Either OR choice (One set of question from each Unit)	5x5=25
Section :C (10 Marks)		Ans three out of five (One question from each Unit)	3x10=30
Total Marks			75

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits
I	23PCH2EC42	MATERIAL SCIENCE	5	3

Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓

Number of Matches(✓) = 42 Relationship: High

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-II					
Course Code	**:**	**23PCH2EC42**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**2**	**Internal Marks**	**:**	**25**
Credits	**:**	**2**	**External Marks**	**:**	**75**
WATER TECHNOLOGY					

Objectives of the course

1. Understand the basic principles and processes involved in treating water for various purposes.
2. Learn to assess and monitor water quality parameters to ensure its suitability for different applications.
3. Familiarize with modern technologies like filtration, disinfection, and desalination used in water treatment processes.
4. Understand regulatory frameworks governing water quality and treatment, and the importance of compliance.
5. Explore strategies for efficient management and conservation of water resources, including sustainable use practices and risk mitigation.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CO1**: Demonstrate a comprehensive understanding of various water treatment processes and techniques, including filtration, disinfection, and desalination, to ensure the provision of safe and potable water.
- **CO2** Apply knowledge of water quality parameters and assessment methods to evaluate the suitability of water for different purposes, considering factors such as chemical, physical, and biological characteristics

- **CO3**: Understand and adhere to relevant regulatory frameworks, standards, and guidelines governing water quality and treatment practices, ensuring compliance with legal and environmental requirements.
- **CO4**: Develop strategies for sustainable water resource management, including conservation practices, watershed management approaches, and the promotion of water reuse and recycling initiatives, to mitigate the impact of water scarcity and pollution.
- **CO5**: Apply knowledge of innovative technologies in water treatment and management, such as advanced oxidation processes, membrane technologies, and remote sensing, to address contemporary challenges in water resource management.

UNIT I

Water: Sources of Water - Chemistry of Water - Hardness of Water - Water in Human Body - Quality of Natural Water - Potability of Water - Water Cycle - National Water Policy.

UNIT II

Socio- Economical Importance of Water: Demand and Consumption of Water – Agriculture – Industry – Household – Recreation - Water Scarcity - Major Causes of Water Quality Degradation - Water Borne Diseases.

UNIT III

Purification of Water: Clarification – Coagulation – Sterilization- Physical Methods -Boiling- Exposure To Sunlight & UV Light- Irradiation With Ultrasound-Chemical Methods -Aeration- Ozonisation – Chlorination-Softening by Zeolite Process-Sea Water as a Source of Water.

UNIT IV

Sewage Treatment: Purpose of Sewage Treatment– Composition- Properties [Physical and Chemical] – 1° Treatment- 2° Treatment- 3° Treatment- Sewage Disposal-Sludge Disposal.

UNIT – V

Conservation of water Resources: Need of Water Harvesting Technologies- Recharging of Ground Water - Rain Water Harvesting- Recycling of Water- Artificial Rain- How to Make Best Use of Water.

TEXT BOOKS

1. **Jat B.C, Sujan Singh,** *Water Management Through Traditional Technologies*, Pointer Publishers, Jaipur, IstEdition, 2010.
2. **Sharma B.K.,** *Industrial Chemistry,* Krishna's Educational Publishers**,** Delhi,16th Edition, 2011.
3. **Sharma B.K,** *Water Pollution,* Krishna Prakashan Media (P) Ltd., Meerut, Vth Edition, 2012.

REFERENCE BOOKS

1. **Ahluwalia V.K,** *Environmental Chemistry*, Ane Books Pvt. Ltd., New Delhi, 2nd Edition, 2013.
2. **Chandark K. Sharma,** *Introduction To Environmental Studies*, Vrinda Publications (P) Ltd., New Delhi, IstEdition, 2010.
3. **De A.K,** *Environmental Chemistry*, New Age International (P) Ltd Publishers, Delhi, VIthEdition, 2006.
4. **Dr. Punnia B.C, Arun Kumar Jain, Ashok Kumar Jain,** *Environmental Engineering2 Waste Water Engineering (Including Air Pollution),*Laxmi Publications (P) Ltd., New Delhi, IIndEdition,1988.
5. **Raghunath H.M,** *Ground Water*, New Age International Publishers, New Delhi, 3rd Edition, 2007.
6. **Santhosh Kumar Garg,** *Water Supply Engineering*, Khanna Publishers, New Delhi, 21st Edition, 2012.
7. **Santra S.C,** *Environmental Science*, New Central Book Agency (P) Ltd., Kolkata, II Nd Edition, 2013.
8. **Stanley E. Manahan**, *Water Chemistry Green Science & Technology Of Nature´s Most Renewable Resource,* CRC Press, New York, 1st Indian Reprint, 2015.

3. Website and e-learning source:

https://www.labconco.com/category/water-purification-systems?msclkid=2bc9a0a354451860907bc57c55f48c5f&utm_source=bing&utm_medium=cpc&utm_campaign=**LP%202.0%20-%20(US)%20-%20Search%20%20Water%20Purification&utm_term=laboratory%20water%20purification&utm_content=Laboratory%20Water%20Purification

Question Pattern			
Section :A	I. a	5 Multiple Chose Questions (One question from each Unit)	5x1=5
	I.b	5 Fill in the blanks Questions (One question from each Unit)	5x1=5
	II	5 short answer Questions (One question from each Unit)	5x2=10
Section :B (5 Marks)		Either OR choice (One set of question from each Unit)	5x5=25
Section :C (10 Marks)		Ans three out of five (One question from each Unit)	3x10=30
Total Marks			75

Relationship Matrix for COs, POs and PSOs

Semester	Code		Title of the Course			Hours		Credits	
I	23PCH2EC42		WATER TECHNOLOGY			5		3	
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-II					
Course Code	**:**	**23PCH2OC**	**Exam Hours**	**:**	
Instruction Hours	**:**		**Internal Marks**	**:**	
Credits	**:**	**2***	**External Marks**	**:**	
SWAYAM/NPTEL Online Course					

SWAYAM/NPTEL Online Course

SEMESTER-III					
Course Code	**:**	**23PCH2CC8**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**6**	**Internal Marks**	**:**	**25**
Credits	**:**	**4**	**External Marks**	**:**	**75**
ORGANIC SYNTHESIS AND PHOTOCHEMISTRY					

Objectives of the course

- To understand the molecular complexity of carbon skeletons and the presence of functional groups and their relative positions.
- To study various synthetically important reagents for any successful organic synthesis.
- To apply disconnection approach and identifying suitable synthons to effect successful organic synthesis.
- To learn the concepts of pericyclic reaction mechanisms.
- To gain the knowledge of photochemical organic reactions.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

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

UNIT-I: Planning an Organic Synthesis and Control elements: Preliminary Planning – knowns and unknowns of the synthetic system studied, analysis of the complex and interrelated carbon

framework into simple rational precursors, retrosynthetic analysis, alternate synthetic routes, key intermediates that would be formed, available starting materials and resulting yield of alternative methods. Linear Vs convergent synthesis. synthesis based on umpolung concepts of Seeback, regiospecific control elements. Use of protective groups, activating groups and bridging elements. Examples on retrosynthetic approach, calculation of yield, advantages of connvergent synthesis, synthesis of stereochemistry-controlled products.

UNIT-II: Organic Synthetic Methodology: Retrosynthetic analysis; Alternate synthetic routes. Synthesis of organic mono and bifunctional compounds via disconnection approach. Key intermediates, available starting materials and resulting yields of alternative methods. Convergent and divergent synthesis, Synthesis based on umpolung concepts of Seebach. Protection of hydroxyl, carboxyl, carbonyl, thiol and amino groups. Illustration of protection and deprotection in synthesis. Control elements: Regiospecific control elements. Use of protective groups, activating groups, and bridging elements. Stereospecific control elements. Functional group alterations and transposition.

UNIT-III: Pericyclic Reactions: Woodward Hoffmann rules; The Mobius and Huckel concept, FMO, 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; * triplets; Norrish type-I and type-II cleavage reactions; photo reductions; Paterno-Buchi reactions;

UNIT-V: Organic Photochemistry-I: Photochemistry of ,-unsaturated ketones; cis-trans isomerisation. Photon energy transfer reactions, Photo cycloadditions, Photochemistry of aromatic compounds; photochemical rearrangements; photo-stationery state; di-π-methane rearrangement; Reaction of conjugated cyclohexadienone to 3,4-diphenyl phenols; Barton's reactions.

Recommended Text

1. F. A. Carey and Sundberg, Advanced Organic Chemistry, 5thed, Tata McGraw-Hill, New York, 2003.
2. J. March and M. Smith, Advanced Organic Chemistry, 5th ed., John-Wiley and sons, 2007.
3. R. E. Ireland, Organic synthesis, Prentice Hall India, Goel publishing house, 1990.
4. Clayden, Greeves, Warren, Organic Chemistry, Oxford University Press, Second Edition, 2016.
5. M. B. Smith, Organic Synthesis 3rd edn, McGraw Hill International Edition, 2011.

Reference Books

1. Gill and Wills, Pericyclic Reactions, Chapman Hall, London, 1974.
2. J.A. Joule, G.F. Smith, Heterocyclic Chemistry, Garden City Press, Great Britain, 2004.
3. W. Caruthers, Some Modern Methods of Organic Synthesis 4thedn, Cambridge University Press, Cambridge, 2007.
4. H. O. House. Modern Synthetic reactions, W.A. Benjamin Inc, 1972.
5. Jagdamba Singh and Jaya Singh, Photochemistry and Pericyclic Reactions, New Age International Publishers, New Delhi, 2012.

Website and e-learning source

1. https://rushim.ru/books/praktikum/Monson.pdf

Question Pattern			
Section :A	**I. a**	**5 Multiple Chose Questions (One question from each Unit)**	**5x1=5**
	I.b	**5 Fill in the blanks Questions (One question from each Unit)**	**5x1=5**
	II	**5 short answer Questions (One question from each Unit)**	**5x2=10**
Section :B (5 Marks)		**Either OR choice (One set of question from each Unit)**	**5x5=25**
Section :C (10 Marks)		**Ans three out of five (One question from each Unit)**	**3x10=30**
Total Marks			**75**

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**				**Hours**		**Credits**	
I	23PCH2CC8		ORGANIC SYNTHESIS AND PHOTOCHEMISTRY				5		4	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-III					
Course Code	**:**	**23PCH2CC9**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**5**	**Internal Marks**	**:**	**25**
Credits	**:**	**4**	**External Marks**	**:**	**75**
COORDINATION CHEMISTRY – I					

Objectives of the 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 Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CO1:** Understand and comprehend various theories of coordination compounds.
- **CO2:** Understand the spectroscopic and magnetic properties of coordination complexes.
- **CO3:** Explain the stability of complexes and various experimental methods to determine the stability of complexes.
- **CO4:** Predict the electronic transitions in a complex based on correlation diagrams and UV-visible spectral details.
- **CO5:** Comprehend the kinetics and mechanism of substitution reactions in octahedral and square planar complexes

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's method) Magnetic property of complexes: Spin-orbit coupling, effect of spin-orbit coupling on magnetic moments, quenching of orbital magnetic moments.

UNIT-IV: Kinetics and mechanisms of substitution reactions of octahedral and square planar complexes: Inert and Labile complexes; Associative, Dissociative and SNCB mechanistic pathways for substitution reactions; acid and base hydrolysis of octahedral complexes; Classification of metal ions based on the rate of water replacement reaction and their correlation to Crystal Field Activation Energy; Substitution reactions in square planar complexes: Trans effect, theories of trans effect and applications of trans effect in synthesis of square planar compounds; 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

6. Keith F. Purcell and John C. Kotz, Inorganic Chemistry, Saunders Publications, USA, 1977.
7. Peter Atkins and Tina Overton, Shriver and Atkins' Inorganic Chemistry, 5th Edition, Oxford University Press, 2010.

8. Basic Inorganic Chemistry, F. A. Cotton, G. Wilkinson, P. L. Guas, John Wiley, 2002, 3rd edn.

9. Concepts and Models of Inorganic Chemistry, B. Douglas, D. McDaniel, J. Alexander, John Wiley, 1994, 3rd edn.

10. Inorganic Chemistry, D. F. Shriver, P. W. Atkins, W. H. Freeman and Co, London, 2010.

Website and e-learning source

11. https://ocw.mit.edu/courses/5-04-principles-of-inorganic-chemistry-ii-fall-2008/pages/syllabus/

Question Pattern			
Section :A	**I. a**	**5 Multiple Chose Questions (One question from each Unit)**	**5x1=5**
	I.b	**5 Fill in the blanks Questions (One question from each Unit)**	**5x1=5**
	II	**5 short answer Questions (One question from each Unit)**	**5x2=10**
Section :B (5 Marks)		**Either OR choice (One set of question from each Unit)**	**5x5=25**
Section :C (10 Marks)		**Ans three out of five (One question from each Unit)**	**3x10=30**
Total Marks			**75**

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**				**Hours**		**Credits**	
I	23PCH2CC9		COORDINATION CHEMISTRY – I				5		4	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-III					
Course Code	**:**	**23PCH2CC10**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**6**	**Internal Marks**	**:**	**25**
Credits	**:**	**4**	**External Marks**	**:**	**75**
ELECTROCHEMISTRY					

Objectives of the course

1. To understand the behavior of electrolytes in terms of conductance, ionic atmosphere, interactions.
2. To familiarize the structure of the electrical double layer of different models.
3. To compare electrodes between current density and over potential.
4. To discuss the mechanism of electrochemical reactions.
5. To highlight the different types of over voltages and its applications in electroanalytical techniques.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

1. **CO1**: To understand the behaviour of electrolytes in solution and compare the structures of electrical double layer of different models.
2. **CO2**: To predict the kinetics of electrode reactions applying Butler-Volmer and Tafel equations
3. **CO3**: To study different thermodynamic mechanism of corrosion,
4. **CO4**: To discuss the theories of electrolytes, electrical double layer, electrodics and activity coefficient of electrolytes
5. **CO5**: To have knowledge on storage devices and electrochemical reaction mechanism.

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 appreciable concentration of electrolytes modifications and applications. Electrolytic conduction-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 electro capillary 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 and potential 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: Rates of 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 I3-, Fe2+, and dissolution of Fe to Fe2+. 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 differential pulse 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. Chemistry of Glass and cement tone, 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.Joseph Wang, Analytical Electrochemistry, 2nd edition, Wiley, 2004.

Reference Books

1. J.O.M. Bockris and A.K.N. Reddy, Modern Electro chemistry, vol.1 and 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.

Question Pattern			
Section :A	I. a	5 Multiple Chose Questions (One question from each Unit)	5x1=5
	I.b	5 Fill in the blanks Questions (One question from each Unit)	5x1=5
	II	5 short answer Questions (One question from each Unit)	5x2=10
Section :B (5 Marks)		Either OR choice (One set of question from each Unit)	5x5=25
Section :C (10 Marks)		Ans three out of five (One question from each Unit)	3x10=30
Total Marks			75

Relationship Matrix for COs, POs and PSOs

Semester	Code		Title of the Course			Hours		Credits	
I	23PCH2CC10		ELECTROCHEMISTRY			5		4	
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓

CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-III					
Course Code	**:**	**23PCH2CC11P**	**Exam Hours**	**:**	**6**
Instruction Hours	**:**	**6**	**Internal Marks**	**:**	**40**
Credits	**:**	**4**	**External Marks**	**:**	**60**
PHYSICAL CHEMISTRY PRACTICAL-I					

Objectives of the course

- To understand the principle of conductivity experiments through conductometric titrations.
- 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 density distribution and Maxwell's speed distribution by computational calculation.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CO1:** To recall the principles associated with various physical chemistry experiments.
- **CO2**: To scientifically plan and perform all the experiments.
- **CO3**: To observe and record systematically the readings in all the experiments.
- **CO4**: To calculate and process the experimentally measured values and compare with graphical data.
- **CO5:** To interpret the experimental data scientifically to improve students' efficiency for societal developments.

Any ten experiments from the following experiments (to be decided by the course teacher):

1. Kinetics – Acid Hydrolysisof Ester – Comparison of strength of acids.
2. Kinetics – Acid Hydrolysisof Ester – Determination of Energy of Activation (Ea).
3. Kinetics – Saponification of Ester – DeterminationofEa by conductometry.
4. Kinetics – Persulphate – Iodide Reaction – Determination of order, effect of Ionic strengthon rate constant.

5. Polymerization – Rate ofpolymerization of acrylamide.
6. Distribution Law – Study of iodine – Iodide equilibrium.
7. Distribution Law – Study ofAssociation of Benzoic Acid in Benzene.
8. Adsorption – oxalic Acid\Acetic Acid on charcoal using Freundlich isotherm.
9. Determination of critical solution temperature of phenol-watersystem and effect of impurity of added electrolyte on CST.
10. Determination of molecular weight by Rast Macro method
11. Determination of molecular weight by Transition Temperature.
12. Determination of eutectic temperature and eutectectic composition of binary mixture.
13. Determination of primary salt effect.

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

1. https://web.iitd.ac.in/~nkurur/2015-16/Isem/cmp511/lab_handout_new.pdf

Question Pattern			
Section :A	I. a	5 Multiple Chose Questions (One question from each Unit)	5x1=5
	I.b	5 Fill in the blanks Questions (One question from each Unit)	5x1=5
	II	5 short answer Questions (One question from each Unit)	5x2=10
Section :B (5 Marks)		Either OR choice (One set of question from each Unit)	5x5=25
Section :C (10 Marks)		Ans three out of five (One question from each Unit)	3x10=30
Total Marks			75

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits
I	23PCH2CC11P	PHYSICAL CHEMISTRY PRACTICAL-I	5	4

Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-III					
Course Code	**:**	**23PCH3EC51**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**5**	**Internal Marks**	**:**	**25**
Credits	**:**	**3**	**External Marks**	**:**	**75**
Chemistry of Natural Products					

Course Outcomes:

- Occurrence, classification and isolation
- Classification, Occurrence And isolation of terpenes
- General nature of anthocyanins, introduction and biological importance of flavones.
- Occurrence and isolation of purines. Classification and spectral properties of steroids.
- Classification- isolation-purification and properties.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- CO1: To understand the basic concepts of biomolecules and natural products.
- CO2: To integrate and assess the different methods of preparation of structurally different biomolecules and natural products.
- CO3: To illustrate the applications of biomolecules and their functions in the metabolism of living organisms.
- CO4: To analyse and rationalise the structure and synthesis of Purines and Steroids
- CO5: To Classify the isolation-purification and properties.

UNIT-1: **(18 − Hours)**

Alkaloids: Introduction-simple alkaloids I pyrrole deravative- aromatic alkaloids- functions of alkaloids-General methods of structural elucidation-Structural elucidation-synthesis and biological properties of coniine - piperine-nicotine and papaverine.

UNIT-2: **(18 − Hours)**

Terpenoids and Carotenoids: Terpenoids: Introduction-Isoprene rule-General methods of determining structure-Structure and synthesis of citral-menthol-Geraniol and camphor-Carotenoids: Introduction-geometrical isomerism-Structure determination and synthesis of β-carotene -vitamin-A.

UNIT-3: **(18 − Hours)**

Anthocyanines and flavones: Anthocyanines: Introduction to anthocyanines-Structure and general methods of synthesis of anthocyanines-Cyanidine chloride: structure and determination-Flavones: Structure and determination of flavone - flavonoids- Quercetin: Structure determination and importance.

UNIT-4: **(18 − Hours)**

Purines and Steroids: Purines: Introduction-biological importance-Synthesis and structural elucidation of Uric acid- Xanthine- Caffeine and Theophylline- Steroids: Introduction-stereochemistry and nomenclature- Structural determination and synthesis of cholesterol-Synthesis of (±)-oestrone.

UNIT 5: **(18 − Hours)**

Natural Dyes-separation-structure innovation- Occurrence-colour and constitution-Structural determination and synthesis of indigoitin and alizarin-Dying and application using eco-friendly mordants.

Text books:

1. O. P. Agarwal, Chemistry of Natural Products, Vol-1, Goel Publishing House, 1997.
2. Gurdeep Chatwal and Anand, Chemistry of Natural Products, Himalayan Publishing Co, 2001

Reference book:

1. I. L. Finar, Organic Chemistry, Vol-2, 5th edition, Pearson education, London, 1975.

Question Pattern

Section :A (1 Marks)	**MCQ Type**	**20x1=20**
Section :B (5 Marks)	**Either OR choice**	**5x5=25**
Section :C (10 Marks)	**Answer three out of five**	**3x10=30**
Total Marks		**75**

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**				**Hours**		**Credits**	
IV	20PCH4EC51		Chemistry of natural products				5		3	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-III					
Course Code	**:**	**23PCH3EC52**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**5**	**Internal Marks**	**:**	**25**
Credits	**:**	**3**	**External Marks**	**:**	**75**
Biomolecules and heterocyclic compounds					

Objectives of the course

- To learn the basic concepts and biological importance of biomolecules and natural 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 from different methods.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CO1**: To understand the basic concepts of biomolecules and natural products.
- **CO2**: To integrate and assess the different methods of preparation of structurally different biomolecules and natural products.
- **CO3**: To illustrate the applications of biomolecules and their functions in the metabolism of living organisms.
- **CO4**: To analyse and rationalise the structure and synthesis of heterocyclic compounds.
- **CO5**: To develop the structure of biologically important heterocyclic compounds by different methods.

UNIT-I: Chemistry and metabolism of carbohydrates: Definition, classification and biological role of carbohydrates. onosaccharides: Linear and ring structures (Haworth formula) of ribose, glucose, fructose and mannose (structure determination not required), physical and chemical properties of glucose and fructose. Disaccharides: Ring structures (Haworth formula) – occurrence, physical and chemical properties of maltose, lactose and sucrose. Polysaccharides: Starch, glycogen and cellulose – structure and properties, glycolysis of carbohydrates.

UNIT-II: Steroids and Hormones: 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. Hormones-Introduction, classification, functions of sex hormones- androgens and estrogens, adrenocortical hormones-cortisone and cortisol structure and functions of non-steroidal hormones-adrenaline and thyroxin.

UNIT-III: Proteins and nucleic acids: Separation and purification of proteins – dialysis, gel filtration and electrophoresis. Catabolism of amino acids - transamination, oxidative deamination and decarboxylation. Biosynthesis of proteins: Role of nucleic acids. Amino acid metabolism and ureacycle. Structure, methods for the synthesis of nucleosides - direct combination, formation of heterocyclic base and nucleoside modification, conversion of nucleoside to nucleotides. Primary and secondary structure of RNA and DNA, Watson-Crick model, solid phase synthesis ofoligonucleotides.

UNIT-IV: Proteins and nucleic acids: Separation and purification of proteins – dialysis, gel filtration and electrophoresis. Catabolism of amino acids - transamination, oxidative deamination and decarboxylation. Biosynthesis of proteins: Role of nucleic acids. Amino acid metabolism and ureacycle. Structure, methods for the synthesis of nucleosides - direct combination, formation of heterocyclic base and nucleoside modification, conversion of nucleoside to nucleotides. Primary and secondary structure of RNA and DNA, Watson-Crick model, solid phase synthesis ofoligonucleotides.

UNIT-V: Fused Ring Heterocyclic Compounds: Benzofused five membered rings: Indole, isoindole, benzofuran and benzothiophene, Preparation and properties. Benzofused six membered rings: Quinoline and isoquinoline: Preparation by ring closure reactions, Reactions: Mechanism of electrophilic and nucleophilic substitutions, oxidation and reduction reactions.

Recommended Text

1. T. K Lindhorst, Essentials of Carbohydrate Chemistry and Biochemistry, Wiley VCH, North America,2007.
2. I. L. Finar, Organic Chemistry Vol-2, 5th edition, Pearson Education Asia, 1975.
3. V. K. Ahluwalia and M. Goyal, Textbook of Heterocyclic compounds, Narosa Publishing, New Delhi,2000.
4. M. K. Jain and S. C. Sharma, Modern Organic Chemistry, Vishal Publishing Co., Jalandhar, Delhi, 2014.
5. V. K. Ahluwalia, Steroids and Hormones, Ane books pub., New Delhi,2009.

Reference Books

6. I. L. Finar, Organic Chemistry Vol-1, 6thedition, Pearson Education Asia,2004.
7. Pelletier, Chemistry of Alkaloids, Van Nostrand Reinhold Co,2000.
8. Shoppe, Chemistry of the steroids, Butterworthes,1994.

9. I. A. Khan, and A. Khanum. Role of Biotechnology in medicinal & aromatic plants, Vol 1 and Vol 10, Ukkaz Publications, Hyderabad,2004.

10. M. P. Singh. and H. Panda, Medicinal Herbs with their formulations, Daya Publishing House, Delhi,2005.

Website and e-learning source

11. https://www.organic-chemistry.org/

12. https://www.studyorgo.com/summary.php

13. https://www.clutchprep.com/organic-chemistry

Question Pattern			
Section :A	I. a	5 Multiple Chose Questions (One question from each Unit)	5x1=5
	I.b	5 Fill in the blanks Questions (One question from each Unit)	5x1=5
	II	5 short answer Questions (One question from each Unit)	5x2=10
Section :B (5 Marks)		Either OR choice (One set of question from each Unit)	5x5=25
Section :C (10 Marks)		Ans three out of five (One question from each Unit)	3x10=30
Total Marks			75

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits
I	23PCH3EC51	BIOMOLECULES AND HETEROCYCLIC COMPOUNDS	5	3

Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-IV					
Course Code	**:**	**23PCH3NME2**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**2**	**Internal Marks**	**:**	**25**
Credits	**:**	**2**	**External Marks**	**:**	**75**
HOME CARE					

Objectives of the course

- Gain a foundational understanding of the principles of home care, including safety protocols, hygiene practices, and basic caregiving techniques.
- Acquire practical skills in providing care and support to individuals in a home setting, including assistance with activities of daily living (ADLs), medication management, and basic first aid.
- Learn strategies to promote client independence and improve their overall well-being through person-centered care approaches, effective communication, and fostering a supportive environment.
- Understand how to assess and address home safety hazards, create a comfortable living environment for clients, and implement appropriate infection control measures to maintain a clean and hygienic space.
- Explore ethical dilemmas and legal considerations relevant to home care practice, including confidentiality, informed consent, boundaries, and respecting clients' rights and autonomy.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CO1** Demonstrate proficiency in providing basic care and support to individuals in a home setting, including assistance with activities of daily living (ADLs), medication management, and mobility assistance.
- **CO2**: Apply person-centered care principles to promote the independence, dignity, and well-being of clients, fostering a supportive and empowering environment that respects their preferences and individuality.
- **CO3**: Implement effective safety protocols and infection control measures to ensure a safe and hygienic home environment for clients, minimizing the risk of accidents, injuries, and infections.
- **CO4**: Demonstrate strong communication skills in interacting with clients, families, and other healthcare professionals, fostering positive relationships, facilitating care coordination, and advocating for the needs of clients.

- **CO5**: Adhere to ethical principles and legal standards in home care practice, maintaining confidentiality, respecting clients' rights and autonomy, and navigating ethical dilemmas with integrity and professionalism.

UNIT I:

Dietetics and Food nutrition: Balanced diet, Specific functions of nutrients, Effects of cooking on various nutrients.

UNIT II: chemicals in pharmacy

2.1 Definition and therapeutic uses - Antiseptics: Alum, boric acid- Mouth washes: Hydrogen peroxideAntacids: Aluminium hydroxide- Analgesics: Aspirin, Paracetamol.

2.2. Antibiotics: Penicillin , Tetracyclines- Hematinics:Ferrous Fumarate, Ferrous glucomate- Laxatives : Epsomsalt, milk of magnesia- Sedatives: Diazepam

2.3 Metal ions in Biology- Essential and trace elements in biological system - biological importance andtoxicity of elements such as Fe, Cu, Zn, Co, Mo, W, V, Mn and Cr in biological system and their vital rolein the active site.

UNIT III:

Major causes of fire in Homes, Fire prevention and fire fighting in homes, Methods of extinguishing fires - starvation, cooling and smothering. Simple extinguishing agents. Chemical fire extinguisher -CO2 extinguisher .

UNIT IV:

Care of house hold metals:Metal polishes - functions, composition, mode of action, general rules for cleaning and polishing,cleaning and polishing of aluminium utensils, silverwares, copper and brassware, gold and teflon.

UNIT V:

Safe use of Pesticides:

Need of pesticides at home, Types of insects and their control at home - mosquitoes, flies, ants, cockroaches, termites and head louse. Precautions in the applications of pesticides.

REFERENCE:

1. Bharathi V.V. & M. Jacinth ‘Family resource management’ Discovery publishing house, 1994.
2. Matin Khan ‘Consumer Behavior’ New age international (p) Ltd.,
3. Raheena Begum “A Text Book of applied Chemistry’ Sterling publishers private Ltd, 1991.
4. Swaminathan M., ‘Essentials of food and nutrition’ the Bangalore printing & publishing Co., Ltd. 1985.
5. Shankar Rao C.N., ‘Sociology’ S.Chand & Company Ltd., 1997.
6. Sumati Mudambi R. Rajagopal M.V., Fundamentals of food and nutrition, third edition.
7. Thankamma Jacob ‘A Text Book of Applied Chemistry’ Macmillan India Ltd. 1987.

Website and e-learning source

https://www.adaptivespecialties.com/index.aspx?msclkid=e9b49b0b2d2e19b67428fed43e16d14b

Question Pattern			
Section :A	**I. a**	**5 Multiple Chose Questions (One question from each Unit)**	**5x1=5**
	I.b	**5 Fill in the blanks Questions (One question from each Unit)**	**5x1=5**
	II	**5 short answer Questions (One question from each Unit)**	**5x2=10**
Section :B (5 Marks)		**Either OR choice (One set of question from each Unit)**	**5x5=25**
Section :C (10 Marks)		**Ans three out of five (One question from each Unit)**	**3x10=30**
Total Marks			**75**

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**				**Hours**		**Credits**	
I	23PCH3NME		HOME CARE				5		4	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-IV					
Course Code	**:**	**23PCH4CC12**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**6**	**Internal Marks**	**:**	**25**
Credits	**:**	**4**	**External Marks**	**:**	**75**
COORDINATION CHEMISTRY – II					

Objectives of the course

- To recognize the fundamental concepts and structural aspects of organometallic compounds.
- To learn reactions of organometallic compounds and their catalytic behaviour.
- To identify or predict the structure of coordination compounds using spectroscopic tools.
- To understand the structure and bonding in coordination complexes.
- To evaluate the spectral characteristics of selected complexes.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CO1**: Understand and apply 18 and 16 electron rule for organometallic compounds
- **CO2**: Understand the structure and bonding in olefin, allyl, cyclopentadienyl and carbonyl containing organometallic compounds
- **CO3**: Understand the reactions of organometallic compounds and apply them
- **CO4:** understanding the catalytic cycles
- **CO5**: Identify / predict the structure of coordination complexes using spectroscopic tools such as IR, NMR, ESR, Mossbauer and optical rotatory dispersion studies to interpret the structure of molecules by various spectral techniques.

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 [(NH3)5Co-O2-Co(NH3)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 (N2, O2) and heteronuclear diatomic molecules (CO, HCl) and polyatomic molecules (H2O, CO2, CH4, NH3) – 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

6. Crabtree, Robert H. The Organometallic Chemistry of the Transition Metals. 3rd ed. New York, NY: John Wiley, 2000.
7. P Gütlich, E Bill, A X Trautwein, Mossbauer Spectroscopy and Transition Metal Chemistry: Fundamentals and Applications, 1st edition, Springer-Verlag Berlin Heidelberg, 2011.
8. Concepts and Models of Inorganic Chemistry, B. Douglas, D. McDaniel, J. Alexander, John Wiley, 1994, 3rd edn.
9. K. F. Purcell, J. C. Kotz, Inorganic Chemistry; Saunders: Philadelphia, 1976.
10. R. S. Drago, PhysicaI Methods in Chemistry; Saunders: Philadelphia, 1977.

Website and e-learning source

11. https://archive.nptel.ac.in/courses/104/101/104101100/

Question Pattern			
Section :A	I. a	5 Multiple Chose Questions (One question from each Unit)	5x1=5
	I.b	5 Fill in the blanks Questions (One question from each Unit)	5x1=5
	II	5 short answer Questions (One question from each Unit)	5x2=10
Section :B (5 Marks)		Either OR choice (One set of question from each Unit)	5x5=25
Section :C (10 Marks)		Ans three out of five (One question from each Unit)	3x10=30
Total Marks			75

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits
I	23PCH4CC12	COORDINATION CHEMISTRY – II	5	4

Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-IV					
Course Code	**:**	**23PCH2CC13**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**6**	**Internal Marks**	**:**	**25**
Credits	**:**	**4**	**External Marks**	**:**	**75**
PHYSICAL CHEMISTRY – II					

Objectives of the course

- To understand the essential characteristics of wave functions and need for the quantum mechanics.
- To know the importance of quantum mechanical models of particle in a box, rigid rotor and harmonic oscillator.
- To apply the quantum mechanics to hydrogen and polyelectronic systems.
- To familiarize the symmetry in molecules and predict the point groups.
- To predict the vibrational modes, hybridization using he concepts of group theory.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CO1**: To discuss the characteristics of wave functions and symmetry functions.
- **CO2**: To classify the symmetry operation and wave equations.
- **CO3**: To apply the concept of quantum mechanics and group theory to predict the electronic structure.
- **CO4**: To specify the appropriate irreducible representations for theoretical applications.
- **CO5**: To develop skills in evaluating the energies of molecular spectra

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 and time dependent

UNIT-II: Quantum models: Particle in a box-1D, two dimensional and three-dimensional, degeneracy, application to linear conjugated molecular system, free particles, ring systems. Harmonic Oscillator-wave equation and solution, 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: Groups, sub groups, symmetry elements, operations, classification-axial and non-axial. Dihedral point groups- Cn, Cnh, Dn, Dnh, Dnd, Td and Oh. Matrix representation and classes of symmetry operations, reducible irreducible and direct product representation. The Great orthogonality theorem – irreducible representation and reduction formula, construction of character table for C2v, C2h, C3v and D2h point groups.

UNIT-V: Applications of quantum and group theory: Hydrogen Molecule-Molecular orbital theory and Heitler London (VB) treatment, Energy level diagram, Hydrogen molecule ion; Use of linear variation function and LCAO methods. Electronic conjugated system:Huckel method to Ethylene butadiene, cyclopropenyl, cyclo butadiene and Benzene. Applications of group theory to molecular vibrations, electronic spectra of ethylene.

Recommended Text

1. R.K. Prasad, Quantum Chemistry, New Age International Publishers, New Delhi, 2010, 4th revised edition.
2. F. A. Cotton, Chemical Applications of Group Theory, John Wiley & Sons, 2003, 2nd edition.
3. A. Vincent, Molecular Symmetry and Group Theory. A Programmed Introduction to Chemical Applications, John and Willy & Sons Ltd., 2013, 2nd Edition.
4. T. Engel & Philip Reid, Quantum Chemistry and Spectroscopy, Pearson, New Delhi, 2018, 4th edition.
5. G. K. Vemulapalli, Physical Chemistry, Prentice Hall of India Pvt. Ltd. 2001. 6. D.A. McQuarrie, Quantum Chemistry, Viva Books PW. Ltd, 2013, 2nd edition.

Reference Books

6. N. Levine, Quantum Chemistry, Allyn& Bacon Inc, 1983, 4th edition.
7. D.A. McQuarrie and J. D. Simon, Physical Chemistry, A Molecular Approach, Viva Books
8. Pvt. Ltd, New Delhi, 2012.
9. R. P. Rastogi & V. K. Srivastava, An Introduction to Quantum Mechanics of Chemical
10. Systems, Oxford & IBH Publishing Co., New Delhi, 1999.
11. R.L. Flurry. Jr, Symmetry Group Theory and Chemical applications, Prentice Hall. Inc, 1980
12. J. M. Hollas, Symmetry in Molecules, Chapman and Hall, London, 2011, Reprint.

Website and e-learning source

13. https://nptel.ac.in/courses/104101124
14. https://ipc.iisc.ac.in/~kls/teaching.html

Question Pattern			
Section :A	**I. a**	**5 Multiple Chose Questions (One question from each Unit)**	**5x1=5**
	I.b	**5 Fill in the blanks Questions (One question from each Unit)**	**5x1=5**
	II	**5 short answer Questions (One question from each Unit)**	**5x2=10**
Section :B (5 Marks)		**Either OR choice (One set of question from each Unit)**	**5x5=25**
Section :C (10 Marks)		**Ans three out of five (One question from each Unit)**	**3x10=30**
Total Marks			**75**

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**				**Hours**		**Credits**	
I	23PCH2CC5		PHYSICAL CHEMISTRY – II				5		4	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-III					
Course Code	**:**	**23PCH4CC14P**	**Exam Hours**	**:**	**6**
Instruction Hours	**:**	**4**	**Internal Marks**	**:**	**40**
Credits	**:**	**4**	**External Marks**	**:**	**60**
PHYSICAL CHEMISTRY PRACTICAL-II					

Objectives of the course

- To understand the principle of conductivity experiments through conductometric titrations.
- 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 density distribution and Maxwell's speed distribution by computational calculation.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CO1:** To recall the principles associated with various physical chemistry experiments.
- **CO2**: To scientifically plan and perform all the experiments.
- **CO3**: To observe and record systematically the readings in all the experiments.
- **CO4**: To calculate and process the experimentally measured values and compare with graphical data.
- **CO5:** To interpret the experimental data scientifically to improve students' efficiency for societal developments.

Any ten experiments (to be dedided by the course teacher) out of the following experiments.

1. Conductometry- Acid- alkali titrations.
2. Cuctometry- Precipitationtritrations.
3. Conductometry- Displacementtitrations.
4. Conductometry- Determinationof dissociation constant of weak acids.

5. Conductometry- solubilityproduct of sparingly soluble silver salts.
6. Verification of Onsagerequation- conductivity method.
7. Determination of degreeof hydrolysis and hydrolysis constant of a substance.
8. Potentiometric titrations- Acid alkali titrations.
9. Potentiometric titrations- Precipitation titrations.
10. Potentiometric titrations- Redox titrations.
11. Potentiometry- Determination of dissociation constant of weak acids.
12. Potentiometry- Determination of solubility of silver salts.
13. Potentiometry- Determinationof activity and activity coefficient of ions.
14. pH titration of ortho-phosphoric acid.
15. To determine the relative strengthof two acids by conductance measurements.
16. To determine the pH of a buffersolution using a quinhydrone electrode.

Recommended Text

5. B. Viswanathan and P.S.Raghavan, Practical Physical Chemistry, Viva Books, New Delhi, 2009.
6. Sundaram, Krishnan, Raghavan, Practical Chemistry (Part II), S. Viswanathan Co. Pvt., 1996.
7. V.D. Athawale and Parul Mathur, Experimental Physical Chemistry, New Age International (P) Ltd., New Delhi, 2008.
8. E.G. Lewers, Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics, 2nd Ed., Springer, New York, 2011.

Reference Books

6. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.

7. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th edition, McGraw Hill, 2009.

8. J. N. Gurthu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 1987.

9. Shailendra K Sinha, Physical Chemistry: A laboratory Manual, Narosa Publishing House Pvt, Ltd., New Delhi, 2014.

10. F. Jensen, Introduction to Computational Chemistry, 3rd Ed., Wiley-Blackwell.

Website and e-learning source

2. https://web.iitd.ac.in/~nkurur/2015-16/Isem/cmp511/lab_handout_new.pdf

Question Pattern			
Section :A	**I. a**	**5 Multiple Chose Questions (One question from each Unit)**	**5x1=5**
	I.b	**5 Fill in the blanks Questions (One question from each Unit)**	**5x1=5**
	II	**5 short answer Questions (One question from each Unit)**	**5x2=10**
Section :B (5 Marks)		**Either OR choice (One set of question from each Unit)**	**5x5=25**
Section :C (10 Marks)		**Ans three out of five (One question from each Unit)**	**3x10=30**
Total Marks			**75**

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**		**Credits**	
I	23PCH4CC14P		PHYSICAL CHEMISTRY PRACTICAL-Ii			5		4	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-IV					
Course Code	**:**	**232PCH4PW**	**Exam Hours**	**:**	**-**
Instruction Hours	**:**	**5**	**Internal Marks**	**:**	**-**
Credits	**:**	**4**	**External Marks**	**:**	**-**
PROJECT WITH VIVA-VOCE					

Objectives:

The student can get the knowledge to prepare the document, to implement tools for the specific problem and learn the industrial need programs for their placement.

S.No.	Work Description	Maximum Marks
1	Dissertation	80
2	Viva voce	20
	Total	100

Note:

PASSING MINIMUM - 50 MARKS

I Review -December last week

- Confirmation letter from the company
- Project type & title

Company profile

- Synopsis
- Contact number &mail_id of the external guide
- S/w selection

II Review - January3rdweek

- Data or System flow diagram
- Documentation of first three chapters
- Database design
- Input design - Forms
- Output design - Reports

III Review - February 3rd week

- Complete coding
- Test plan with demo
- Rough documentation of the entire project

IV Review - March 1st week

- Corrected rough draft
- Explanation of the entire project
- Execution of Implementation Work

- Attending all the review is compulsory
- PPT and necessary Documentation should be brought for each Review
- Font size in documentation has to be 12, Times New Roman, Space 1.5
- Document should be neatly aligned and justified
- No change can be made in the review marks later
- Internal mark will be submitted at the same day of review to controller section.

SEMESTER-IV					
Course Code	**:**	**232PCH4EC6**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**5**	**Internal Marks**	**:**	**25**
Credits	**:**	**3**	**External Marks**	**:**	**75**
POLYMER CHEMISTRY					

Objectives of the 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 synthetic uses.
- To determine the molecular weight of polymers.
- To predict the degradation of polymers and conductivities.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CO1**: To understand the bonding in polymers.
- **CO2**: To scientifically plan and perform the various polymerization reactions.
- **CO3**: To observe and record the processing of polymers.
- **CO4**: To calculate the molecular weight by physical and chemical methods.
- **CO5**: To interpret the experimental data scientifically to improve the quality of synthetic
    - polymers.

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 (Mn) and Weight average molecular mass (Mw) 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, poly phenylene, 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

1.1. 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.

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**				**Hours**		**Credits**	
I	232PCH4EC6		POLYMER CHEMISTRY				5		3	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-IV					
Course Code	**:**	**23PCH4SE1**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**5**	**Internal Marks**	**:**	**25**
Credits	**:**	**2**	**External Marks**	**:**	**75**
ANALYTICAL INSTRUMENTATION TECHNIQUES					

Objectives of the course

- To design chromatographic methods for identification of species.
- To analyze different constituents through instrumental methods of analysis.
- To evaluate different contaminants in materials using turbidimetry and conductivity measurements.
- To design experiments for analysis of inorganic and organic materials.
- To analyze constituents in materials using emission and absorption techniques.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CO1**: To recall the principles associated with various inorganic organic and physical chemistry experiments
- **CO2**: To scientifically plan and perform all the experiments
- **CO3**: To observe and record systematically the readings in all the experiments
- **CO4**: To calculate and process the experimentally measured values and compare with graphical data.
- **CO5:** To interpret the experimental data scientifically to improve students efficiency for societal developments.

UNIT-I:

1.Determination of the equivalent conductance of a weak acid at different concentrations and verifying Ostwald dilution law. Calculation of the dissociation constant of the acid.

2.Determination of the equivalent conductance of a strong electrolyte at different concentrations and examining the validity of the Onsager's theory as limiting law at high dilutions.

3.Conductometric titration of a mixture of HCl and CH3COOH Vs NaOH.

4.Conductometric titration of NH4Cl Vs NaOH.

5.Conductometric titration of CH3COONa Vs HCl.

6.Potentiometric titration of a mixture of HCl and CH3COOH Vs NaOH

7.Determination of pKa of weak acid by EMF method.

8.Potentiometric titration of FAS Vs K2Cr2O7

9.Potentiometric titration of KI Vs KMnO4.

10.Potentiometric titration of a mixture of Chloride and Iodide Vs AgNO3.

11.Determination of the pH of buffer solution by EMF method using Quinhydrone and Calomel electrode.

12.Study of the inversion of cane sugar in the presence of acid by Polarimetric method.

UNIT-II:

1.Estimation of Fe, Cu and Ni by colorimetric method.

2.Estimation of Na and K by flame photometric method.

3. Determination of spectrophotometrically the mole ratio of the ferrithiocyanate complex and equilibrium constant for the complex formation.

4.Determination of the amount (mol/L) of ferricyanide present in the given solution using cyclic voltammetry.

5.Determination of the diffusion coefficient of ferricyanide using cyclic voltammetry.

6.Determination of the standard redox potential of ferri-ferrocyanide redox couple using cyclic voltammetry.

7.Estimation of the amount of sulphate present in the given solution using Nephelometric turbidimeter.

8.Estimation of the amount of nitrate present in the given solution using spectrophotometric method.

9.Heavy metal analysis in textiles and textile dyes by AAS

10.Determination of caffeine in soft drinks by HPLC

11.Analysis of water quality through COD, DO, BOD measurements.

12.Assay of Riboflavin and Iron in tablet formulations by spectrophotometry

13.Estimation of chromium in steel sample by spectrophotometry

14.Determination of Stern-Volmer constant of Iodine quenching by fluorimetry

15.Determination of ascorbic acid in real samples using Differential Pulse Voltammetry and comparing with specifications

16.Separation of (a) mixture of Azo dyes by TLC (b) mixture of metal ions by Paper chromatography

17.Estimation of chlorophyll in leaves and phosphate in waste water by colorimetry.

18. Estimation of Fe(II) by 1,10 phenonthroline using spectrophotometry

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

6.Mass etc.,

Recommended Text

1.Vogel's Text book of Practical Organic Chemistry, 5th Ed, ELBS/Longman, England, 2003.

2. G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denney, Vogel's Textbook of Quantitative Chemical Analysis; 6th ed., ELBS, 1989.

3. J. D. Woollins, Inorganic Experiments; VCH: Weinheim, 1995.

4. B. Viswanathan and P.S.Raghavan, Practical Physical Chemistry, Viva Books, New Delhi, 2009.

5.Sundaram, Krishnan, Raghavan, Practical Chemistry (Part II), S.Viswanathan Co. Pvt., 1996.

Reference Books

1.N. S. Gnanapragasam and G. Ramamurthy, Organic Chemistry – Labmanual, S. Viswanathan Co. Pvt. Ltd, 2009.

2.J. N. Gurtu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 2011.

3.J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.

4.G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th edition, McGraw Hill, 2009.

5.J. N. Gurthu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 1987.

Website and e-learning source

1. https://bit.ly/3QESF7t
2. https://bit.ly/3QANOnX

Question Pattern			
Section :A	I. a	5 Multiple Chose Questions (One question from each Unit)	5x1=5
	I.b	5 Fill in the blanks Questions (One question from each Unit)	5x1=5
	II	5 short answer Questions (One question from each Unit)	5x2=10
Section :B (5 Marks)		Either OR choice (One set of question from each Unit)	5x5=25
Section :C (10 Marks)		Ans three out of five (One question from each Unit)	3x10=30
Total Marks			75

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits
I	23PCH4CC12	ANALYTICAL INSTRUMENTATION TECHNIQUES	6	2

Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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SEMESTER-IV					
Course Code	**:**	**23PCH4SE2**	**Exam Hours**	**:**	**3**
Instruction Hours	**:**	**5**	**Internal Marks**	**:**	**25**
Credits	**:**	**2**	**External Marks**	**:**	**75**
CHEMISTRY OF POLLUTION, FOOD AND COSMETICS					

Objectives of the course

- To learn the methods of pollution
- To analyze different constituents of Pollution.
- To evaluate different contaminants in food materials
- To learn Cosmetic analysis of inorganic and organic materials.
- To Explain the control of pollution.

Course Learning Outcomes (for Mapping with POs and PSOs)

Students will be able:

- **CO1**: To recall the different types of pollution.
- **CO2**: To scientifically Analysis and prevention of pollution.
- **CO3**: To observe and record systematically all food contamination.
- **CO4**: To calculate and process the experimentally measured values and compare with graphical data.
- **CO5:** To interpret the experimental data scientifically to improve students efficiency for societal developments.

UNIT – I AIR POLLUTION:

Air- Introduction- Definition- Composition of air- Air pollution-Definition-Air pollutants-Types of Air pollution - Causes of Air pollution on human healthPrevention of Air pollution

UNIT – II WATER POLLUTION:

Water-Introduction-Definition-Sources of water-Types of water-Water quality parameters-Water pollution- Definition-Types of Water pollution- Causes of Water pollution on human health-Prevention of Water pollution.

UNIT – III SOIL POLLUTION:

Soil quality standards, monitoring and analysis of selected soil contaminants: pesticides, heavy metals, POP's, fluoride, cyanide, nitrate, phosphate, oil & grease, Geobiochemical impact of municipal solid waste, steel plants effluent, domestic sewage.

UNIT – IV FOOD CHEMISTRY:

Introduction to general Constituents of food, Proximate Constituents and their analysis, Additives- Introduction -Types - Study of preservatives colors and Antioxidants and method of estimation, adulteration - Introduction, Types, Test for adulterants. Introduction of standards composition and analysis of following foods: Wheat, Bread, Biscuits, Jam, Jelly, Honey, Milk, Ice Cream, Butter, Cheese, Milk Powder, Oils and Fats, Tea, Coffee, Soft drinks, Alcoholic beverages, Cereal and pulses, Confectionery, Fruits, Vegetables, Egg, Fish, Meat.

UNIT – V COSMETICS:

Introduction of Cosmetics, evaluation of cosmetics materials, raw material and additives, Cosmetics colors, Perfumes in cosmetics, Cosmetics formulating, introduction, standards and methods of analysis, Creams, Face powders, Makeup, Shaving preparations, Bath preparations.

UNIT – VI NOISE POLLUTION (For Continuous Internal Assessment Only):

Noise pollution: Basics of acoustics and specification of sound; sound power, sound intensity and sound pressure levels; plane, point and line sources, multiple sources; outdoor and indoor noise propagation; psychoacoustics and noise criteria, effects of noise on health, annoyance rating schemes; special noise environments: Infrasound, ultrasound, impulsive sound and sonic boom; noise standards and limit values; noise instrumentation and monitoring procedure.

Noise indices.Noise control methods.

Recommended Text

1. Environmental Chemistry, S.E. Manahan, Lewis Publishers.
2. Environmental chemistry, Sharma and Kaur, Krishna Publishers.
3. Environmental Chemistry, A.K. De, Wiley Eastern.
4. Environmental Chemistry, Analysis, S.M. Khopkar, Wiley Eastern.
5. Standard Method of Chemical Analysis, F.J. Welcher Vol. III, Van Nostr

Reference Books

1. Environmental Chemistry, C. Baird, W.H. Freeman.
2. Analytical chemistry, G.D. Christian, J. Wiley.
3. Fundamentals of Analytical Chemistry, D.A.Skoog, D.m. Westand F.J.
4. Holler, W.B. Saunders.
5. Analytical Chemistry - Principles, J.H. Kennedy, W. Saunders.

Question Pattern			
Section :A	**I. a**	**5 Multiple Chose Questions (One question from each Unit)**	**5x1=5**
	I.b	**5 Fill in the blanks Questions (One question from each Unit)**	**5x1=5**
	II	**5 short answer Questions (One question from each Unit)**	**5x2=10**
Section :B (5 Marks)		**Either OR choice (One set of question from each Unit)**	**5x5=25**
Section :C (10 Marks)		**Ans three out of five (One question from each Unit)**	**3x10=30**
Total Marks			**75**

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**				**Hours**		**Credits**	
I	23PCH4SE2		CHEMISTRY OF POLLUTION, FOOD AND COSMETICS				5		2	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	✓		✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓		✓		✓	✓	✓	✓	✓	✓
CO4	✓		✓		✓	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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VALUE ADDED COURSES

ENVIRONMENTAL CHEMISTRY

Course Code: 23PCHVA1 Hours: 30
Credit: 2 Marks: 100

COURSE OBJECTIVES:

- Environmental Chemistry is important to study the chemicals and chemical processes within the air, water, and soil ecosystems.
- It also involves the source, route, transformation and the effects of the chemicals on various ecosystems.

LEARNING OUTCOMES

- Develop an understanding of Environmental Chemistry.
- Understand the knowledge of Acid-Base Reactions.
- Outline the industry specific solid waste management practices .

UNIT I: Concept and Scope of Environmental Chemistry, Elements and compounds – Atomic structure, their properties, electronic configuration, types of chemical bonds (ionic, covalent, coordinate and hydrogen bonds). Formation of Molecules, Molecular Weight, Equivalent Weight, Strength of the Solution – Molality, Molarity, Normality, Valency and Oxidation State, Oxidation and Reduction Reactions, Metals and Nonmetals, Aromatic and Aliphatic Compounds, Saturated and Unsaturated Hydrocarbons, Radio nuclides, polarity of the functional groups.

UNIT II: Stochiometry, Acids, bases & salts, Acid-Base Reactions, Ph & Poh, Ionic Product of Water, Common Ion Effect, Buffer Solutions, solutes & solvents; Solubility& Solubility Product, Hydrolysis, Oxidation & Reduction, Chemical Speciation. Exothermic & endothermic reactions, spontaneous & nonspontaneous reactions.

UNIT III: Chemistry of water, Water Quality Parameters – Physical, Chemical and Biological Properties of Water and their Environmental Significance, Distribution of Chemical Species in Water; Gases, Organic Matter and Humic Matter in Water. Heavy metals, metal solubility, Complexation and chelation in Natural and Waste Water, Role of Microorganisms in Aquatic

Chemical Reactions. Water Resources, Hydrological Cycle, drinking water quality standards; Water pollution; Classification of water pollutants, Groundwater pollution, Sources and sinks, Eutrophication.

UNIT IV: Structure and Composition of Atmosphere, Classification of Elements, Particulate Matter, Ions and Radicals in the Atmosphere. Chemical and Photochemical Reactions in the Atmosphere – Formation of Smog, PAN, aerosols; chemistry of Acid Rain, reactions of NO2 and SO2. Oxygen and Ozone Chemistry, ozone layer depletion, role of CFCs in ozone depletion, Green House Gases and Global Warming. Temperature Inversion – Climatic Factors, Topographic Factors, Meteorological Parameters – Humidity, Wind Direction, Wind Speed and Temperature.

UNIT V: Soil Profile, Soil Horizons, Physical, Chemical and Biological Characteristics of soil, Nature of Soil, Soil Structure and Texture. Soil Macro and Micro Nutrients, Soil Water, Soil Air, Soil Temperature, Soil Organic Matter. Soil Colloids, Ion Exchange Capacity. Inorganic& organic components of soil, anion &cation exchange reactions in soil, nitrogen pathways & NPK in soils

REFERENCE BOOKS:

1. Basic Concept of Environmental Chemistry, Des W. Connell (2005), Taylor & Francis
2. Chemisity for Environmental Engineering, C. N. Sawyer & P.
3. L. McCarty (1990), McGraw Hill Kogakusha Ltd.
4. Environmental Chemistry with Green Chemistry. Asim K. Das & Mahua Das (2012), Books & Allied Pvt. Ltd.
5. Environmental Chemistry, A.K. De (2010), New Age International Pvt. Ltd.
6. Environmental Chemistry, B.K. Sharma & H.Kaur (1995), Goel Publishing House
7. Environmental Chemistry, Colin Baird & Michael Cann (2008),
8. W.H. Freman & Co.
9. EnvironmentalChemistry,PeterO'Neil,(2004),BlackieAcademic&Professional
10. EnvironmentalChemistry,StanleyE.Manahan(1999),CRCPress
11.EnvironmentalScience&Technology,StanleyE.Manahan(2007), Tailor&Francis,CRCPress
12. http://base.dnsgb.com.ua/files/book/Agriculture/Soil/The-Chemistry-ofSoils.pdf
13. http://www.ncert.nic.in/ncerts/l/kech101.pdf
14. https://www.khanacademy.org/science/chemistry

15.https://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring2008/lecture-notes/

16. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-84jatmospheric-chemistry-fall-2013/lecture-notes/

17. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-89- environmental-microbiology-fall-2004/lecture-notes/

ECOLOGY AND WASTE MANAGEMENT

Course Code: 23PCHVA2 Hours: 30
Credit: 2 Marks: 100

OBJECTIVES

- To provide insight on current environmental issues
- Role of individual in protecting the environment
- Enable students to understand concept of waste management and the ways of reducing waste
- Disposal and treatment of waste- 3 R system

LEARNING OUTCOMES

- Develop an understanding of structure and function of an ecosystem.
- Propose different biodiversity conservation measures.
- Outline the industry specific solid waste management practices .
- Formulate and assess various bio treatment technologies for solid and liquid waste management.
- Plan the management, treatment and disposal of hazardous wastes.

UNIT I Introduction to environment-Eco system-balanced eco system-human activities-effects of human activities on environment-Need for public awareness-Health Risk & Vulnerability of humans due to environmental Degradation.

UNIT II Ecology- biodiversity-impact of economy on ecology-restoration-biodiversity threats and conservation.

UNIT III Introduction to waste management-Environmental issues –ways of environmental pollution-need of waste management- State of municipal waste generation in the world-ways of dealing with municipal solid waste-sanitary land fill- recycling of plastic.

UNIT IV Liquid waste management-hazardous and toxic waste-Municipal waste handling in Indian cities and towns- Bio medical and chemical waste- Nuclear and E waste- environmental consequences of ship breaking- polluting industries of India-hazardous waste from other countries to India.

UNIT V Disposal of solid waste and management -3R sytem –new technologies in 3R -3R in home-3R in our country- ways of minimizing wastages- home-city-country-organic waste management -waste prevention-Climate change and adaptation.

References

1. Zero waste : management practices for environmental sustainability / edited by Ashok K. Rathoure.
2. Yung-Tse Hung, Handbook of Environment and Waste Management
3. Natural Wastewater Treatment Systems, Second Edition by Ronald W. Crites; E. Joe Middlebrooks; Robert K. Bastian