

2025



THANTHAI HANS ROEVER COLLEGE



(Autonomous)

Nationally Re-Accredited by NAAC

UGC Recognized 2(f) and 12(B) Institution

Affiliated to Bharathidasan University, Tiruchirapalli

Perambalur-621 220, Tamil Nadu, India

PG & Research Department of Chemistry



M.Sc- Chemistry

CHOICE BASED CREDIT SYSTEM SYLLABUS & LOCF

SEMESTER PATTERN

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.

PO6: To attain profound Expertise in Discipline

PO7: To acquire the ability to function in multidisciplinary Domains.

PO8: To attain Maturity to respond to others.

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.

M.Sc. Chemistry

Choice-Based Credit System – Learning Outcome-Based Curriculum Framework

(For the candidate admitted from the academic year 2025 -2026)

Semester	Course Code	Title of the Course	Int. Hrs /Week	Credits	End Sem. Exam Hrs	Max. Marks		
						CIA	ESE	Total
I	25PCH1CC1	Organic Reaction Mechanism-I	5	4	3	25	75	100
	25PCH1CC2	Structure and Bonding in Inorganic Compounds	5	4	3	25	75	100
	25PCH1CC3	Molecular Spectroscopy	5	4	3	25	75	100
	25PCH1CP1	Organic Chemistry Practical	6	4	6	40	60	100
	25PCH1EC11 25PCH1EC12	Nanomaterials and Nanotechnology Instrumentation Techniques	5	3	3	25	75	100
	25PCH1EC21 25PCH1EC22	Industrial Chemistry Concepts and models in chemistry	4	3	3	25	75	100
	25PCHVA1	Environmental Chemistry	-	2*	-	-	-	-
Total			30	22	-	-	-	600
II	25PCH2CC4	Organic reaction mechanism-II	6	5	3	25	75	100
	25PCH2CC5	Physical Chemistry-I	6	4	3	25	75	100
	25PCH2CP2	Inorganic Chemistry Practical	6	4	6	40	60	100
	25PCH2EC31 25PCH2EC32	Green Chemistry Medicinal chemistry	5	3	3	25	75	100
	25PCH2EC41 25PCH2EC42	Bio Inorganic Chemistry Material science	5	3	3	25	75	100
	25PCH2NME1	Water Technology	2	2	3	25	75	100
	25PCH2OC	SWAYAM/NPTEL Online Course		2**				
Total			30	21	-	-	-	600
III	25PCH3CC6	Organic synthesis and Photochemistry	6	4	3	25	75	100
	25PCH3CC7	Coordination Chemistry-I	5	4	3	25	75	100
	25PCH3CC8	Electro Chemistry	6	4	3	25	75	100
	25PCH3CP3	Physical Chemistry Practical – I	6	4	6	40	60	100
	25PCH3EC51 25PCH3EC52	Chemistry of natural products Biomolecules and heterocyclic compounds	5	3	3	25	75	100
	25CH3NME2	Home care	2	2	3	25	75	100
	25PCH3SI	Summer Internship/Industrial Activity***	-	2	-	-	-	100
	25PCHVA2	Ecology and waste management *	-	2*	2	50	50	100*
Total			30	23	-	-	-	700

M.Sc. Chemistry

Choice-Based Credit System – Learning Outcome-Based Curriculum Framework

(For the candidate admitted from the academic year 2025 -2026)

Semester	Course Code	Title of the Course	Int. Hrs /Week	Credits	End Sem. Exam Hrs	Max. Marks		
						CIA	ESE	Total
IV	25PCH4CC9	Coordination Chemistry-II	5	4	3	25	75	100
	25PCH4CC10	Physical Chemistry-II	5	4	3	25	75	100
	25PCH4CP4	Physical Chemistry Practical – II	5	4	6	40	60	100
	25PCHA4PW	Project with Viva-Voce	5	5	-	-	-	100
	25PCH4EC6	Elective- VI (Industry Entrepreneurship) Polymer Chemistry	4	3	3	25	75	100
	25PCH4SE1	Skill Enhancement Course/ Professional Competency Skill Analytical instrumentation techniques	3	2	3	25	75	100
	25PCH4SE2	Soft Skill (Discipline oriented) Chemistry of Pollution, Food and Cosmetics	3	2	3	25	75	100
Total			30	24	-	-	-	700
Total			120	90	-	-	-	2600

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

* 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

Sem.	Course Code	Credits	Title of the Course	AC/CC/DE/ ES / GS / NME/ PF / PW / VAC/ VE / SE / WK	Category			Sem. Exam	Max. Marks		
					Lect. Hrs.	Tutorial Hrs.	Lab. Hrs.		CIA	ESE	Total.
I	25PCH1CC1	4	ORGANIC REACTION MECHANISM- I	CC	5	-	-	3 Hrs.	25	75	100
Pre-Requisite:											
Course Objectives: The purpose of learning this course is:											
1. To understand the feasibility and the mechanism of various organic reactions.											
2. To comprehend the techniques in the determination of reaction mechanisms.											
3. To understand the concept of stereochemistry involved in organic compounds.											
4. To correlate and appreciate the differences involved in the various types of organic reaction mechanisms.											
5. To design feasible synthetic routes for the preparation of organic compounds.											
Course Outcomes:											
CO1:To recall the basic principles of organic chemistry.											
CO2:To understand the formation and detection of reaction intermediates of organic reactions.											
CO3:To predict the reaction mechanism of organic reactions and stereochemistry of organic compounds.											
CO4: To apply the principles of kinetic and non-kinetic methods to determine the mechanism of reactions.											
CO5:To design and synthesize new organic compounds by correlating the stereochemistry of organic compounds.											
Unit-I	Methods and Determination of Reaction Mechanism									12 Hrs.	
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 stereochemical evidences. Kinetic methods - relation of rate and mechanism. Effect of structure on reactivity: Hammett equation - Linear free energy relationship, partial rate factor, substituent and reaction constants, Taft equations and its application.											
Unit-II	Aromatic and Aliphatic Electrophilic Substitution									11 Hrs.	
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 reaction and mechanism: SE₂ and SE_i, SE₁ and evidences.											
Unit-III	Aromatic and Aliphatic Nucleophilic Substitution									12 Hrs.	
Aromatic nucleophilic substitution: Mechanisms - S _N Ar, S _N 1 and Benzyne mechanisms - Evidences - Reactivity, Effect of structure, leaving group and attacking nucleophile. Reactions: Oxygen and Sulphur-nucleophiles, Bucherer and Rosenmund reactions, von Richter, Sommelet- Hauser and Smiles rearrangements. S _N 1, ion pair, S _N 2 mechanisms and evidences. Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon.S _N 1, S _N 2, S _N i, and SE ₁ mechanism and evidences, Swain- Scott, Grunwald-Winstein relationship - Ambident nucleophiles.											
Unit-IV	Stereochemistry – I									14 Hrs.	
Introduction to molecular symmetry and chirality – axis, plane, center, alternating axis of symmetry. Optical isomerism due to asymmetric and dissymmetric molecules with C, N, S based chiral centers. Optical purity, prochirality, enantiotopic and diastereotopic atoms, groups, faces, axial and planar chirality, chirality due to helical shape, methods of determining the configuration. Racemic modifications: Racemization by thermal, anion, cation, reversible formation, epimerization, mutarotation. D, L system, Cram's and Prelog's rules: R, S-notations, 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	11 Hrs.
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.		

Text Book(s):

1. J. March and M. Smith, Advanced Organic Chemistry, 5th edition, John-Wiley and Sons.2001.
2. E. S. Gould, Mechanism and Structure in Organic Chemistry, Holt, Rinehart and Winston Inc., 1959.
3. P.S.Kalsi, Stereochemistry of carbon compounds, 8th edition, New Age International Publishers, 2015.
4. P. Y. Bruice, Organic Chemistry, 7th edn, Prentice Hall, 2013.
5. J.Clayden, N. Greeves, S. Warren, Organic Compounds, 2nd edition, Oxford University Press, 2014.

Reference Book(s):

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.

Web Resources:

1. <https://sites.google.com/site/chemistrybookscollection02/home/organic-chemistry/organic>
2. <https://www.organic-chemistry.org/>

Course Outcomes (COs)	Program Outcomes (POs)								Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	2	1	1	2	3	1	1	2	1	2	1	1
CO2:	3	2	1	2	2	3	2	1	2	1	2	1	1
CO3:	3	3	1	2	2	3	2	1	3	1	3	2	2
CO4:	3	3	1	2	3	3	2	2	3	2	3	2	2
CO5:	3	3	2	3	3	3	2	2	3	3	3	3	3
Overall CO – PO Mapping index = 2.3									Overall CO – PSO Mapping index = 2.4				

1 – Low Correlation

2 – Medium Correlation

3 – High Correlation

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HoD

Sem.	Course Code	Credits	Title of the Course	AC/CC/DE/ ES / GS / NME/ PF / PW / VAC/ VE / SE / WK	Category			Sem. Exam	Max. Marks		
					Lect. Hrs.	Tutorial Hrs.	Lab. Hrs.		CIA	ESE	Total.
I	25PCH1CC2	4	STRUCTURE AND BONDING IN INORGANIC COMPOUNDS	CC	5	-	-	3 Hrs.	25	75	100
Pre-Requisite:											
Course Objectives: The purpose of learning this course is:											
1. To determine the structural properties of main group compounds and clusters.											
2. To gain fundamental knowledge on the structural aspects of ionic crystals.											
3. To familiarize various diffraction and microscopic techniques.											
4. To study the effect of point defects and line defects in ionic crystals.											
5. To evaluate the structural aspects of solids.											
Course Outcomes:											
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									14 Hrs.	
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									11 Hrs.	
Ionic crystals: Packing of ions in simple, hexagonal and cubic close packing, voids in crystal lattice, Radius ratio, Crystal systems and Bravais lattices, Symmetry operations in crystals, glide planes and screw axis; point group and space group; Solid state energetics: Lattice energy – Born-Landé equation - Kapustinski equation, Madelung constant..											
Unit-III	Solid state chemistry – II									11 Hrs.	
Structural features of the crystal systems: Rock salt, zinc blende & wurtzite, fluorite and anti-fluorite, rutile and anatase, cadmium iodide and nickel arsenide; Spinel - 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									12 Hrs.	
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									12 Hrs.	
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.											
Text Book(s):											
1. A R West, Solid state Chemistry and its applications, 2nd Edition (Students Edition), John Wiley & Sons Ltd., 2014.											
2. A K Bhagi and G R Chatwal, A textbook of inorganic polymers, Himalaya Publishing House, 2001.											
3. L Smart, E Moore, Solid State Chemistry – An Introduction, 4th Edition, CRC Press, 2012.											
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: New York,											

1983.

Reference Book(s):

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

Web Resources:

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

Course Outcomes (COs)	Program Outcomes (POs)								Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	2	1	1	2	3	2	1	2	1	3	1	1
CO2:	3	3	1	1	2	3	2	1	2	1	3	2	2
CO3:	3	3	1	2	2	3	2	1	3	1	3	2	2
CO4:	3	2	1	2	3	3	2	2	3	2	3	3	2
CO5:	3	3	2	2	3	3	2	2	3	2	3	3	3
Overall CO – PO Mapping index = 2.3									Overall CO – PSO Mapping index = 2.4				

1 – Low Correlation

2 – Medium Correlation

3 – High Correlation

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Sem.	Course Code	Credits	Title of the Course	AC/CC/DE/ ES / GS / NME/ PF / PW / VAC/ VE / SE / WK	Category			Sem. Exam	Max. Marks		
					Lect. Hrs.	Tutorial Hrs.	Lab. Hrs.		CIA	ESE	Total.
I	25PCH1CC3	4	MOLECULAR SPECTROSCOPY	CC	5	-	-	3 Hrs.	25	75	100
Pre-Requisite:											
Course Objectives: The purpose of learning this course is:											
1. To understand the influence of rotation and vibrations on the spectra of the polyatomic molecules.											
2. To study the principle of Raman spectroscopy, ESR spectroscopy, EPR spectroscopy and fragmentation patterns in Mass spectroscopy.											
3. To highlight the significance of Franck-Condon principle to interpret the selection rule, intensity and types of electronic transitions.											
4. To interpret the first and second order NMR spectra in terms of splitting and coupling patterns using correlation techniques such as COSY, HETCOR, NOESY.											
5. To carry out the structural elucidation of molecules using different spectral techniques.											
Course Outcomes:											
CO1: To understand the importance of rotational and Raman spectroscopy.											
CO2: To apply the vibrational spectroscopic techniques to diatomic and polyatomic molecules.											
CO3: To evaluate different electronic spectra of simple molecules using electronic spectroscopy.											
CO4: To outline the NMR, ¹³ C NMR, 2D NMR – COSY, NOESY, Introduction to ³¹ P, ¹⁹ F NMR and ESR spectroscopic techniques.											
CO5: To develop the knowledge on principle, instrumentation and structural elucidation of simple molecules using Mass Spectrometry, EPR and Mossbauer Spectroscopy techniques.											
Unit-I	Rotational and Raman Spectroscopy										11 Hrs.
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										12 Hrs.
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										11 Hrs.
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, X-ray photoelectron spectroscopy (XPS). Lasers: Laser action, population inversion, properties of laser radiation, examples of simple laser systems.											
Unit-IV	NMR and ESR spectroscopy										14 Hrs.
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, AX ₂ , AB types. Vicinal, germinal and long-range coupling-spin decoupling. 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.											

Unit-V	Mass Spectrometry, EPR and Mossbauer Spectroscopy	12 Hrs.
<p>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.</p>		

Text Book(s):
<ol style="list-style-type: none"> 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 Book(s):
<ol style="list-style-type: none"> 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.

Web Resources:
<ol style="list-style-type: none"> 1. https://onlinecourses.nptel.ac.in/noc20_cy08/preview 2. https://www.digimat.in/nptel/courses/video/104106122/L14.html

Course Outcomes (COs)	Program Outcomes (POs)								Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	2	1	1	2	3	2	1	2	1	3	1	1
CO2:	3	3	1	2	2	3	2	1	3	1	3	2	2
CO3:	3	3	1	2	2	3	2	1	3	1	3	2	2
CO4:	3	2	2	2	3	3	2	2	3	2	3	3	3
CO5:	3	3	2	2	3	3	2	2	3	3	3	3	3
Overall CO – PO Mapping index = 2.4									Overall CO – PSO Mapping index = 2.6				

1 – Low Correlation

2 – Medium Correlation

3 – High Correlation

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Sem.	Course Code	Credits	Title of the Course	AC/CC/DE/ ES / GS / NME/ PF / PW / VAC/ VE / SE / WK	Category			Sem. Exam	Max. Marks		
					Lect. Hrs.	Tutorial Hrs.	Lab. Hrs.		CIA	ESE	Total.
I	25PCH1CP1	4	ORGANIC CHEMISTRY PRACTICAL	CC	--	-	6	6 Hrs.	40	60	100

Pre-Requisite:

Course Objectives: The purpose of learning this course is:

1. To understand the concept of separation, qualitative analysis and preparation of organic compounds.
2. To develop analytical skill in the handling of chemical reagents for separation of binary and ternary organic mixtures.
3. To analyze the separated organic components systematically and derivative them suitably.
4. To construct suitable experimental setup for the organic preparations involving two stages.
5. To experiment different purification and drying techniques for the compound processing.

Course Outcomes:

- 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** | 25 Hrs

A. Two component mixtures.

Unit-II | **Estimations** | 20 Hrs

- a) Estimation of Phenol (bromination)
- b) Estimation of Aniline (bromination)
- c) Estimation of Glucose (redox)
- d) Estimation of Ascorbic acid (iodimetry)
- e) Estimation of Aromatic nitro groups (reduction)
- f) Estimation of Hydroxyl group (acetylation)
- g) Estimation of Amino group (acetylation)

Unit-III | **Two stage preparations** | 15 Hrs

- a) p-Bromoacetanilide from aniline
- b) p-Nitroaniline from acetanilide
- c) 1,3,5-Tribromobenzene from aniline
- d) Acetyl salicylic acid from methyl salicylate
- e) Benzilic acid from benzoin
- f) m-Nitroaniline from nitrobenzene
- g) m-Nitrobenzoic acid from methyl benzoate

Text Book(s):

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

Reference Book(s):

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.

Web Resources:

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

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Sem.	Course Code	Credits	Title of the Course	AC/CC/DE/ EC / GS / NME/ PF / PW / VAC/ VE / SE / WK	Category			Sem. Exam	Max. Marks		
					Lect. Hrs.	Tutorial Hrs.	Lab. Hrs.		CIA	ESE	Total.
I	25PCH1EC11	3	NANO MATERIALS AND NANO TECHNOLOGY	EC	5	-	-	3 Hrs.	25	75	100
Pre-Requisite:											
Course Objectives: The purpose of learning this course is:											
1. To introduce the fundamental concepts, origin, and evolution of nanotechnology and nanomaterials.											
2. To classify nanomaterials based on composition, dimensionality, and morphology, and understand their unique nanoscale properties.											
3. To impart knowledge on various top-down and bottom-up methods for the synthesis of nanomaterials.											
4. To familiarize students with advanced analytical and characterization techniques used for studying nanomaterials.											
5. To explore the wide-ranging applications of nanomaterials in fields such as electronics, energy, healthcare, and biotechnology.											
Course Outcomes: After completing this course, students will be able to:											
CO1: Explain the background, emergence, and classification of nanomaterials, and their distinct properties at the nanoscale.											
CO2: Describe quantum dots, quantum confinement effects, and carbon-based nanostructures like fullerenes and carbon nanotubes along with their synthesis and applications.											
CO3: Compare various synthesis techniques of nanomaterials, including top-down and bottom-up methods, and evaluate their advantages and limitations.											
CO4: Apply appropriate analytical techniques such as XRD, UV-Vis, FTIR, SEM, TEM, and XPS for the characterization of nanomaterials.											
CO5: Assess the practical applications of nanomaterials in nanoelectronics, biomedical engineering, energy conversion, and environmental technologies.											
9	Background and emergence of Nanotechnology									09 Hrs.	
Nanotechnology – Emergence of nanotechnology – Nanomaterials – Classification of nanomaterials based on composition, number of dimensions in nanoscale and morphology – Characteristics of nanomaterials – Surface to volume ratio – Its effect on properties of nanomaterials – Nanoparticles – Nanoclusters – Nanocomposites – Nanohybrids – An overview on the applications of nanomaterials.											
Unit-II	Quantum dots and Carbon nanotubes									09 Hrs.	
Quantum dots (QDs) – Quantum confinement – Production and applications of QDs –Quantum wires – Quantum wells – Carbon allotropes – Discovery of C ₆₀ – Fullerenes – Types of fullerenes – Bucky balls – Carbon nanotubes (CNTs) – Single walled CNTs – Multiwalled CNTs – Properties of CNTs – Synthesis of CNTs – Plasma-arc discharge method – Laser ablation technique – Chemical vapour deposition method – Potential applications of CNTs.											
Unit-III	Preparation of nanomaterials									09 Hrs.	
Nanomaterials – Preparation – Top-down method – Ball milling – Photolithography– Electron beam lithography – Molecular beam epitaxy – Bottom-up technique – Soft-chemical method – Sol-gel synthesis – Electro chemical deposition – Atomic layer deposition- Molecular self assembly – Langmuir-Blodgett film (2D nanostructure).											
Unit-IV	Analytical techniques for nanomaterials characterization									09 Hrs.	
Structural characterization – Principle of X-ray powder diffraction – Determination of structural parameters – Optical studies – UV-Vis-NIR spectrometry – Band gap determination by Tauc's plot method – FTIR spectroscopy – Surface morphological analysis – Scanning electron microscopy (SEM) – Scanning tunnelling microscope (STM) – Transmission Electron Microscope (TEM) –Photoluminescence spectroscopy –X-ray photoelectron spectroscopy (XPS).											
Unit-V	Applications of nanomaterials									09 Hrs.	

Nanoelectronics – Molecular diodes and transistors – Quantum electronic devices – Nanophotonics – Photonic crystals – Nanoelectromechanical systems (NEMS) – Nanomaterials in energy conversion and storage – Nanomaterials as antibacterial agents – Nanomaterials as photocatalysts – Energy efficient windows – Nanomaterial in industrial applications – Bio-medical applications : Targeted drug delivery – Nanomaterial based radiation therapy – Photodynamic therapy (PDT) – Tissue engineering – Bioimaging.

Text Book(s):

1. K. Ravichandran, K. Swaminathan, P. K. Praseetha, P. Kavitha, Introduction to Nanotechnology, Jazym Publications, Tiruchirappalli. ISBN: Not available (Local publication)
2. Preedep, Essentials of Nanotechnology. ISBN: Not officially listed (Author-specific/local publisher)
3. G. Cao and Y. Wang, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press, London. ISBN: 978-1-84816-857-5,
4. K. P. Mathur, Nanoscience and Nanotechnology, 1st Edition, Rajat Publications, New Delhi, 2007. ISBN: 9788178803142,
5. C. N. R. Rao, A. Müller, A. K. Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Wiley-VCH, 2004. ISBN: 978-3-527-30686-2,

Reference Book(s):

1. M. Ratner, Nanotechnology: A Gentle Introduction, Prentice Hall, 2003. ISBN: 0-13-101400-5,
2. Nanotechnology: Basic Science and Emerging Technologies, CRC Press. Authors: Mick Wilson, KamaliKannangara, Geoff Smith, Michelle Simmons, BurkhardRaguse ISBN: 978-0-8493-1055-7,
3. Charles P. Poole Jr. and Frank J. Owens, Introduction to Nanotechnology, Wiley, 2003. ISBN: 978-0-471-07935-4,
4. A. S. Edelstein and R. C. Cammarata, Nanomaterials: Synthesis, Properties and Applications, 2nd Edition, IOP Publishing, UK, 1996. ISBN: 978-0750305785
5. G. Timp (Ed.), Nanotechnology, Springer-Verlag, New York, 1999. ISBN: 978-0387983349,

Web Resources:

1. <https://en.wikipedia.org/wiki/Nanotechnology> (Unit I)
2. https://en.wikipedia.org/wiki/Carbon_nanotube (Unit II)
3. <https://www.sciencedirect.com/science/article/abs/pii/S0001868621002384> (Unit III)
4. <https://www.rsc.org/nanocharacterization> (Unit IV)
5. <https://pubs.acs.org/doi/10.1021/acsnano.4c09566> (Unit V)

Course Outcomes (COs)	Program Outcomes (POs)								Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	2	1	1	2	3	2	1	2	1	3	2	2
CO2:	3	3	1	2	2	3	2	1	3	2	3	2	2
CO3:	3	3	1	2	3	3	2	1	3	2	3	3	2
CO4:	3	3	2	2	3	3	2	2	3	2	3	3	3
CO5:	3	3	2	2	3	3	3	2	3	3	3	3	3
Overall CO – PO Mapping index = 2.5									Overall CO – PSO Mapping index = 2.6				

1 – Low Correlation

2 – Medium Correlation

3 – High Correlation

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Sem.	Course Code	Credits	Title of the Course	AC/CC/DE/ EC / GS / NME/ PF / PW / VAC/ VE / SE / WK	Category			Sem. Exam	Max. Marks		
					Lect. Hrs.	Tutorial Hrs.	Lab. Hrs.		CIA	ESE	Total.
I	25PCH1EC12	3	INSTRUMENTATION TECHNIQUES	EC	5	-	-	3 Hrs.	25	75	100
Pre-Requisite:											
Course Objectives: The purpose of learning this course is:											
1. To improve the technical knowledge about various spectroscopy											
2. To study the detailed information about conductometry											
3. To understand the separation of compounds by using chromatography											
4. To correlate the characteristics of various instruments by new technologies.											
5. To design synthetic routes for synthetically used instrument materials.											
Course Outcomes:											
CO1: To Learn improve the technical knowledge about various spectroscopy.											
CO2: To Learn the detailed information about conductometry.											
CO3: To Learn the separation of compounds by using chromatography.											
CO4: To Learn the ion fragmentation.											
CO5: To Learn the prediction of NMR.											
Unit-I	UV- Visible spectroscopy									09 Hrs.	
Instrumentation- sources, filters and monochromators, slits grating cuvette, 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) monochromator, 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)									09 Hrs.	
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									09 Hrs.	
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									09 Hrs.	
Electrophoresis : Separation by Adsorption- Affinity techniques, Affinity elution from Ion exchangers and other Adsorbents, Pseudo affinity adsorbents polycrylamide gel electrophoresis-IsoelectricfocussingIsotachopheresis, Two dimensional gel electrophoresis, 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									09 Hrs.	
Mass spectrometry principle,condition Instrumentation-Ionization methods - EL, CI, FAB, arc & spark, photoionization, thermal ionization, FI*& FD, laser induced, Photoelectric ionization, SIMS, stereochemical activity of lone pair,magnetic interaction-Mass analyzers - Magnetic, Double focusing, Time of flight, Quadrupolar, Ion cyclotron resonance analyzer. Coupled techniques, GC FTIR, GCMS (Use of stable isotopes) HPLC-MS. Applications of mass spectroscopy.											

Text Book(s):

1. H. Kaur - "Instrumental methods of Chemical Analysis", 6th edition, (2010), Pragatiprakashan 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.
4. G.Aruldas - "Molecular structure & Spectroscopy", PHI Course Pvt. Ltd. 2nd Edition, -2008.
5. Colin N. Banwell - "Fundamentals of Molecular structure Spectroscopy" Mc.Graw-Hill publishing company Ltd. 4th edition, 1995.

Reference Book(s):

1. Willard, Merritt, 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 Course India Pvt. Ltd - 2010.
5. Harald Guthrie, "NMR Spectroscopy", Wiley India (p) Ltd, 2nd Edn, 2010.

Web Resources:

1. <https://www.scribd.com/document/713865488/Advanced-Instrumentation-Techniques-PV-Publication>

Course Outcomes (COs)	Program Outcomes (POs)								Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	2	1	1	2	3	2	1	3	2	3	2	2
CO2:	3	2	1	2	2	3	2	1	3	2	3	2	2
CO3:	3	2	2	2	2	3	2	2	3	2	3	3	2
CO4:	3	2	2	2	2	3	2	2	3	2	3	2	2
CO5:	3	2	1	1	2	3	2	1	3	2	3	2	2
Overall CO – PO Mapping index = 2.2									Overall CO – PSO Mapping index = 2.4				

1 – Low Correlation

2 – Medium Correlation

3 – High Correlation

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Sem.	Course Code	Credits	Title of the Course	AC/CC/DE/ EC / GS / NME/ PF / PW / VAC/ VE / SE / WK	Category			Sem. Exam	Max. Marks		
					Lect. Hrs.	Tutorial Hrs.	Lab. Hrs.		CIA	ESE	Total.
I	25PCH1EC21	3	INDUSTRIAL CHEMISTRY	EC	4	-	-	3 Hrs.	25	75	100
Pre-Requisite:											
Course Objectives: The purpose of learning this course is:											
1. To study the information about green methods for industries.											
2. To understand the non-conventional energy sources.											
3. To know about water pollution and control methods.											
4. To correlate the characteristics of various Chemical products by new technologies.											
5. To design synthetic routes for synthetically used instrument materials.											
Course Outcomes:											
CO1: To Learn develop the knowledge about chemical industries.											
CO2: To Learn the fuels and dyes.											
CO3: To Learn about synthesis of dyes and polymer chemistry.											
CO4: To Learn the application of chemistry in quality control measurements.											
CO5: To Learn about the polymers.											
Unit-I	Green Methods and Industrial Process									09 Hrs.	
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									09 Hrs.	
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									09 Hrs.	
Polymers definition types of polymers liquid crystalline polymers. 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. Preparation and properties of Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins and silicone polymers-Functional polymers-Fire retarding polymers and electrically conducting polymers. Biomedicalpolymers.											
Unit-IV	Safety measures and conversion of organic compounds									09 Hrs.	
Chemistry lab layout and safety procedures practiced in the Chemical laboratory that pertains to general laboratory safety and awareness including eye shower to fume hoods. Safety kits, devices, uses and storage. SOP for personal safety. Chemical, radiation, fire, electrical and gas safety; Clean room facility, Universal Precautions and its importance in the handling of hazardous chemicals in the lab; handling radioactive materials and biohazardous materials											
Unit-V	Industrial Water Pollution and its Control & Analysis									09 Hrs.	
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 Book(s):											
1. B. K. Sharma, Industrial Chemistry; 8th Ed., Goel Publishing House, New Delhi, 1997.											
2. V.R.Gowariker, N.V. Viswanathan and JayadevSreedhar, Polymer Science, New Age Publishers, New Delhi, 1986.											
3. B.K. Sharma and H. Kaur, "Environmental chemistry" ,Goel Publishing House, Meerut, 2008											
4. Prudent practices in the laboratory: handling and management of chemical hazards, updated version. National Academies Press, 25-Mar-2011 - Science - 360 pages											
5. F.W.Billmeyer, Jr., A Text Book of Polymer Science, Wiley & Sons, New York, 1971.											

Reference Book(s):

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.

Web Resources:

1. <https://youtu.be/GjAD83B4JaY>-PPE and Lab Safety
2. <https://tech.chemistrydocs.com/Books/Applied%20-%20Industrial/Fundamentals-of-Industrial-Chemistry-Pharmaceuticals,-Polymers,-and-Business-by-John-A.-Tyrell.pdf>

Course Outcomes (COs)	Program Outcomes (POs)								Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	2	2	2	3	3	2	2	3	2	3	3	2
CO2:	3	2	2	1	3	3	2	2	3	2	3	3	2
CO3:	3	3	2	2	3	3	2	2	3	2	3	3	2
CO4:	3	3	3	2	3	3	2	2	3	2	3	3	3
CO5:	3	2	2	2	3	3	2	2	3	2	3	3	2
Overall CO – PO Mapping index = 2.1									Overall CO – PSO Mapping index = 2.3				

1 – Low Correlation

2 – Medium Correlation

3 – High Correlation

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Sem.	Course Code	Credits	Title of the Course	AC/CC/DE/ EC / GS / NME/ PF / PW / VAC/ VE / SE / WK	Category			em. Exam	Max. Marks		
					Lect. Hrs.	Tutorial Hrs.	Lab. s.		CIA	ESE	Total.
I	25PCH1EC22	3	CONCEPTS AND MODELS IN CHEMISTRY	EC	4	-	-	3 Hrs.	25	75	100
Pre-Requisite:											
Course Objectives: The purpose of learning this course is:											
1. To study the information about bio-organic molecules and metal ions.											
2. To understand the chemical bonding and chemical thermodynamics.											
3. To know about chemical kinetics.											
4. To study the information about new concepts of chemistry.											
5. To understand the modern biological concepts.											
Course Outcomes:											
CO1: To learn about polymeric bio-organic molecules such as carbohydrates- proteins and nucleic acids.											
CO2: To enable the students to understand the importance of trace elements in biological system											
CO3: To enable the students to understand the structure and importance of biomolecules such as proteins- nucleic acids and carbohydrate.											
CO4: Learn the chemical bonding and chemical thermodynamics. Learn chemical kinetics.											
CO5: To Learn about the polymers.											
Unit-I	Bio-Organic Chemistry										09 Hrs.
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										10 Hrs.
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: Hemerythrin - Hemocyanin. Chemotherapy- Platinum complexes in Cancer therapy - Cisplatin and its mode of action - Cytotoxic compounds of other metals.											
Unit-III	Chemical Bonding										08 Hrs.
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 coordinate 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										10 Hrs.
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 temperature 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										08 Hrs.
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 - MichaelisMenten equation - Salt effect on reaction rate (derivation not needed).											

Text Book(s):
<ol style="list-style-type: none"> 1. S. J. Lippard and J. M. Berg- Principles of Bioinorganic Chemistry- Purnima Publishing Company- 1997 2. Geoffrey L. Zubay- William W. Parson and Dennis E. Vance- Principles of Biochemistry- McGraw-Hill Education-1995. 3. D. E. Douglas- D.H. McDaniel and J. J. Alexander- Concepts and Models in Inorganic Chemistry- 3rd Ed- 1994. 4. S. Glasstone- Thermodynamics for Chemists- Affiliated East West Press- New Delhi-1960. 5. Gordon M. Barrow- Physical Chemistry- Tata McGraw Hill- 1994.
Reference Book(s):
<ol style="list-style-type: none"> 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.
Web Resources:
1. https://archive.org/details/conceptsof00doug/page/n7/mode/2up

Course Outcomes (COs)	Program Outcomes (POs)								Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	2	2	2	2	3	2	2	3	2	3	2	2
CO2:	2	2	3	2	2	3	2	2	2	2	3	2	3
CO3:	3	2	2	2	2	3	3	2	3	2	3	2	3
CO4:	3	3	2	2	2	3	2	2	3	2	3	2	2
CO5:	3	2	2	2	3	3	2	2	3	3	2	3	3
Overall CO – PO Mapping index = 2.3									Overall CO – PSO Mapping index = 2.4				

1 – Low Correlation

2 – Medium Correlation

3 – High Correlation

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Sem.	Course Code	Credits	Title of the Course	AC/CC/DE/ ES / GS / NME/ PF / PW / VAC/ VE / SE / WK	Category			Sem. Exam	Max. Marks		
					Lect. Hrs.	Tutorial Hrs.	Lab. Hrs.		CIA	ESE	Total.
II	25PCH2CC4	5	ORGANIC REACTION MECHANISM – I	CC	5	1	-	3 Hrs.	25	75	100
Pre-Requisite:											
Course Objectives: The purpose of learning this course is:											
1. To impart advanced knowledge on the mechanistic aspects of electrophilic and nucleophilic substitution reactions in both aromatic and aliphatic systems.											
2. To develop a deep understanding of the orientation, reactivity, and effects of substituents in substitution reactions, with emphasis on structure–reactivity relationships.											
3. To explore the mechanistic pathways and stereochemical features of addition and elimination reactions, particularly in the context of organic synthesis.											
4. To introduce fundamental principles and diverse examples of organic photochemistry, including energy transfer, photosensitization, and photorearrangement processes.											
5. To provide an in-depth understanding of pericyclic reactions through molecular orbital theory, orbital symmetry, and selection rules, enabling analysis and prediction of concerted reaction pathways.											
Course Outcomes: After completing this course, students will be able to:											
CO1: Explain the mechanisms of electrophilic substitution reactions in aromatic and heteroaromatic compounds and analyze the influence of substituents using the Hammett and Taft equations.											
CO2: Distinguish between various nucleophilic substitution mechanisms (SN1, SN2, SNi) and evaluate stereoelectronic effects, solvent effects, and structural factors influencing the reactivity of aliphatic and aromatic compounds.											
CO3: Illustrate mechanisms of addition and elimination reactions, understand regions of selectivity and stereoselectivity, and apply this knowledge to the synthesis of key functional molecules.											
CO4: Describe the fundamental principles of organic photochemistry and interpret the mechanisms of photochemical reactions involving carbonyl compounds, alkenes, dienes, and aromatic systems.											
CO5: Analyze pericyclic reactions using molecular orbital theory and orbital symmetry considerations, and predict the stereochemical outcomes of electrocyclic, cycloaddition, sigmatropic, and ene reactions.											
Unit-I	Electrophilic Substitution Reactions								15 Hrs.		
Aromatic electrophilic substitution: Orientation, reactivity, and mechanisms – Synthetic applications – Substitutions in thiophene and pyridine – Quantitative treatment of the structural effects on reactivity – Substituents effect – Origins of Hammett equation – Principles of Hammett correlation – Effect of structure on reaction mechanisms Hammett parameters; σ and ρ , modified forms of Hammett equation – Taft Equation. Aliphatic electrophilic substitution: SE1, SE2, SEi mechanisms – Simple examples only.											
Unit-II	Nucleophilic Substitution Reactions								13 Hrs.		
Aliphatic nucleophilic substitution – Mechanisms; SN1, SN2, SNi – stereochemical aspects of nucleophilic substitution reactions – Ion-pairs in SN1 mechanism – Neighboring group participation – Non-classical carbocations – Substitutions at allylic and vinylic carbons – Reactivity: Effect of structure, nucleophile, leaving group and solvent – Ambident substrates and nucleophiles – Aromatic nucleophilic substitution: Mechanisms; SNAr, Benzyne, SN1.											
Unit-III	Addition and Elimination Reactions								15 Hrs.		
Addition to carbon-carbon multiple bonds: Electrophilic, nucleophilic, and free radical additions – Orientation of the addition – Stereochemical factors influencing the addition of bromine and hydrogen bromide, hydroxylation, 1,2-dihydroxylation – Hydroboration leading to formation of alcohols – Oxidation – Sharpless asymmetric epoxidation and ozonolysis. Addition to carbonyl and conjugated carbonyl systems – Mechanism – Grignard reagents – 1,2 and 1,4-additions (dimethyl lithium cuprate type). Addition to carbon-oxygen double bond: A study of benzoin, Knoevenagel, Stobbe and Darzen-glycidic ester condensation reactions. Elimination Reactions: Mechanisms; E1, E2, E1cB – Stereochemistry of elimination, Hofmann, and Zaitsev rules – Pyrolytic cis elimination, Chugaev reaction – Cope elimination – Bredt's rule.											
Unit-IV	Organic Photochemistry								15 Hrs.		
Fundamental concepts – Energy transfer – Types of excitation – Quantum yield - Photosensitization – Photochemistry of carbonyl compounds: Norrish Type I, II and related reactions – Paterno-Büchi reaction – Photochemistry of unsaturated carbonyl compounds: Photodimerisation - Photochemistry of alkenes, dienes and aromatic compounds – Photorearrangement of enones and dienones - Photo-Fries rearrangement – Di- π -methane rearrangement – Photoreduction and Photooxidation – Photosubstitution reactions; de											

Unit-V	Pericyclic Reactions	15 Hrs.
Molecular orbitals in conjugated polyenes, ions, radicals – Orbital symmetry – Electrocyclic reactions: Con-rotatory and Dis-rotatory – Frontier molecular orbital method – Correlation diagram – Selection rules – Cycloaddition reactions: FMO method - Correlation diagram – Selection rules – Chelotropic reactions - 1,3-Dipolar cycloaddition reactions - Sigmatropic rearrangement: 1,3- and 1,5-hydrogen shifts - FMO method - Selection rules – Cope and Claisen rearrangements – Group transfer reactions: ene reactions including diimide – Problems in each section.		
Text Book(s):		
<ol style="list-style-type: none"> 1. Jerry March – Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Wiley –Peter Sykes – A Guidebook to Mechanism in Organic Chemistry, Pearson 2. F.A. Carey & R.J. Sundberg – Advanced Organic Chemistry Part B, Springer 3. Jagdamba Singh & Jaya Singh – Photochemistry and Pericyclic Reactions, New Age International 4. Jagdamba Singh & L.D.S. Yadav – Pericyclic Reactions, Pearson 		
Reference Book(s):		
<ol style="list-style-type: none"> 1. I.L. Finar – Organic Chemistry Volume I, Pearson 2. Clayden et al. – Organic Chemistry, Oxford 3. P.S. Kalsi – Organic Reactions and Their Mechanisms, New Age International 4. H. Hart – Organic Chemistry: A Short Course, Houghton Mifflin 5. Mukherjee & Singh – Reaction Mechanism in Organic Chemistry, Macmillan 		
Web Resources:		
<ol style="list-style-type: none"> 1. https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Organic_Chemistry_(Wade)/Electrophilic_Aromatic_Substitution (Unit I) 2. https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Organic_Chemistry_(Wade)/Nucleophilic_Substitution_Reactions (Unit II) 3. https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Organic_Chemistry_(Madsen)/12%3A3_A_Alkenes_Addition_Reactions (Unit III) 4. https://www.masterorganicchemistry.com/2020/06/03/introduction-to-photochemistry/ (Unit IV) 5. https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Organic_Chemistry_(Wade)/16%3A_Pericyclic_Reactions (Unit V) 		

Course Outcomes (COs)	Program Outcomes (POs)								Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	2	1	1	2	3	2	1	3	2	3	2	2
CO2:	3	3	1	1	2	3	2	1	3	2	3	2	2
CO3:	3	3	1	1	3	3	2	1	3	2	3	3	2
CO4:	3	2	1	1	2	3	3	1	2	2	3	2	2
CO5:	3	3	1	1	3	3	3	1	2	2	3	2	2
Overall CO – PO Mapping index = 2.2									Overall CO – PSO Mapping index = 2.4				

1 – Low Correlation 2 – Medium Correlation

3 – High Correlation

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Sem.	Course Code	Credits	Title of the Course	AC/CC/DE/ ES / GS / NME/ PF / PW / VAC/ VE / SE / WK	Category			Sem. Exam	Max. Marks		
					Lect. Hrs.	Tutorial Hrs.	Lab. Hrs.		CIA	ESE	Total.
II	25PCH2C C5	4	PHYSICAL CHEMISTRY-I	CC	5	1	-	3 Hrs.	25	75	100

Pre-Requisite:

Course Objectives: The purpose of learning this course is:

1. To introduce the foundational principles of classical thermodynamics with a focus on chemical potential, fugacity, and their applications to real systems.
2. To enable learners to understand and apply the principles of statistical thermodynamics to derive macroscopic thermodynamic properties from microscopic molecular behaviors.
3. To provide in-depth knowledge on chemical kinetics, including the theories of reaction rates, mechanisms of reactions in both gas and solution phases, and catalysis.
4. To explore the kinetics of elementary and complex reactions, and understand the impact of temperature, solvent, and pressure on reaction rates using transition state theory.
5. To familiarize students with modern experimental techniques for the study of fast reactions and the kinetics of polymerization and chain reaction mechanisms.

Course Outcomes: After completing this course, students will be able to:

CO1: Explain the concepts of chemical potential and fugacity, and their variations with temperature and pressure, including applications in solutions and electrolytes.

CO2: Apply the principles of statistical thermodynamics, including probability distributions and ensemble theory, to predict thermodynamic behavior of ideal gases and molecular systems.

CO3: Analyze reaction kinetics using collision theory and transition state theory, and evaluate how solvent, ionic strength, and kinetic isotope effects influence reaction mechanisms.

CO4: Interpret energy profiles and potential energy surfaces, and compute thermodynamic activation parameters using the Arrhenius and transition state equations.

CO5: Evaluate the mechanisms and kinetics of complex and fast reactions using modern techniques such as flash photolysis, stopped flow, and pulse radiolysis; distinguish different polymerization mechanisms.

Unit-I | **Classical Thermodynamics** | 12 Hrs.

Concept of chemical potential-Determination of chemical potential -Direct Method and Method of Intercepts – variation of chemical potential with temperature and pressure-Fugacity –Methods of determination of fugacity – Variation of fugacity with temperature and pressure. Standard states for gases, liquids, solids and components of solutions. Solution of electrolytes – Concept of ionic strength – activity, mean ionic activity and mean ionic activity coefficient – determination of activity coefficient from freezing point.

Unit-II | **Statistical Thermodynamics** | 12 Hrs.

Concept of Mathematical probability and thermodynamic probability - States of maximum thermodynamic probability of systems involving energy levels. Distinguishable and indistinguishable particles-microstates and macrostates. Ensembles– definition- microcanonical, canonical and grand canonical ensembles. Maxwell's distribution law of molecular velocities - Evaluation of average velocity, root mean square velocity and most probable velocity from distribution law of molecular velocities - molecular velocities and energies of an ideal gas.

Unit-III | **Chemical Kinetics –I** | 12 Hrs.

Theories of reaction rates-Hard sphere collision theory and transition state theory of reaction rates– Comparison of collision theory and activated complex theory – Lindemann and Hinshelwood theories of unimolecular reaction rates-Potential energy surface -Reactions in solutions – comparison between gas phase and solution reactions – cage effect-influence of solvent, ionic strength, and pressure on reactions in solution – Kinetic isotope effects. Homogeneous catalysis- acid- base catalysis-mechanism of acid base catalyzed reactions-Bronsted catalysis law, enzyme catalysis-Michelis-Menton catalysis.

Unit-IV | **Chemical Kinetics –II** | 12 Hrs.

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.

Unit-V	Kinetics of complex and fast reactions	12 Hrs.
Kinetics of complex reactions, reversible reactions, consecutive reactions, parallel reactions, chain reactions. Chain reactions-chain length, kinetics of H ₂ – Cl ₂ & H ₂ – Br ₂ reactions (Thermal and Photochemical reactions) - Rice Herzfeld mechanism. Study of fast reactions-relaxation methods-temperature and pressure jump methods electric and magnetic field jump methods -stopped flow flash photolysis methods and pulse radiolysis. Kinetics of polymerization-free radical, cationic, anionic polymerization - Polycondensation.		
Text Book(s):		
<ol style="list-style-type: none"> 1. J. Rajaram and J.C. Kuriacose, Thermodynamics for Students of Chemistry, 2nd edition, S.L.N. Chand & Co., Jalandhar, 1986. ISBN: 9788185099007 2. I.M. Klotz and R.M. Rosenberg, Chemical Thermodynamics, 6th edition, W.A. Benjamin Publishers, California, 1972. ISBN: 9780805390032 3. M.C. Gupta, Statistical Thermodynamics, New Age International Pvt. Ltd., New Delhi, 1995. ISBN: 9788122405758 4. K.J. Laidler, Chemical Kinetics, 3rd edition, Pearson, Reprint 2013. ISBN: 9788131708417 5. J. Rajaram and J.C. Kuriacose, Kinetics and Mechanisms of Chemical Transformations, Macmillan India Ltd., Reprint 2011. ISBN: 9780333925377 		
Reference Book(s):		
<ol style="list-style-type: none"> 1. D.A. McQuarrie and J.D. Simon, Physical Chemistry: A Molecular Approach, Viva Books Pvt. Ltd., New Delhi, 1999. ISBN: 9788176490018 2. R.P. Rastogi and R.R. Misra, Classical Thermodynamics, Vikas Publishing House Pvt. Ltd., New Delhi, 1990. ISBN: 9780706993621 3. S.H. Maron and J.B. Lando, Fundamentals of Physical Chemistry, Macmillan Publishers, New York, 1974. ISBN: 9780023761516 4. K.B. Yatsimirskii, Kinetic Methods of Analysis, Pergamon Press, 1996. ISBN: 9780080123985 5. Gurdeep Raj, Phase Rule and Its Applications, Goel Publishing House, 2011. ISBN: 		
Web Resources:		
<ol style="list-style-type: none"> 1. https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/DeVoes_Thermodynamics_and_Chemistry/07%3A_Pure_Substances_in_Single_Phases/7.08%3A_Chemical_Potential_and_Fugacity(Unit I) 2. https://www.physics.udel.edu/~glyde/PHYS813/Lectures/chapter_6.pdf(Unit II) 3. https://chem.libretexts.org/Courses/Pacific_Union_College/Kinetics/08%3A_Chemical_Kinetics/8.07%3A_Theories_of_Reaction_Rates(Unit III) 4. https://en.wikipedia.org/wiki/Lindemann_mechanism(Unit IV) 5. https://www.britannica.com/science/chemical-kinetics/Measuring-fast-reactions(Unit V) 		

Course Outcomes (COs)	Program Outcomes (POs)								Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	2	1	1	2	3	2	1	2	1	3	2	2
CO2:	3	3	1	1	2	3	2	1	2	1	3	2	2
CO3:	3	3	1	2	3	3	2	2	3	2	3	2	2
CO4:	3	3	1	2	3	3	2	2	3	2	3	2	2
CO5:	3	3	2	2	3	3	3	2	3	2	3	2	3
Overall CO – PO Mapping index = 2.1									Overall CO – PSO Mapping index = 2.3				

1 – Low Correlation

2 – Medium Correlation

3 – High Correlation

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Sem.	Course Code	Credits	Title of the Course	AC/CC/DE/ ES / GS / NME/ PF / PW / VAC/ VE / SE / WK	Category			Sem. Exam	Max. Marks		
					Lect. Hrs.	Tutorial Hrs.	Lab. Hrs.		CIA	ESE	Total.
II	25PCH2CP2	4	INORGANIC CHEMISTRY PRACTICAL	CC	--	-	6	6 Hrs.	40	60	100
Pre-Requisite:											
Course Objectives: The purpose of learning this course is:											
1. To develop the skills necessary for the qualitative identification of common and rare cations using semi-micro analysis techniques.											
2. To train students in the preparation and characterization of coordination compounds through well-established inorganic synthesis methods.											
3. To introduce the principles and procedures of complexometric titrations for accurate estimation of metal ions in single and mixed samples.											
4. To enable students to apply concepts like pH control, masking, and demasking in titrimetric analysis for better selectivity and accuracy.											
5. To cultivate analytical thinking, precision, and laboratory discipline through systematic experimentation and proper record-keeping.											
Course Outcomes: After completing this course, students will be able to:											
CO1: Systematically analyze and identify a mixture of inorganic cations using semi-micro qualitative analysis techniques, including rare and common cations across analytical groups.											
CO2: Demonstrate proficiency in the preparation and purification of various inorganic and coordination complexes with a focus on stoichiometry, solubility, and ligand coordination.											
CO3: Perform complexometric titrations to determine individual and mixed metal ions accurately using EDTA and other reagents, with appropriate control of pH, masking, and demasking agents.											
CO4: Apply theoretical concepts to practical experiments by interpreting observed chemical reactions during salt analysis and metal ion estimation.											
CO5: Develop precision, accuracy, and scientific reporting skills through systematic documentation and critical evaluation of experimental results.											
Unit-I	Analysis of mixture of cations:									25 Hrs.	
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:									20 Hrs.	
Preparation of inorganic complexes: a. Preparation of trithiourea copper(I) sulphate b. Preparation of potassium tri oxalate chromate(III) c. Preparation of tetrammine copper(II) sulphate d. Preparation of Reineck's salt e. Preparation of hexathiourea copper(I) chloride dihydrate f. Preparation of cis-Potassium tri oxalate diaqua chromate(III) g. Preparation of sodium trioxalato ferrate(III) h. Preparation of hexathiourea lead(II) nitrate											
Unit-III	Complexometric Titration:									15 Hrs.	
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.											

Text Book(s):

1. G. Svehla, Vogel's Qualitative Inorganic Analysis, Pearson Education, ISBN: 9788131722165
2. J. Mendham et al., Vogel's Textbook of Quantitative Chemical Analysis, Pearson Education, ISBN: 9788131726347
3. Gurdeep Raj, Advanced Practical Inorganic Chemistry, Goel Publishing House, ISBN: 9788174092483
4. G. Pass and H. Sutcliffe, Practical Inorganic Chemistry, Chapman and Hall, ISBN: 9780412230906
5. James E. Huheey et al., Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education, ISBN: 9789332549861

Reference Book(s):

1. W.G. Palmer, Experimental Inorganic Chemistry, Cambridge University Press, ISBN: 9780521098066
2. V. Malathi and N. Kalaiselvi, Inorganic Chemistry: A Laboratory Manual, Pearson Education, ISBN: 9788131766817
3. W.G. Palmer, Selected Experiments in Inorganic Chemistry, University Tutorial Press, ISBN: 9780723200627
4. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, Wiley India, ISBN: 9788126510450
5. A.G. Sharpe, Comprehensive Inorganic Chemistry, ELBS/Longman, ISBN: 9780582443863

Web Resources:

1. <https://edu.rsc.org>
2. <https://chem.libretexts.org>
3. <https://vlab.amrita.edu>
4. <https://www.chemguide.co.uk>
5. <https://www.khanacademy.org/science/chemistry>

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Sem.	Course Code	Credits	Title of the Course	AC/CC/DE/ EC/ GS / NME/ PF / PW / VAC/ VE / SE / WK	Category			Sem. Exam	Max. Marks		
					Lect. Hrs.	Tutorial Hrs.	Lab. Hrs.		CIA	ESE	Total.
II	25PCH2EC31	3	GREEN CHEMISTRY	EC	5	-	-	3 Hrs.	25	75	100
Pre-Requisite:											
Course Objectives: The purpose of learning this course is:											
1. To introduce the principles, necessity, and fundamental goals of Green Chemistry.											
2. To enable students to explore eco-friendly organic reactions using modern synthetic techniques like microwave and ultrasound.											
3. To familiarize learners with the chemistry and applications of ionic liquids and phase-transfer catalysis.											
4. To demonstrate the use of green solvents and media like water in organic transformations.											
5. To cultivate sustainable thinking in organic synthesis through real-time applications and modern reaction design.											
Course Outcomes: After completing this course, students will be able to:											
CO1: Explain the basic concepts, principles, and need for Green Chemistry, along with examples of green organic reactions.											
CO2: Apply microwave-assisted techniques for performing reactions under greener and more efficient conditions.											
CO3: Describe the synthesis and applications of ionic liquids and phase-transfer catalysts in organic synthesis.											
CO4: Perform and evaluate organic reactions under ultrasound-assisted and solvent-free conditions.											
CO5: Analyze the role of water as a green solvent in promoting key organic transformations and reductions.											
Unit-I	Introduction to green chemistry										16 Hrs.
Introduction to green chemistry-Need for Green Chemistry-Goals of Green Chemistry-Advantages-Limitations/Obstacles in the pursuit of the goals of Green Chemistry--Basic principles of Green Chemistry-Atom economy-Rearrangement reactions-Claisen and Fries- Addition reaction-Addition of HBr to alkene-Michel addition-Diels-Alder reaction-reducing toxicity-green solvents.											
Unit-II	Microwave Assisted organic synthesis (MAOS)										18 Hrs.
Microwave activation – advantage of microwave exposure – specific effects of microwave-Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis (of benzamide, methylbenzoate to benzoic acid), Oxidation (of toluene, alcohols)-Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Diels- Alder Reaction, Decarboxylation-Microwave assisted solid state reactions: Deacetylation, Deprotection, Alkylation of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes; benzimidazoles.											
Unit-III	Ionic liquids and PTC										13 Hrs.
Introduction – synthesis of ionic liquids – physical properties – applications in alkylation - hydroformylations– epoxidations – synthesis of ethers – Friedel-craft reactions – DielsAlder reactions – Knoevenagel condensations – Wittig reactions – Phase transfer catalyst - Synthesis – applications of Quaternary ammonium salts.											
Unit-IV	Ultrasound Assisted organic synthesis (UAOS)										14 Hrs.
Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.											
Unit-V	Organic Reactions in Aqueous media										14 Hrs.
Organic reactions in water: Acid catalyst (Lewis acid catalyst)-Metal mediated C-C bond formation-(Allylation, Benzylation and Arylation of carbonyl compounds, Aldol, Pinacol coupling-Conjugate addition -1,3- dipolar reactions-triazole and tetrazole ring formation- Reduction of epoxides and halidesHydroxylation,Bayer-villigeroxidation).											

Text Book(s):

1. V.K. Ahluwalia and M. Kidwai, *New Trends in Green Chemistry*, Springer, ISBN: 9789048161282 C
2. P. T. Anastas and J. C. Warner, *Green Chemistry: Theory and Practice*, Oxford University Press, ISBN: 9780198506980
3. Gnanamani, *Green Chemistry – Fundamentals and Applications*, MJP Publishers, ISBN: 9788180942616
4. A. S. Matlack, *Introduction to Green Chemistry*, CRC Press, ISBN: 9780367448550
5. M. Lancaster, *Green Chemistry: An Introductory Text*, RSC Publishing, ISBN: 9780854046204

Reference Book(s):

1. Kenneth M. Doxsee and James E. Hutchison, *Green Organic Chemistry*, Brooks/Cole, ISBN: 9780534388515
2. B.K. Sharma, *Environmental Chemistry*, Goel Publishing House, ISBN: 9788174092483
3. R. A. Sheldon et al., *Green Chemistry and Catalysis*, Wiley-VCH, ISBN: 9783527315779
4. M. C. Cann and M. E. Connely, *Real World Cases in Green Chemistry*, American Chemical Society, ISBN: 9780841237933
5. V. Kumar, *Green Chemistry*, Vishal Publishing Co., ISBN: 9789388651145

Web Resources:

1. <https://www.acs.org/greenchemistry.html>
2. <https://www.rsc.org/journals-books-databases/about-journals/green-chemistry/>
2. https://chem.libretexts.org/Bookshelves/Green_Chemistry
3. <https://www.epa.gov/greenchemistry>
- <https://www.york.ac.uk/green-chemistry/>

Course Outcomes (COs)	Program Outcomes (POs)								Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	2	3	2	2	3	2	2	2	2	3	2	3
CO2:	3	2	2	2	3	3	2	1	3	2	3	2	2
CO3:	3	3	2	2	3	3	2	1	3	3	3	2	2
CO4:	3	2	2	2	3	3	2	2	3	2	3	2	2
CO5:	3	2	3	2	3	3	3	2	3	2	3	2	3
Overall CO – PO Mapping index = 2.2									Overall CO – PSO Mapping index = 2.3				

1 – Low Correlation

2 – Medium Correlation

3 – High Correlation

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Sem.	Course Code	Credits	Title of the Course	AC/CC/DE/ EC / GS / NME/ PF / PW / VAC/ VE / SE / WK	Category			Sem. Exam	Max. Marks		
					Lect. Hrs.	Tutorial Hrs.	Lab. Hrs.		CA	ESE	Total.
II	25PCH2EC3	3	MEDICINAL CHEMISTRY	EC	5	-	-	3 Hrs.	25	75	100
Pre-Requisite:											
Course Objectives: The purpose of learning this course is:											
1. To understand the physicochemical principles governing drug action and metabolism.											
2. To learn the synthesis, mechanism, and therapeutic uses of sulpha drugs and antibiotics.											
3. To explore structure-activity relationships (SAR) in analgesics, sedatives, and cardiovascular drugs.											
4. To study various classes of drugs including anti-tubercular agents and their mechanisms.											
5. To gain insight into drug discovery, clinical trials, regulatory affairs, and ethical practices.											
Course Outcomes: After completing this course, students will be able to:											
CO1: Understand the biological impact of drug properties and administration routes.											
CO2: Analyze sulpha drugs and antibiotics in terms of synthesis and action.											
CO3: Apply SAR concepts to analgesics and sedatives for drug design.											
CO4: Classify cardiovascular and anti-tubercular drugs with respect to their function.											
CO5: Interpret drug discovery phases, clinical trial designs, and regulatory standards.											
Unit-I	Drug action and sulpha drugs									15 Hrs.	
Physiochemical properties in relation to biological action - influence of route of administration. Biotransformation/absorption from stomach -absorption from intestines -sites of loss - metabolism and excretion, harmful drugs and their side effects. Sulpha drugs - sulphathiazole, sulphamerazine, sulphaguanidine and other sulpha drugs, -synthesis, mechanism of action –uses											
Unit-II	Antibiotics									15 Hrs.	
Antibiotics -A study of Chloramphenicol, Penicillin - semisynthetic Penicillin -gross structural features Streptomycin-Cephalosporin and Tetracycline. Polyene antifungal antibiotics-nystatin, fusicidic acid-griesofulvin. (gross structural features not needed)..											
Unit-III	Analgesics and antipyretics									14 Hrs.	
Study of morphine -structure activity relationship (SAR) -morphine analogues -Codeine -synthetic analgesics - pethidines and methadones -narcotic antagonist. Antipyreticanalgesics - salicylic acid, pyrazole and para amino phenol derivatives. Sedatives:Barbiturates, Benzodiazepines.											
Unit-IV	Cardio Vascular and anti - tubercular drugs									13 Hrs.	
Cardiovascular Drugs -classification, cardiac glycosides, anti -hypertensive and hypotensive agents -mode of action –anti -arythamic agents. Anti -tubercular drugs - sulphanamides -sulphones, p - amino salicylic acid -INH - ethambutal, Rifampicin											
Unit-V	Drug Development and Regulatory Affairs									18 Hrs.	
Drug Discovery and Preclinical Testing - stages of drug discovery - identification and optimization. Explore preclinical testing methodologies - in vitro and in vivo studies - assessing drug safety and efficacy. Clinical Trials: Study the phases of clinical trials (I, II, III) - drug approval by regulatory agencies. Understand the design of clinical trials – endpoints - statistical considerations - ethical issues. Regulatory Standards and Ethics: Overview of regulatory frameworks and standards (e.g., FDA, EMA) - drug development and approval. Discuss ethical considerations in clinical research, - protection of human subjects.											
Text Book(s):											
1. Jayashree Ghosh, <i>A Textbook of Pharmaceutical Chemistry</i> , S. Chand & Company, ISBN: 9788121904127											
2. V.K. Ahluwalia & Madhu Chopra, <i>Medicinal Chemistry</i> , Ane Books Pvt. Ltd., ISBN: 9789386768044											
3. Ashutosh Kar, <i>Medicinal Chemistry</i> , New Age International Publishers, ISBN: 9788122434525 (Unit III)											
4. R. Krishnamurthy, <i>Textbook of Medicinal Chemistry</i> , Himalaya Publishing House, ISBN: 9789352622823											
5. Graham L. Patrick, <i>An Introduction to Medicinal Chemistry</i> , Oxford University Press, ISBN: 9780198749691											

Reference Book(s):

1. Thomas L. Lemke & David A. Williams, Foye's Principles of Medicinal Chemistry, Wolters Kluwer, ISBN: 9781975120643
2. William O. Foye, Medicinal Chemistry, Lippincott Williams & Wilkins, ISBN: 9780683307375
3. S.N. Pandeya, A Textbook of Medicinal Chemistry, S.G. Wasani Publications, ISBN: 9788189617526
4. B.G. Reuben & Harry L. Reuben, Pharmaceutical Chemistry Practice, Wiley Eastern Ltd., ISBN: 9780853126975
5. Raymond G. Hill & Duncan Richards, Drug Discovery and Development, Elsevier, ISBN: 9780702078055

Web Resources:

1. <https://www.drugs.com> – Drug profiles and side effects (All Units)
2. <https://pubchem.ncbi.nlm.nih.gov> – Molecular structures and bioactivities (All Units)
3. <https://www.fda.gov/drugs> – Regulatory and approval standards (Unit V)
4. <https://www.ema.europa.eu> – EU regulatory body for drug approvals (Unit V)
2. <https://www.medchemexpress.com> – Synthetic pathways and SAR insights (Unit II & III)

Course Outcomes (COs)	Program Outcomes (POs)								Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	2	3	2	2	3	2	2	3	2	3	2	3
CO2:	3	3	2	2	2	3	2	2	3	2	3	2	3
CO3:	3	3	2	2	3	3	2	2	3	2	3	2	3
CO4:	3	2	2	2	3	3	2	2	3	2	3	2	3
CO5:	3	3	3	3	3	3	3	3	3	2	3	2	3
Overall CO – PO Mapping index = 2.4									Overall CO – PSO Mapping index = 2.6				

1 – Low Correlation

2 – Medium Correlation

3 – High Correlation

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Sem.	Course Code	Credits	Title of the Course	AC/CC/DE/ EC / GS / NME/ PF / PW / VAC/ VE / SE / WK	Category			Sem. Exam	Max. Marks		
					Lect. Hrs.	Tutoria Hrs.	Lab. Hrs.		CIA	ESE	Total.
II	25PCH2EC41	3	BIO-INORGANIC CHEMISTRY	EC	5	-	-	3 Hrs.	25	75	100

Pre-Requisite:

Course Objectives: The purpose of learning this course is:

1. To understand the role and storage mechanisms of essential trace elements and metal ions in biological systems.
2. To explore the structure and function of metalloproteins and transport proteins involved in oxygen transfer and electron flow.
3. To study the biochemical mechanism of nitrogen fixation and the role of metal complexes.
4. To identify both toxic and therapeutic effects of metals in medicinal and diagnostic applications.
5. To learn enzyme kinetics and understand the factors affecting catalytic efficiency in biological reactions.

Course Outcomes: After completing this course, students will be able to:

CO1: Describe biological roles of essential metals and their selective transport/storage.

CO2: Explain the mechanism of oxygen transport and redox processes in bioinorganic systems.

CO3: Analyze metal-involved nitrogen fixation and understand photosynthetic electron transport.

CO4: Evaluate the applications and toxicities of metals in medicine and diagnostic chemistry.

CO5: Interpret enzyme structure, classification, kinetics, and their roles in metabolism.

Unit-I | Essential trace elements: | 15 Hrs

Selective transport and storage of metal ions: Ferritin, Transferrin and siderophores; Sodium and potassium transport, Calcium signalling proteins. Metalloenzymes: Zinc enzymes-carboxypeptidase and carbonic anhydrase. Iron enzymes-catalase, peroxidase. Copper enzymes – superoxide dismutase, Plastocyanin, Ceruloplasmin, Tyrosinase. Coenzymes - Vitamin-B12 coenzymes.

Unit-II | Transport Proteins: | 15 Hrs

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 | 15 Hrs

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: | 15 Hrs

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: | 15 Hrs.

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.

Reference Book(s):

1. Banerjee, D. Bioinorganic Chemistry, CBS Publishers, 2005. ISBN: 9788123912117.
2. Sharma, R. K., & Kumar, A. Concepts of Bioinorganic Chemistry, PragatiPrakashan, 2007. ISBN: 9788173071999.
3. Fraústo da Silva, J. J. R., & Williams, R. J. P. The Biological Chemistry of the Elements, 2nd Ed., Oxford University Press, 2001. ISBN: 9780198508489.
4. Crichton, R. Biological Inorganic Chemistry: An Introduction, 2nd Ed., Elsevier, 2012. ISBN: 9780123858704.
5. Voet, D., & Voet, J. G. Biochemistry, 4th Ed., Wiley, 2010. ISBN: 9780470570950.

Web Resources:

1. <https://www.ncbi.nlm.nih.gov/books/NBK459455/> — *Metalloenzymes and Metal Ions in Biology* <https://www.ebi.ac.uk/training/online/courses/oxygen-binding-proteins/> — *Hemoglobin, Myoglobin and Cytochromes*
2. <https://www.nature.com/scitable/topicpage/biological-nitrogen-fixation-14362863/> — *Nitrogen Fixation & Photosynthesis*
3. <https://www.cancer.gov/about-cancer/treatment/drugs/metal-based-drugs> — *Metals in Medicine & Cancer Therapy*
4. <https://www.khanacademy.org/science/biology/macromolecules/enzymes-and-the-environment/a/enzyme-structure-and-function> — *Enzymes: Kinetics and Mechanism*

Course Outcomes (COs)	Program Outcomes (POs)								Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	2	2	2	2	3	2	2	3	2	3	2	3
CO2:	3	2	2	2	2	3	3	2	3	2	3	2	3
CO3:	3	3	2	2	2	3	3	2	3	2	3	2	3
CO4:	3	3	3	2	3	3	2	3	3	2	3	2	3
CO5:	3	2	2	2	3	3	2	2	3	2	3	2	3
Overall CO – PO Mapping index = 2.3									Overall CO – PSO Mapping index = 2.5				

1 – Low Correlation

2 – Medium Correlation

3 – High Correlation

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Sem.	Course Code	Credits	Title of the Course	AC/CC/DE/ EC / GS / NME/ PF / PW / VAC/ VE / SE / WK	Category			Sem. Exam	Max. Marks		
					Lect. Hrs.	Tutorial Hrs.	Lab. Hrs.		CA	AESE	Total.
II	25PCH2EC42	3	MATERIAL SCIENCE	EC	5	-	-	3 Hrs.	25	75	100
Pre-Requisite:											
Course Objectives: The purpose of learning this course is:											
1. To understand fundamental principles of nucleation and different crystal growth techniques.											
2. To explore the optical and dielectric properties of crystals and their technological applications.											
3. To study special materials like superconductors, magnetic, piezoelectric, and nonlinear optical materials.											
4. To examine materials used in renewable energy conversion, including photovoltaic and photocatalytic materials.											
5. To develop a conceptual understanding of the structural, electrical, and optical behavior of advanced materials.											
Course Outcomes: After completing this course, students will be able to:											
CO1: Explain various crystal growth methods and nucleation processes.											
CO2: Analyze optical and dielectric properties of crystalline materials.											
CO3: Distinguish between different types of magnetic, superconducting, and ferroic materials and their applications.											
CO4: Evaluate the performance of materials used in renewable energy systems like solar cells and water-splitting catalysts.											
CO5: Interpret structure-property relationships for functional materials used in modern technology.											
Unit-I	Crystallography									09 Hrs.	
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									09 Hrs.	
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									09 Hrs.	
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									09 Hrs.	
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 andgian 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									09 Hrs.	
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.											

Text Book(s):
<ol style="list-style-type: none"> 1. Solid State Physics by S.O. Pillai, New Age International Publishers, ISBN: 9788122430160 2. Materials Science and Engineering by V. Raghavan, PHI Learning, ISBN: 9788120331957 3. Introduction to Solid State Physics by Charles Kittel, Wiley, ISBN: 9788126535182 4. Principles of Materials Science and Engineering by William F. Smith, McGraw-Hill, ISBN: 9780070647203 5. Energy Materials by Duncan W. Bruce, Wiley, ISBN: 9781118695573
Reference Book(s):
<ol style="list-style-type: none"> 1. Crystal Growth for Beginners by Ivan V. Markov, World Scientific, ISBN: 9789812563583 2. Optical Properties of Solids by Mark Fox, Oxford University Press, ISBN: 9780199573363 3. Introduction to Magnetism and Magnetic Materials by David Jiles, CRC Press, ISBN: 9781138898317 4. Superconductivity: A Very Short Introduction by Stephen Blundell, OUP, ISBN: 9780199540907 5. Advanced Renewable Energy Sources by G. N. Tiwari & Mukesh Dubey, Royal Society of Chemistry, ISBN: 9781849730226
Web Resources:
<ol style="list-style-type: none"> 1. https://www.sciencedirect.com/topics/materials-science/crystal-growth (Unit I) 2. https://www.britannica.com/science/dielectric (Unit II) 3. https://www.explainthatstuff.com/how-superconductors-work.html (Unit III) 4. https://www.chemeurope.com/en/encyclopedia/Ferroc material.html (Unit IV) 5. https://www.nrel.gov/research/re-materials-science.html (Unit V)

Course Outcomes (COs)	Program Outcomes (POs)								Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	2	1	1	2	3	2	1	3	2	3	2	2
CO2:	3	2	1	1	3	3	2	1	3	2	3	2	2
CO3:	3	2	2	2	3	3	2	2	3	2	3	3	2
CO4:	3	3	2	2	3	3	3	2	3	3	3	3	3
CO5:	3	2	2	2	3	3	3	2	3	2	3	3	3
Overall CO – PO Mapping index = 2.2									Overall CO – PSO Mapping index = 2.3				

1 – Low Correlation

2 – Medium Correlation

3 – High Correlation

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Sem.	Course Code	Credits	Title of the Course	AC/CC/DE/ ES / GS / NME/ PF / PW / VAC/ VE / SE / WK	Category			Sem. Exam	Max. Marks		
					Lect. Hrs.	Tutorial Hrs.	Lab. Hrs.		CIA	ESE	Total
II	25PCH2NME1	2	WATER TECHNOLOGY	NME	2	-	-	3 Hrs.	25	75	100
Pre-Requisite:											
Course Objectives: The purpose of learning this course is:											
1. To provide foundational knowledge on water sources, chemistry, and its role in human and environmental health.											
2. To explain the socio-economic significance of water, causes of scarcity, and associated health hazards.											
3. To introduce water purification methods using both physical and chemical techniques.											
4. To describe the stages of sewage treatment and methods of waste and sludge disposal.											
5. To emphasize the importance of water conservation techniques and sustainable water use strategies.											
Course Outcomes: After completing this course, students will be able to:											
CO1: Understand the chemistry, cycle, and importance of water and water policies.											
CO2: Analyze the impact of water scarcity and pollution on public health and economy.											
CO3: Apply knowledge of purification techniques to improve water quality.											
CO4: Explain sewage treatment stages and evaluate methods for safe disposal.											
CO5: Identify and recommend appropriate water conservation methods for sustainable usage.											
Unit-I	Water									6 Hrs.	
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									6 Hrs.	
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									6 Hrs.	
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									6 Hrs.	
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									6 Hrs.	
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 Book(s):											
1. Environmental Chemistry by A. K. De, New Age International, ISBN: 9788122419462											
2. Water Resource Engineering by R. A. Wurbs& W. P. James, PHI Learning, ISBN: 9788120320906											
3. Water Supply Engineering by B. C. Punmia, Laxmi Publications, ISBN: 9789381255119											
4. Wastewater Engineering: Treatment and Resource Recovery by Metcalf & Eddy, McGraw-Hill, ISBN: 9780073401185											
5. Water Harvesting and Conservation by A.K. Bhattacharya, PHI Learning, ISBN: 9788120352655											
Reference Book(s):											
1. Introduction to Environmental Engineering by Mackenzie L. Davis & David A. Cornwell, McGraw-Hill, ISBN: 9780073401147											
2. Water and Wastewater Technology by Mark J. Hammer, Prentice Hall, ISBN: 9780131721443											
3. Principles of Water Treatment by Kerry J. Howe, Wiley, ISBN: 9781118088146											
4. Handbook of Water and Wastewater Treatment Technologies by Nicholas P. Cheremisinoff, Butterworth-Heinemann, ISBN: 9780750674980											
5. Rainwater Harvesting: Theory and Practice by A. Deshpande, Atlantic Publishers, ISBN: 9788126909198											

Web Resources:

1. <https://www.usgs.gov/special-topics/water-science-school/science/water-cycle-science-school> (Unit I)
2. <https://www.unwater.org/water-facts/scarcity> (Unit II)
3. https://www.cdc.gov/healthywater/drinking/public/water_treatment.html (Unit III)
4. <https://www.epa.gov/npdes/municipal-wastewater> (Unit IV)
5. <https://www.indiawaterportal.org/articles/rainwater-harvesting-concepts-benefits-and-techniques> (Unit V)

Course Outcomes (COs)	Program Outcomes (POs)								Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5
CO1:	3	2	2	1	2	3	2	2	3	2	2	2	3
CO2:	3	3	3	2	2	3	3	2	3	2	3	3	3
CO3:	3	2	2	2	3	3	2	1	3	2	3	2	3
CO4:	3	2	2	2	3	3	2	2	3	2	3	2	3
CO5:	3	3	3	2	3	3	3	3	3	3	3	3	3
Overall CO – PO Mapping index = 2.1									Overall CO – PSO Mapping index = 2.3				

1 – Low Correlation

2 – Medium Correlation

3 – High Correlation

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					Lect. Hrs.	Tutorial Hrs.	Lab. Hrs.		CIA	ESE	Total.
II	25PCH2OC	2*	SWAYAM/NPTEL Online Course		2	-	-	3 Hrs.	25	75	100
Pre-Requisite:											
Course Objectives: The purpose of learning this course is:											
1. To provide learners with a strong foundational understanding of the core concepts of the subject.											
2. To enable students to apply theoretical knowledge to practical and real-world situations through online interactive content.											
3. To introduce advanced topics and emerging trends through structured modules delivered by expert faculty from premier institutions.											
4. To develop learners' critical thinking and problem-solving abilities in the respective discipline.											
5. To promote self-paced, technology-enhanced learning to support academic and career advancement.											
Course Outcomes: After completing this course, students will be able to:											
CO1: Demonstrate conceptual clarity on the subject matter through quizzes, assignments, and final assessments.											
CO2: Apply learned concepts to solve subject-specific problems and case studies.											
CO3: Evaluate and analyze core and advanced topics using digital content and lectures.											
CO4: Improve technical communication and research capabilities using online resources.											
CO5: Integrate online course learnings with traditional curriculum for enhanced academic performance.											
*SWAYAM/NPTEL Online Course											

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