Sadakathullah Appa College

(Autonomous)

(Reaccredited by NAAC at an 'A^{++}' Grade. An ISO 9001:2015 Certified Institution)

Rahmath Nagar, Tirunelveli- 11.

Tamil Nadu.

DEPARTMENT OF CHEMISTRY

CBCS SYLLABUS

Learning Outcome-Based Curriculum Framework For

M.Sc. CHEMISTRY

(Applicable for students admitted in June 2024 and onwards)

(As per the Resolution of the Academic Council Meetings held on 01.06.2024)

CONTENTS

Sadakathullah Appa College, Rahmath Nagar,

Tirunelveli – 627 011.

Programme Structure & Credits – PG CHEMISTRY - 2024 – 2027

Sem	Course Type	Title of the Course	Course Code	H/W	C	Marks		
						I	E	T
I	Core-I	Organic Reaction Mechanism-I	24PCCH11	6	5	40	60	100
	Core-II	Structure and Bonding in Inorganic Compounds	24PCCH12	5	5	40	60	100
	Core- III	Molecular Spectroscopy	24PCCH13	5	4	40	60	100
	Core-P-I	Organic Chemistry Practical - I	24PCCH1P1	4	2	20	30	50
	Core-P-II	Physical Chemistry Practical -I	24PCCH1P2	4	2	20	30	50
	EC-I	Nanomaterials and Nanotechnology	24PECH11A	4	3	40	60	100
		Pharmaceutical Chemistry	24PECH11B					
		Medicinal Chemistry	24PECH11C					
	EC-II (IDC-I)	Water Treatment Technology	24PICH11	2	2	15	35	50
		SOP		-	-			
				30	**23**			**550**
II	Core-IV	Organic Reaction Mechanism-II	24PCCH21	5	5	40	60	100
	Core-V	Physical Chemistry-I	24PCCH22	5	4	40	60	100
	Core-P-III	Inorganic Chemistry Practical -I	24PCCH2P1	4	2	20	30	50
	Core-P-IV	Organic Chemistry Practical -II	24PCCH2P2	4	2	20	30	50
	EC-III	Material Science	24PECH21A	4	3	40	60	100
		Pharmocognosy and Phytochemistry	24PECH21B					
		Chemistry of Natural Products	24PECH21C					
	EC-IV (IDC-II)	Analytical Biochemistry	24PICH21	2	2	15	35	50
	SEC-I	Green Chemistry	24PSCH21	4	3	40	60	100
	SEC-II	NPTEL-SWAYAM Online Certification Course (or) Naan Muthalvan : (Choose any one course from the list of courses suggested by TANSCHE)	24PSCH22	2	2	-	-	50
		SOP		-	1			100
	Summer – Internship Industry Training during the 1st year vacation - credits be given in the third semester mark statement							
				30	**23+1**			**700**

Programme Learning Outcomes

PLO	Upon completion of M.Sc. Degree Programmes, the graduates will be able to:
PO 1	**Disciplinary Knowledge** Acquire in-depth scientific knowledge in the core areas of study.
PO 2	**Creative Thinking and Practical Skills / Problem Solving Skills** Enrich skills of observation to draw logical inferences from scientific experiments /programming and skills of creative thinking to develop novel ideas. Hone problem solving skills in theoretical, experimental and computational areas and to apply them in real life situations.
PO 3	**Sense of inquiry and Skilled Communicator / Research, Innovation and Entrepreneurship** Develop the capability for raising appropriate questions relating to the current/emerging issues encountered in the scientific field and to plan, execute and express the results of experiments / investigations through technical writings as well as through oral presentations. Design innovations for exploring the unexplored areas in diverse fields to accomplish socially relevant and economically beneficial innovative research projects. Become a skilled entrepreneur for launching start-up / business ventures to improve the economy of the nation.
PO 4	**Ethical Awareness / Team Work / Environmental Conservation and Sustainability** Equip them for conducting work as an individual / as a member, or as a leader in diverse teams upholding values such as honesty and precision, and thus preventing unethical behaviours such as fabrication, falsification, misrepresentation of data, plagiarism etc. to ensure academic integrity. Realise that environment and humans are dependent on one another and to know about the responsible management of our ecosystem for survival, and for the well-being of the future generation as well.
PO 5	**Digital Literacy/Self-Directed Learning/Usage of ICT/Lifelong Learning** Get access to digital resources, to use them judiciously for updation of knowledge and also to engage in remote/ independent learning. Inculcate the habit of learning continuously through the effective adoption of ICT to update knowledge in the emerging areas in Sciences for inventions/discoveries so that the knowledge transferred from laboratory to land would yield fruitful results for the betterment of global society.

Programme Specific Outcomes(PSOs)

PSO	Upon completion of M.Sc. Chemistry Degree Programmes, the students will be able to:	POs Mapped
PSO-1	**Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions..	PO1, PO2, PO3, PO4, PO5
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.	PO2, PO3, PO4, PO5
PSO-3	**Research and Development** Design and implement HR systems and practices grounded in researches that comply with employment laws, leading the organization towards growth and development.	PO1, PO2, PO3
PSO-4	**Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world.	PO1, PO2, PO3, PO4, PO5
PSO-5	**Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.	PO1, PO2, PO3, PO4

Semester – I	ORGANIC REACTION MECHANISM - I		24PCCH11			
Core-I			L	T	P	C
Hrs./Week: 6	Hrs./Semester : 90	Marks :100	5	1	-	5

General Objective:

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.

Learning Objectives (LO)

LO	The learners will be able to:
LO-1	Understand the basic principles of organic chemistry.
LO-2	Outline the mechanism and evidences of aromatic and aliphatic electrophilic substitution reactions.
LO-3	Apply the principles of kinetic and non-kinetic methods to determine the mechanismof reactions.
LO-4	Predict the reaction mechanism of organic reactions by analyzing the stereochemistry of organic compounds.
LO-5	Design and synthesize new organic compounds by correlating the stereochemistry of organic compounds.

UNIT I - Methods of Determination of Reaction Mechanism

Reaction intermediates, the transition state, Reaction coordinate diagrams, Thermodynamic and kinetic requirements of reactions: Hammond postulate.

Methods of determining mechanism: non-kinetic methods - product analysis, determination of intermediates-isolation, detection, and trapping. Cross-over experiments, isotopic labelling, isotope effects and stereo chemical evidences. Kinetic methods - relation of rate and mechanism. Effect of structure on reactivity: Hammett and Taft equations.

UNIT II - Aromatic and Aliphatic Electrophilic Substitution

Aromaticity: 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 reactions.

Aliphatic electrophilic substitution: S_E2 and S_Ei, S_E1- Mechanism and evidences.

UNIT III – Aromatic and Aliphatic Nucleophilic Substitution

Aromatic nucleophilic substitution: Mechanisms - S_NAr: S_N1, S_N2 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.

Aliphatic nucleophilic substitutions: S_N1, S_N2, S_Ni, allylic carbon, and vinyl carbon. mechanism and evidences - Ambident nucleophiles.

UNIT IV – Stereochemistry-I

Introduction to molecular symmetry and chirality – axis, plane, center, alternating axis of symmetry. Optical isomerism: 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. Stereochemical notation and

configuration rule: D-, L- systems, Cram's and Prelog's rules - R, S- notations, pro-R, pro-S, side phase and re-phase Cahn-Ingold-Prelog rules, absolute and relative configurations. Configurations of allenes, spiranes, biphenyls, cyclooctene and ansa compounds. Topicity and prostereoisomerism. Criteria for optical purity: Resolution of racemic modifications. Stereoselective and stereospecific synthesis.

UNIT V – Stereochemistry-II

Conformation and reactivity of acyclic systems, intramolecular rearrangements, neighbouring group participation, chemical consequence of conformational equilibrium: Curtin-Hammett Principle. Stability of five and six-membered rings: mono-, di- and polysubstituted cyclohexanes, conformation and reactivity in cyclohexane systems. Fused and bridged rings: bicyclic, poly cyclic systems, Decalins and Brett's rule.

Optical rotation and Optical rotatory dispersion: conformational asymmetry, Octant rule, configuration and conformation, Cotton effect, and determination of configuration.

Textbooks:

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

Reference Books:

1. F.A. Carey and R.J. Sundberg, Advanced Organic Chemistry Part-A and B, 5th edition, Kluwer Academic / Plenum Publishers, 2007.
2. D. G. Morris, Stereochemistry, RSC Tutorial Chemistry Text 1, 2001.
3. N.S. Isaacs, Physical Organic Chemistry, ELBS, Longman, UK, 1987.
4. E. L. Eliel, Stereochemistry of Carbon Compounds, Tata-McGraw Hill, 2000.

5. I. L. Finar, Organic chemistry, Vol-1 & 2, 6th edition, Pearson Education Asia, 2004.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	To understand the basic principles of organic chemistry.	2,3	K2
CO-2	To organize the formation and detection of reaction intermediates of organic reactions.	3	K3
CO-3	To predict the reaction mechanism of organic reactions and stereochemistry of organic compounds.	3	K4
CO-4	To evaluate the principles of kinetic and non-kinetic methods to determine the mechanism of reactions.	2,3	K5
CO-5	To design and synthesize new organic compounds by correlating the stereochemistry of organic compounds.	2,3	K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PCCH11	ORGANIC REACTION MECHANISM - I	90	5

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	2	2	3	3	3	3	2
CO-2	3	3	3	3	2	3	3	3	3	3
CO-3	3	3	3	2	2	3	3	3	3	3
CO-4	3	3	3	3	2	3	3	3	3	2
CO-5	3	3	3	2	2	3	3	3	3	2

S-Strong (3), M-Medium (2), L-Low (1)

Prepared by :Dr.M.Fathima Shahana Checked by: Dr.S.Brillians Revin

Head of the Department

Semester – I	STRUCTURE AND BONDING IN INORGANIC COMPOUNDS		24PCCH12			
Core-II			L	T	P	C
Hrs./Week: 5	Hrs./Semester : 75	Marks :100	5	-	-	5

General Objective:

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.

Learning Objectives

LO	The learners will be able to:
LO-1	Explains the of main group compounds and clusters.
LO -2	Explain about the packing of ions in crystals and predict the coordination number of cations.
LO -3	Understand the different types of ionic crystal systems.
LO -4	Interpret the various techniques of crystal growth.
LO -5	Elucidate the different defects in solid state.

UNIT I - Structure of main group compounds and clusters

VB theory – Effect of lone pair and electronegativity of atoms (Bent's rule) on the geometry of the molecules; Structure of silicates - applications of Paulings rule of electrovalence - isomorphous replacements in silicates – ortho, meta and pyro silicates – one dimensional, two dimensional and three-dimensional silicates. Structure of silicones, Structural and bonding features of B-N, S-N and P-N compounds; Poly acids – types, examples and structures; Borane cluster: Structural features of closo, nido, arachano and klado.

UNIT II - Solid state Chemistry – I

Ionic crystals: Packing of ions in simple, hexagonal and cubic close packing,

voids in crystal lattice, Radius ratio, Crystal systems and Bravis lattices, Symmetry operations in crystals, glide planes and screw axis; point group and space group; Solid state energetics: Lattice energy – Born-Lande equation.

UNIT III - Solid state Chemistry – II

Structural features of the crystal systems: Rock salt, Zinc blende & Wurtzite, Fluorite and Anti-fluorite, Rutile and Anatase, Cadmium iodide and Nickel arsenide; Spinels -normal and inverse types and Perovskite structures.

UNIT IV - Techniques in solid state Chemistry

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

UNIT-V: Band theory and defects in solids

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

Textbooks:

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: NewYork, 1983

Reference Books:

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

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Predict the geometry of main group compounds and clusters	1,2	K3
CO-2	Explain about the packing of ions in crystals and apply the radius ratio rule to predict the coordination number of cations.	2,3	K2
CO-3	Apply the various types of ionic crystal systems and analyze their structural features.	2,3	K3
CO-4	Analyse the crystal growth methods	4,3	K4
CO-5	Evaluate of diffraction techniques and microscopic techniques.	2,5	K5

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PCCH12	STRUCTURE AND BONDING INORGANICCOMPOUNDS	75	5

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	2	1	3	3	3	3	2
CO-2	3	3	3	3	2	3	3	3	3	3
CO-3	3	3	3	1	2	3	3	3	2	3
CO-4	3	3	3	3	1	3	3	3	2	2
CO-5	3	3	3	2	2	3	3	3	3	2

STRONG (3), MEDIUM (2) and LOW (1)

Prepared by : Dr.P.Anvar Kasim Checked by: Dr.S.Brillians Revin

Head of the Department

Semester – I	MOLECULAR SPECTROSCOPY		24PCCH13			
Core-III			L	T	P	C
Hrs./Week: 5	Hrs./Semester : 75	Marks :100	4	1	-	4

General Objective:

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

Learning outcome (LO)

LO	The learners will be able to:
LO -1	Understand the importance of rotational and Raman spectroscopy
LO -2	Apply the vibrational spectroscopic techniques to diatomic and polyatomic molecules.
LO -3	Evaluate different electronic spectra of simple molecules using electronic spectroscopy.
LO -4	Outline the NMR, ^{13}C NMR, 2D NMR – COSY, NOESY, Introduction to ^{31}P, ^{19}F NMR and ESR spectroscopic techniques.
LO -5	Develop the knowledge on principle, instrumentation and structural elucidation of simple molecules using Mass Spectrometry, EPR and Mossbauer Spectroscopy techniques.

UNIT I - Rotational and Raman Spectroscopy:

Rotational spectra of diatomic and polyatomic molecules. Intensities of rotational spectral lines, effect of isotopic substitution. Non-rigid rotators. Classical theory of the Raman effect, polarizability as a tensor, polarizability ellipsoids, Pure rotational Raman spectra of linear and asymmetric top molecules, Stokes and anti-Stokes lines. Vibrational Raman spectra, Raman activity of vibrations, rule of mutual exclusion, rotational fine structure-O and S branches, Polarization of Raman scattered photons.

UNIT II - Vibrational Spectroscopy:

Vibrations of molecules, harmonic and anharmonic oscillators-vibrational energy expression, energy level diagram, vibrational wave functions and their symmetry, selection rules, expression for the energies of spectral lines, effect of isotopic substitution. Diatomic vibrating rotor, vibrational-rotational spectra of diatomic molecules, P, R branches, breakdown of the Born-Oppenheimer approximation. Vibrations of polyatomic molecules – symmetry properties, Overtone and combination frequencies. Influence of rotation on vibrational spectra of polyatomic molecule, P, Q, R branches, parallel and perpendicular vibrations of linear and symmetric top molecules.

UNIT III - Electronic Spectroscopy:

Electronic Spectroscopy: Electronic Spectroscopy of diatomic molecules, Frank-Condon principle, dissociation and predissociation spectra. $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ transitions and their selection rules. Photoelectron Spectroscopy: Basic principles, photoelectron spectra of simple molecules, Xray photoelectron spectroscopy (XPS).Lasers: Laser action, population inversion, properties of laser radiation, examples of simple laser systems.

UNIT IV -NMR Spectroscopy and ESR Spectroscopy:

Chemical shift, Factors influencing chemical shifts: electronegativity and electrostatic effects; Mechanism of shielding and deshielding. Spin systems: First order and second order coupling of AB systems, Simplification of complex spectra. Spin-spin interactions: Homonuclear coupling interactions - AX, AX_2, AB types. ^{13}C NMR and structural correlations. 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. Spin orbit coupling and significance of g-tensors, zero/non-zero field splitting, Kramer's degeneracy.

UNIT V - Mass Spectrometry, EPR and Mossbauer Spectroscopy:

Ionization techniques- Electron ionization (EI), chemical ionization (CI), desorption ionization (FAB/MALDI), electrospray ionization (ESI), molecular ion, fragmentation processes of organic molecules, deduction of structure through mass spectral fragmentation, high resolution. EPR spectra of anisotropic systems - anisotropy in g-value, causes of anisotropy, anisotropy in hyperfine coupling, hyperfine splitting caused by quadrupole nuclei. 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.

Textbooks:

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

Reference Books:

1. P.W. Atkins and J. de Paula, *Physical Chemistry*, 7th Ed., Oxford University Press, Oxford, 2002.
2. I. N. Levine, *Molecular Spectroscopy*, John Wiley & Sons, New York, 1974.
3. A. Rahman, *Nuclear Magnetic Resonance-Basic Principles*, Springer-Verlag, New York,1986.
4. K. Nakamoto, *Infrared and Raman Spectra of Inorganic and coordination Compounds*, PartB: 5th ed., John Wiley& Sons Inc., New York, 1997.
5. J. A. Weil, J. R. Bolton and J. E. Wertz, *Electron Paramagnetic Resonance*; Wiley Interscience, 1994

Course Outcomes (CO)

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand the importance of rotational and Raman spectroscopy	1,3	K2
CO-2	Outline the NMR, ^{13}C NMR, 2D NMR – COSY, NOESY, Introduction to ^{31}P, ^{19}F NMRand ESR Spectroscopic techniques.	1,2,3	K2
CO-3	Apply the vibrational spectroscopic techniques to diatomic and polyatomic molecules.	1,3	K3
CO-4	Evaluate different electronic spectra of simple molecules using electronic Spectroscopy.	1,3	K4
CO-5	Develop the knowledge on principle, instrumentation and structural elucidation ofsimple molecules using Mass Spectrometry, EPR and Mossbauer Spectroscopy techniques.	1,3	K5

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PCCH13	MOLECULAR SPECTROSCOPY	75	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	-	3	3	3	1	1
CO-2	3	3	3	2	2	3	3	3	2	1
CO-3	3	3	2	2	-	3	1	3	1	1
CO-4	3	3	3	1	3	3	1	3	1	1
CO-5	3	3	3	-	3	3	3	3	3	1

S-Strong (3), M-Medium (2), L-Low (1)

Prepared by :Dr.Mohamed Khalith

Checked by: Dr.S.Brillians Revin
Head of the Department

Semester – I	ORGANIC CHEMISTRY PRACTICAL-I		24PCCH1P1			
Core-P-I			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :50	-	-	4	2

General Objective:

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 derivatize them suitably.

Learning Objectives

LO	The learners will be able to:
LO-1	Understand the basic principles of separation procedures of organic mixtures.
LO-2	Select the separation methods to separate the Organic Mixtures.
LO-3	Classify the functional groups using systematic procedure and to determine the physical properties of Organic compounds
LO-4	Analyze the separated organic components systematically and derivative them suitably.
LO-5	Estimate the Organic compounds by titrimetric method.

Unit I - Qualitative analysis of Organic mixture (at least six two component mixtures):

1. Separation of organic mixtures
2. Elemental analysis
3. Functional group(s) identification
4. Preparation of derivatives
5. Physical properties determination (melting point and boiling point) for both components and their derivatives.
6. Analysis may be performed in micro (or) macro scale depending upon

the conditions of the laboratory.

Unit II - Estimation:

1. Estimation of ethylmethylketone (iodimetry)
2. Estimation of glucose (redox)
3. Estimation of ascorbic acid

For Class work:

1. Three component mixtures (Separation).

Textbooks:

1. A.I. Vogel, Elementary Practical Organic Chemistry: Small Scale Preparations, Qualitative Organic Analysis, Quantitative Organic Analysis, Pearson Education, 2011.
2. K. Bansal Raj, Laboratory Manual of Organic Chemistry,New Age International, 2009.
3. V. Venkateswaran, R. Veeraswamy and A. R. Kulandaivelu, Basic Principles of Practical Chemistry, Sultan Chand & Sons, 2004.
4. V.K. Ahluwalia, and R. Aggarwal, Comprehensive Practical Organic Chemistry, Universities Press, 2004

Reference Books:

1. R.G. Engel, D.L. Pavia, G.M. Lampman and G.S. Kriz, A Microscale approach to Organic Laboratory, 5th edition, Paperback – International Edition, 2012.
2. P.B. Cranwell, L.M. Harwood, and C. J. Moody, Experimental Organic Chemistry, 3rd edn, Wiley-Blackwell**,** 2017.
3. J. Leonard, B. Lygo and G. Procter, Advanced Practical Organic Chemistry, 3rd edn, CRC Press, 2013.

Course Outcomes (CO)

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand the basic principles of separation procedures of organic mixtures.	2,3	K2
CO-2	Interpret the separation methods to separate the organic mixtures.	2,3	K2
CO-3	Identify the functional groups using systematic procedure.	2,3	K3
CO-4	Examine the physical properties and estimate the organic compounds	2,3	K4
CO-5	Evaluate the separated organic components systematically, derivative them suitably.	2,3	K5

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 – Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PCCH1P1	ORGANIC CHEMISTRY PRACTICAL-I	60	2

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	2	2	3	3	3	3	2
CO-2	3	3	3	2	2	3	3	3	3	2
CO-3	3	3	3	3	2	3	3	3	3	2
CO-4	3	3	3	3	2	3	3	3	3	2
CO-5	3	3	3	3	2	3	3	3	3	2

S-Strong (3), M-Medium (2), L-Low (1)

Prepared by :Dr.M.Fathima Shahana

Checked by: Dr.S.Brillians Revin
Head of the Department

Semester – I	PHYSICAL CHEMISTRY PRACTICAL-I		24PCCH1P2			
Core-P-II			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :50	-	-	4	2

General Objective:

1. To understand the principle of conductivity experiments through conductometric titrations.
2. To evaluate the order of the reaction, temperature coefficient, and activation energy of the reaction by following pseudo first order kinetics.
3. To construct the phase diagram of two component system forming congruent melting solid and find its eutectic temperatures and compositions.
4. To determine the kinetics of adsorption of Oxalic acid on Charcoal.
5. To develop the potential energy diagram of hydrogen ion, charge density distribution and Maxwell's speed distribution by computational calculation.

Learning Outcome (LO)

LO	The learners will be able to:
LO-1	Understand the principles associated with conductivity experiments.
LO-2	Observe and record systematically the readings in all the experiments.
LO-3	Understand the principles associated with kinetics of the reaction through the experiments
LO-4	Calculate and analyze the experimentally measured values and compare with graphical data.
LO-5	Understand the principles associated with simple binary system and adsorption mechanism of the reaction through the experiments

UNIT-I: Conductivity Experiments

1. Determination of equivalent conductance of a strong electrolyte & the verification of DHO equation.
2. Verification of Ostwald's Dilution Law & Determination of pKa of a weak acid.
3. Verification of Kohlrausch's Law for Weak electrolytes.
4. Determination of solubility of a sparingly soluble salt.

5. Acid-base titration (Strong acid and Weak acid vs NaOH). Precipitation titrations (mixture of halides only).

UNIT-II: Kinetics

1. Study the kinetics of acid hydrolysis of an ester, determine the temperature coefficient and also the activation energy of the reaction.
2. Study the kinetics of the reaction between acetone and iodine in acidic medium by half-life method and determine the order with respect toiodine and acetone.

UNIT-III: Phase diagram

Construction of phase diagram for a simple binary system:

1. Naphthalene-phenanthrene
2. Benzophenone- diphenyl amine

Adsorption**:**

1. Adsorption of Oxalic acid on Charcoal & determination of surface area(Freundlich isotherm only).

Textbooks:

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

Reference Books:

1. J. B. Yadav, Advanced Practical Physical Chemistry, Goel PublishingHouse, 2001.
2. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th edition, McGraw Hill, 2009.
3. J. N. Gurthu and R. Kapoor, Advanced Experimental Chemistry, S.Chand and Co., 1987.
4. Shailendra K Sinha, Physical Chemistry: A laboratory Manual, Narosa Publishing House Pvt, Ltd., New Delhi, 2014.
5. F. Jensen, Introduction to Computational Chemistry, 3rd Ed., Wiley-Blackwell.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand the principles associated with various physical chemistry experiments.	1,2	K2
CO-2	Scientifically plan and perform all the experiments.	3	K3
CO-3	Observe and record systematically the readings in all the experiments.	2	K3
CO-4	Calculate and process the experimentally measured values and compare with graphical data.	3	K4
CO-5	Interpret the experimental data scientifically to improve students' efficiency for societal developments.	5	K5

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 – Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PCCH1P2	PHYSICAL CHEMISTRY PRACTICAL-I	60	2

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	2	3	1	1	3	1	3	2	1
CO-2	3	3	3	1	1	3	1	3	2	3
CO-3	3	3	3	-	3	3	2	3	2	2
CO-4	3	3	3	1	3	3	2	3	12	2
CO-5	3	3	3	-	3	3	2	3	2	3
Total	**15**	**14**	**15**	**3**	**11**	**15**	**8**	**15**	**10**	**11**
Average	**3**	**2.8**	**3**	**0.6**	**2.2**	**3**	**1.6**	**3**	**2**	**2.2**

S-Strong (3), M-Medium (2), L-Low (1)

Prepared by :Dr.S.Brillians Revin

Checked by: Dr.S.Brillians Revin

Head of the Department

Semester – I	NANO MATERIALS AND NANO TECHNOLOGY		24PECH11A			
EC-IA			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

1. To understand the concept of nano materials and nano technology.
2. To understand the various types of nano materials and their properties.
3. To understand the applications of synthetically important nano materials.
4. To correlate the characteristics of various nano materials synthesized by new technologies.
5. To design synthetic routes for synthetically used new nano materials.

Learning Objectives

LO	The learners will be able to:
LO-1	Understand the basic concepts of nanomaterials
LO-2	Analyze the properties of nanomaterials
LO-3	Discuss about the preparation of nanomaterials
LO-4	Understand the types of nanomaterials
LO-5	Analyze the applications of nanomaterials

UNIT I - Introduction of nanomaterials

Introduction of nanomaterials and nanotechnologies, Introduction-role of size, classification-0D, 1D, 2D, 3D. Synthesis- Bottom –Up, Top–Down, consolidation of Nano powders. Features of nanostructures. Techniques of synthesis of nanomaterials, Tools of the nanoscience. Applications of nanomaterials and technologies

UNIT II – Synthesis of Nanomaterials

Bonding and structure of the nanomaterials, predicting the Type of Bonding in a Substance crystal structure. Metallic nanoparticles, Surfaces of Materials, Nanoparticle Size and Properties. Synthesis- Physical and chemical methods - inert gas condensation, arc discharge, laser ablation, Sol-gel, solvothermal and hydrothermal-CVD-types. Microwave assisted and electrochemical synthesis.

UNIT III – Properties of Nanomaterials

Mechanical properties of materials, theories relevant to mechanical properties. Techniques to study mechanical properties of nanomaterials. Gold and Silver, metal oxides: silica, iron oxide and alumina - synthesis and properties

UNIT IV – Semiconductor Nanomaterials

Electrical properties, Conductivity and Resistivity, Classification of Materials based on Conductivity, magnetic properties and electronic properties of materials. Semiconductor materials – classification-Ge, Si, GaAs, SiC, GaN, GaP, CdS,PbS. Applications of semiconductors: p-n junction as transistors and rectifiers, Photovoltaic Cell.

UNIT V – Characterisation of Nanomaterials

Nano thin films, nanocomposites. Application of nanoparticles in different fields. Core-shell nanoparticles - types, synthesis, and properties and applications. Characterization – SEM, TEM and AFM - principle, instrumentation and applications.

Textbooks:

1. S.Mohan and V. Arjunan, Principles of Materials Science, MJP Publishers, 2016.
2. Arumugam, Materials Science, Anuradha Publications,2007.
3. Giacavazzo et. al., Fundamentals of Crystallography, International Union of Crystallography. Oxford Science Publications, 2010
4. Woolfson, An Introduction to Crystallography, Cambridge University Press, 2012.
5. James F. Shackelford and Madanapalli K. Muralidhara, Introduction to Materials Science for Engineers. 6th ed., PEARSON Press, 2007.

Reference Books:

1. S.Mohan and V. Arjunan, Principles of Materials Science, MJP Publishers, 2016.
2. Arumugam, Materials Science, Anuradha Publications,2007.
3. Giacavazzo et. al., Fundamentals of Crystallography, International Union of Crystallography. Oxford Science Publications, 2010.

4. Woolfson, An Introduction to Crystallography, Cambridge University Press, 2012.
5. James F. Shackelford and Madanapalli K. Muralidhara, Introduction to Materials Science for Engineers. 6th ed., PEARSON Press, 2007.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Explain the various methods of fabricating the nanostructures.	1,3	K2
CO-2	Relate the unique properties of nanomaterials to reduce dimensionality of thematerial.	3	K2
CO-3	Describe the various tools and properties of nanostructures.	3	K3
CO-4	Discuss the applications of nanomaterials.	1,3,5	K4
CO-5	Create the health and safety related to nanomaterial.	3,5	K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 – Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PECH11A	NANOMATERIALS AND NANOTECHNOLOGY	60	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	1	3	3	2	3	3
CO-2	3	3	3	3	2	3	3	3	3	3
CO-3	3	2	3	1	2	3	2	3	2	3
CO-4	3	3	3	3	3	3	3	3	2	3
CO-5	3	3	3	1	2	3	3	2	3	3

S-Strong (3), M-Medium (2), L-Low (1)

Prepared by :Dr.S.Brillians Revin

Checked by: Dr.S.Brillians Revin

Head of the Department

Semester – I	PHARMACEUTICAL CHEMISTRY		24PECH11B			
EC-IB			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

1. To understand the advanced concepts of pharmaceutical chemistry.
2. To recall the principle and biological functions of various drugs.
3. To train the students to know the importance as well the consequences of various drugs.
4. To have knowledge on the various analysis and techniques.
5. To familiarize on the drug dosage and its structural activities.

Learning Objectives (LO)

LO	The learners will be able to:
LO-1	Identify the suitable drugs for various diseases.
LO-2	Apply the principles of various drug action and drug design.
LO-3	Acquire the knowledge on product development based on SAR.
LO-4	Apply the knowledge on applications of computers in chemistry.
LO-5	Synthesize new drugs after understanding the concepts SAR.

UNIT-I: Physical properties in Pharmaceuticals

Physical properties of drug molecule: physical properties. Refractive index- Definition, explanation, formula, importance, determination, specific & molar refraction. Optical activity\rotation- monochromatic & polychromatic light, Optical activity, angle of rotation, specific rotation examples, measurement of Optical activity. Dielectric constant & Induced Polarization- Dielectric constant explanation & determination. Rheology of pharmaceutical systems: Introduction, Definition, Applications, Concept of Viscosity, Newton's law of flow, Kinematic, Relative, Specific, Reduced & Intrinsic Viscosity. Newtonian system, non-Newtonian system- Plastic flow, Pseudoplastic flow, Dilatent flow. Viscosity measurements- selection of viscometer for Newtonian and non-Newtonian system.

UNIT-II: Isotopic Dilution Analysis

Principle and applications, Neutron activation analysis: Principle, advantages and limitations, Scintillation counters: Body scanning. Introduction to radiopharmaceuticals. Properties of various types of radiopharmaceuticals, Radiopharmaceuticals as diagnostics, as therapeutics, for research and sterilization. Physico Chemical Properties and drug action. Physico chemical properties of drugs (a) Partition coefficient, (b) solubility (c) surface activity, (d) degree of ionization.

UNIT-III: Drug dosage and product development

Introduction to drug dosage Forms & Drug Delivery system – Definition of Common terms. Drug Regulation and control, pharmacopoeias formularies, sources of drug, drug nomenclature, routes of administration of drugs products, need for a dosage form, classification of dosage forms. Drug dosage and product development. Introduction to drug dosage Forms & Drug Delivery system – Definition of Common terms. Drug Regulation and control, pharmacopoeias formularies, sources of drug, drug nomenclature, routes of administration of drugs products, need for a dosage form, classification of dosage forms.

UNIT-IV: Development of New Drugs

Introduction, procedure followed in drug design, the research for lead compounds, molecular modification of lead compounds. Structure-Activity Relationship (SAR): Factors effecting bioactivity, resonance, inductive effect, isoterism, bioisosterism, spatial considerations, biological properties of simple functional groups, theories of drug activity, occupancy theory, rate theory, induced-fit theory, Quantitative structure - activity relationship (QSAR): Development of QSAR, drug receptor interactions, the additivity of group contributions, physico-chemical parameters, lipophilicity parameters, electronic parameter, ionization constants, steric parameters, chelation parameters, redox potential, indicator-variables.

UNIT-V: Computers in Pharmaceutical Chemistry:

Need of computers for chemistry. Computers for Analytical Chemists-Introduction to computers: Organization of Computers, CPU, Computer memory, I/O devices, information storage, software components. Application of

computers in chemistry: Programming in high level language (C+) to handle various numerical methods in chemistry – least square fit, solution to simultaneous equations, interpolation, extrapolation, data smoothing, numerical differentiation and integrations.

Textbooks:

1. Essential of Physical Chemistry- Arun Bahl and G.D.Tuli, S.Chand Publishing, 28th ed. 2020.
2. Text Book of Physical Pharmaceutics, IInd edition, Vallabh Prakashan-. C.V.S. Subramanyam, 2018.
3. Medicinal Chemistry (Organic Pharmaceutical Chemistry), G.R Chatwal, Himalaya Publishing house, 2010.
4. Instrumental method of Analysis: Hubert H, Willard, 7th edition.
5. Textbook of Pharmaceutical Chemistry by, Jayshree Ghosh, S. Chand & company Ltd. Pharmaceutical Chemistry by Dr. S. Lakshmi, Sultan chand & Sons, 2012.

Reference Books:

1. Computers in chemistry, K.V. Raman, Tata Mc.Graw-Hill, 1993.
2. Computers for Chemists, S.K Pundir, Anshu bansal, A pragate prakashan., 2nd edition, New age international (P) limited, New Delhi.
3. Physical Pharmacy and Pharmaceutical Sciences by Martins, Patrick J. Sinko, Lippincott. William and Wilkins, 2010.
4. Cooper and Gunn's Tutorial Pharmacy, 6th edition by S.J. Carter, CBS Publisher Ltd, 2005.
5. Ansels pharmaceutical Dosage forms and Drug Delivery System by Allen Popvich and Ansel, Indian edition-B.I. Publication Pvt. Ltd.

Course Outcomes (CO)

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Explain the applications of computers in chemistry.	1,5	K1
CO-2	Explain the product development based on SAR.	2	K1
CO-3	How to identify the suitable drugs for various diseases.	3,5	K2
CO-4	How to synthesize new drugs after understanding the concepts SAR.	1	K2
CO-5	Apply the principles of various drug action and drug design.	1,3,4	K3

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PECH11B	PHARMACEUTICAL CHEMISTRY	60	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	3	3	3	2
CO-2	3	3	3	3	2	3	3	3	3	2
CO-3	3	3	2	3	2	3	3	3	2	2
CO-4	3	3	2	3	3	3	3	3	3	2
CO-5	3	3	2	2	2	3	3	3	3	2

S-Strong (3), M-Medium (2), L-Low (1)

Prepared by :Dr.S.Brillians Revin

Checked by: Dr.S.Brillians Revin

Head of the Department

Semester – I	MEDICINAL CHEMISTRY		24PECH11C			
EC-IC			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

1. To study the chemistry behind the development of pharmaceutical materials.
2. To gain knowledge on mechanism and action of drugs.
3. To understand the need of antibiotics and usage of drugs.
4. To familiarize with the mode of action of diabetic agents and treatment of diabetes.
5. To identify and apply the action of various antibiotics.

Learning Objectives (LO)

LO	The learners will be able to:
LO-1	Predict a drugs properties based on its structure.
LO-2	Describe the factors that affect its absorption, distribution, metabolism, and excretion, and hence the considerations to be made in drug design.
LO-3	Understand the relationship between drug's chemical structure and its therapeutic properties.
LO-4	Designed to give the knowledge of different theories of drug actions at molecular level.
LO-5	Identify different targets for the development of new drugs for the treatment of infectious and GIT.

UNIT-I: Introduction to receptors:

Introduction, targets, Agonist, antagonist, partial agonist. Receptors, Receptor types, Theories of Drug – receptor interaction, Drug synergism, Drug resistance, physicochemical factors influencing drug action.

UNIT-II: Antibiotics:

Introduction, Targets of antibiotics action, classification of antibiotics, enzyme-based mechanism of action, SAR of penicllins and tetracyclins, clinical application of penicillins, cephalosporin.Current trends in antibiotic therapy.

UNIT-III: Antihypertensive agents and diuretics:

Classification of cardiovascular agents, introduction to hypertension, etiology, types, Classification of antihypertensive agents, Classification and mechanism of action of diuretics, Furosemide, Hydrochlorothiazide, Amiloride.

UNIT-IV: Antihypertensive agents and diuretics:

Classification of cardiovascular agents, introduction to hypertension, etiology, types, classification of antihypertensive agents, classification and mechanism of action of diuretics, Furosemide, Hydrochlorothiazide, Amiloride.

UNIT-V: Analgesics, Antipyretics and Anti-inflammatory Drugs:

Introduction, Mechanism of inflammation, classification and mechanism of action and paracetamol, Ibuprofen, Diclofenac, naproxen, indomethacin, phenylbutazone and meperidine. Medicinal Chemistry of Antidiabetic Agents Introduction, Types of diabetics, Drugs used for the treatment, chemical classification, Mechanism of action, Treatment of diabetic mellitus. Chemistry of insulin, sulfonyl urea.

Textbooks:

1. Wilson.E and Gisvold's textbook of Organic Medicinal and Pharmaceutical Chemistry, 12th edition, 2010.
2. Wilson, Charles Owens: Beale, John Marlowe; Block, John H, Lipincott William, 12th edition, 2011.
3. Graham L. Patrick, An Introduction to Medicinal Chemistry, 5th edition, Oxford University Press, 2013. Jayashree Ghosh, A text book of Pharmaceutical Chemistry, S. Chand and Co. Ltd, 1999, 1999 edn.
4. O. LeRoy, Natural and synthetic organic medicinal compounds, Ealemi, 1976.
5. S. Ashutosh Kar, Medicinal Chemistry, Wiley Eastern Limited, New Delhi, 1993.

Reference Books:

1. Foye's Princles of Medicinal Chemistry, Lipincott Williams, Seventh Edition, 2012
2. Burger's Medicinal Chemistry, Drug Discovery and Development, Donald J. Abraham, David P. Rotella, Alfred Burger, Academic press, 2010.
3. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, John M. Beale Jr and John M. Block, Wolters Kluwer, 2011, 12th edn.
4. P.Parimoo, A Textbook of Medical Chemistry, New Delhi: CBS Publishers.1995.
5. S. Ramakrishnan, K. G. Prasannan and R. Rajan, Textbook of Medical Biochemistry, Hyderabad: Orient Longman. 3rd edition, 2001.

Course Outcomes (CO)

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Explain the relationship between drug's chemical structure and its therapeutic properties.	1,3	K1
CO-2	Describe the factors that affect its absorption, distribution, metabolism, and excretion, and hence the considerations to be made in drug design.	2,3	K2
CO-3	Identify different targets for the development of new drugs for the treatment of infectious and GIT.	1,2	K3
CO-4	Designed to give the knowledge of different theories of drug actions at molecular level.	3	K3
CO-5	Predict a drugs properties based on its structure.	4	K4

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PECH11C	MEDICINAL CHEMISTRY	60	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	3	3	3	2
CO-2	3	3	3	3	2	3	3	3	3	2
CO-3	3	3	3	3	2	3	3	3	2	2
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	3	3	2	2	2	3	3	3	3	3

S-Strong (3), M-Medium (2), L-Low (1)

Prepared by :Dr.S.Brillians Revin

Checked by: Dr.S.Brillians Revin

Head of the Department

Semester – I	Water Treatment Technology		24PICH11			
EC-II-IDC			L	T	P	C
Hrs./Week: 2	Hrs./Semester : 30	Marks :50	2	-	-	2

General Objective:

1. To understand the necessity for treatment of water.
2. To have knowledge on WHO guidelines about drinking water.
3. To have knowledge on water treatment technology.
4. To have knowledge on membrane technology and water treatment plant.
5. To familiarize on the waste water generation and remediation.

Learning Outcome (LO)

LO	The learners will be able to:
LO-1	Understand the overview of wastewater.
LO-2	Knowledge on important of water treatment technology.
LO-3	Learn the principles of water treatment technics.
LO-4	Learn the principles of wastewater treatment technics.
LO-5	Learn about Advanced Water Treatment Techniques.

Unit 1 - Introduction to Wastewater.

Overview of wastewater systems, urban water cycle and wastewater generation, Design considerations for wastewater treatment plants, Fundamentals of wastewater, characteristics and regulations.

Unit 2 - Introduction to Water Treatment

Objectives and necessity for treatment of water. Sources of water and their characteristics. Micro-organisms in natural water purification systems. Drinking water quality requirements as per BIS & WHO guidelines. Sources of water pollution, diseases and control. Public health significance.

Unit 3 - Water Softening Techniques and Treatments

Water Softening Techniques-Zeolite Process, Ion Exchange Resin, Lime- Soda Process, Reverse Osmosis (RO). Water Treatment-Coagulation and Flocculation, Sedimentation and Filtration.

Unit 4 - Wastewater Treatments

Preliminary Treatment- Screening and grit removal, Oil and grease separation. Primary Treatment-sedimentation, Activated sludge process. Secondary Treatment and Sludge Handling- Sludge production, treatment, and disposal, anaerobic digestion and biogas utilization.

Unit 5 - Advanced Water Treatment Techniques

Membrane technologies- microfiltration, ultrafiltration, Nano filtration. Theory of filtration and basic principles, Classification of filters used in water treatment, Filters washing technique/backwash, design of slow and rapid sand filters.

Textbooks:

1. "Environmental Engineering" by Peavy, Rowe, and Tchobanoglous.
2. "Water Quality Engineering: Physical/Chemical Treatment Processes" by Lawler and Benjamin.

Reference Books:

1. Davis, Mackenzie L. Water and Wastewater Engineering: Design Principles and Practice, 2nd Edition.
2. Metcalf and Eddy. Wastewater Engineering: Treatment and Resource Recovery, Fifth Edition.
3. Tchobanoglous, G., et al. Wastewater Engineering: Treatment, Disposal, and Reuse, Fifth Edition.

Course Outcomes (CO)

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand the necessity for treatment of water.	2,3	K2
CO-2	Correlate on WHO guidelines about drinking water.	2,3	K3
CO-3	Understand on water treatment technology.	3	K2
CO-4	Understand on membrane technology and water treatment plant.	3	K2
CO-5	Familiarize on remediate the polluted water and wastewater.	3	K4

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 – Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
I	24PICH11	Water Treatment Technology				30	2			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	1	3	2	-	3	2	3	2	2
CO-2	3	1	3	3	-	3	2	3	2	2
CO-3	3	2	3	3	-	3	3	3	3	3
CO-4	3	2	3	3	1	3	3	3	3	3
CO-5	3	2	3	3	2	3	3	3	3	3

S-Strong (3), M-Medium (2), L-Low (1)

Prepared by :Dr.S.B.Mohamed Khalith Checked by: Dr.S.Brillians Revin

Head of the Department

Semester – II	ORGANIC REACTION MECHANISM-II		24PCCH21			
Core-IV			L	T	P	C
Hrs./Week: 5	Hrs./Semester : 75	Marks :100	5	-	-	5

General Objective:

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

Learning Objectives

LO	The learners will be able to:
LO-1	Understand the basic principles of elimination and free radical reaction
LO-2	Outline the suitable reagents for the conversion of selective organic compounds.
LO-3	Analyse the mechanism of various types of organic rearrangement reactions.
LO-4	Correlate the principles of substitution, elimination, and addition reactions.
LO-5	Design new routes to synthesis modern organic compounds.

UNIT I - Elimination and Free Radical Reactions:

Mechanisms: E_2, E_1, and E_1cB mechanisms. Syn- and anti-eliminations. Reactivity: Effect of substrate, attacking bases, leaving group and medium. Stereochemistry of eliminations in acyclic and cyclic systems, pyrolytic elimination. Orientation of the double bond: Hoffmann, Saytzeff rules and Bredt rule.

Free Radical Reactions: Long lived and short-lived radicals – Production of

radicals by thermal and photochemical reactions, Detection and stability of radicals-characteristics of free radical reactions and free radical. Reactions of radicals: polymerization, addition, halogenations, aromatic Substitutions, Reactivity.

UNIT II - Oxidation and Reduction Reactions:

Mechanisms: Direct electron transfer, hydride transfer, hydrogen transfer, displacement, addition- elimination, oxidative and reductive coupling reactions.

Mechanism of oxidation reactions: selenium dioxides, lead tetraacetate, permanganate, osmium tetroxide, oxidation of saturated hydrocarbons, alkyl groups, alcohols, halides and amines.

Reactions involving cleavage of C-C bonds - cleavage of double bonds, oxidative decarboxylation, allylic oxidation, DMSO-Oxalyl chloride (Swern oxidation) and CoreyKim oxidation, dimethyl sulphoxide- dicyclohexyl carbodiimide (DMSO-DCCD).

Mechanism of reduction reactions: Reduction with $NaBH_4$, $LiAlH_4$, DIBAL-H, Birch reduction, Et_3SiH, Bu_3SnH, Wolff-Kishner, Clemmenson reduction.

UNIT III - Rearrangements:

Rearrangements to electron deficient carbon: Mechanism and application: Pinacolpinacolone rearrangements - Wagner-Meerwein, Demjanov, Dienone-phenol and Wolff rearrangements.

Rearrangements to electron deficient nitrogen: Mechanism and application: Hofmann, Curtius, Schmidt, Lossen, Beckmann. Rearrangements to electron deficient oxygen: Baeyer-Villiger oxidation and Dakin rearrangements.

Rearrangements to electron rich atom: Mechanism and application: Favorskii, [1,2]-Wittig and [2,3]-Wittig rearrangements. Intramolecular rearrangements – Claisen, Cope, oxy-Cope Benzidine rearrangements.

UNIT IV - Addition to Carbon Multiple Bonds:

Mechanisms: (a) Addition to carbon-carbon multiple bonds- Addition reactions involving electrophiles, nucleophiles, free radicals, carbenes and cyclic mechanisms - Orientation and reactivity, hydrogenation of double

and triple bonds, Michael reaction, addition of oxygen and Nitrogen.

(b) Addition to carbon-hetero atom multiple bonds: Mannich reaction- Addition to acids, esters, nitrites - Wittig reaction - Mechanism of condensation reactions involving enolates: Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.

UNIT V - Reagents and Modern Synthetic Reactions:

Reagents: Preparation and synthetic application of Lithium diisopropylamide (LDA), Azobisisobutyronitrile (AIBN), Sodium cyanoborohydride $Na[BH_3(CN)]$, metaChloroperoxybenzoic acid (mCPBA), diazomethane, Triethylamine (TEA), Trichloroethylsilicate, N-bromosuccinimide (NBS), Trifluoroacetic acid (TFA), Tetramethyl piperiridin- 1-yl-oxyl (TEMPO). $TiCl_3$, $NaIO_4$, Pyridinium chlorochromate (PCC), Pyridinium dichromate (PDC).

Modern Synthetic Reactions: Mechanism and its applications: Heck-Stille- Fukuyama Kumada - Hiyama- Negishi – Buchwald Hartwig reaction.

Textbooks:

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

Reference Books:

1. S. H. Pine, *Organic Chemistry*, 5th edn, McGraw Hill International Editionn, 1987.
2. L. F. Fieser and M. Fieser, *Organic Chemistry*, Asia Publishing House,Bombay, 2000.
3. E.S. Gould, *Mechanism and Structure in Organic Chemistry*, Holt, Rinehart and Winston Inc., 1959.
4. T. L. Gilchrist, *Heterocyclic Chemistry*, Longman Press, 1989.

5. J. A. Joule and K. Mills, *Heterocyclic Chemistry*, 4th ed., John-Wiley, 2010.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand the basic principles of aromaticity of organic and heterocyclic compounds.	3	K2
CO-2	Identify the suitable reagents for the conversion of selective organic compounds.	3	K3
CO-3	Analyse the mechanism of various types of organic rearrangement reactions.	3	K4
CO-4	Correlate the principles of substitution, elimination, and addition reactions.	3	K5
CO-5	Design new routes to synthesis modern organic compounds.	3	K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PCCH21	ORGANIC REACTION MECHANISM-II	75	5

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	2	3	3	3	3	3
CO-2	3	3	3	2	2	3	3	3	3	3
CO-3	3	3	3	2	2	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3

S-Strong (3), M-Medium (2), L-Low (1)

Prepared by :Dr.M.Fathima Shahana Checked by: Dr.S.Brillians Revin

Head of the Department

Semester – II	PHYSICAL CHEMISTRY-I		24PCCH22			
Core-V			L	T	P	C
Hrs./Week: 5	Hrs./Semester : 75	Marks :100	4	1	-	4

General Objective:

1. To recall the fundamentals of thermodynamics and the composition of partial molar quantities.
2. To understand the classical and statistical approach of the functions
3. To compare the significance of Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein
4. To correlate the theories of reaction rates for the evaluation of thermodynamic parameters.
5. To study the mechanism and kinetics of reactions.

Learning Outcome (LO)

LO	The learners will be able to:
LO-1	Explain the classical and statistical concepts of thermodynamics.
LO-2	Compare and correlate the thermodynamic concepts to study the kinetics ofchemical reactions.
LO-3	Discuss the various thermodynamic and kinetic determination.
LO-4	Evaluate the thermodynamic methods for real gases ad mixtures.
CO-5	Compare the theories of reactions rates and fast reactions.

UNIT I - Classical Thermodynamics:

Partial molar properties-Chemical potential, Gibb's- Duhem equation-binary and ternary systems. Determination of partial molar quantities. Thermodynamics of real gases - Fugacity- determination of fugacity by graphical and equation of state methods-dependence of temperature, pressure and composition. Thermodynamics of ideal and non-ideal binary mixtures, Duhem - Margulus equation applications of ideal and non-ideal mixtures. Activity and activity coefficients-standard states - determination-vapour pressure, EMF and freezing point methods.

UNIT II - Statistical Thermodynamics:

Introduction of statistical thermodynamics concepts of thermodynamic - distribution of distinguishable and non-distinguishable particles, ensembles particles. Maxwell - Boltzmann, Fermi Dirac & Bose-Einstein Statistics. Partition functions-evaluation of translational, vibrational and rotational partition functions for monoatomic, diatomic and polyatomic ideal gases. Thermodynamic functions in terms of partition functions. Statistical approach to Thermodynamic properties: pressure, internal energy, entropy, enthalpy, Gibb's function, Helmholtz function residual entropy, equilibrium constants and equipartition principle. Heat capacity of mono and di atomic gases-ortho and para hydrogen.

UNIT III - Irreversible Thermodynamics:

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

UNIT IV - Kinetics of Reactions:

Theories of reactions-effect of temperature on reaction rates, collision theory of reaction rates, Unimolecular reactions -Lindeman 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. Factors determine the reaction rates in solution - Primary salt effect and Secondary salt effect, Homogeneous catalysis- acid- base catalysis-mechanism of acid base catalyzed reactions-Bronsted catalysis law, enzyme catalysis-Michelis-Menton catalysis.

UNIT V - Kinetics of complex and fast reactions:

Kinetics of complex reactions, reversible reactions, consecutive reactions, parallel reactions, chain reactions. Chain reactions-chain length, kinetics of $H_2 - Cl_2$ & $H_2 - Br_2$ reactions (Thermal and Photochemical reactions) -

Rice Herzfeld mechanism. Study of fast reactions-relaxation methods-temperature and pressure jump methods electric and magnetic field jump methods -stopped flow flash photolysis methods and pulse radiolysis.

Textbooks:

1. J. Rajaram and J.C. Kuriacose, Thermodynamics for Students of Chemistry, 2nd edition,S.L.N.Chand and Co., Jalandhar, 1986.
2. I.M. Klotz and R.M. Rosenberg, Chemical thermodynamics, 6th edition, W.A. BenjaminPublishers, California, 1972.
3. M.C. Gupta, Statistical Thermodynamics, New Age International, Pvt. Ltd., New Delhi, 1995.
4. K.J. Laidler, Chemical Kinetics, 3rd edition, Pearson, Reprint - 2013.
5. J. Rajaram and J.C. Kuriokose, Kinetics and Mechanisms of chemical transformation,M acmillan India Ltd, Reprint - 2011.

Reference Books:

1. D.A. Mcqurrie And J.D. Simon, Physical Chemistry - A Molecular Approach, Viva Books Pvt. Ltd., New Delhi, 1999.
2. R.P. Rastogi and R.R. Misra, Classical Thermodynamics, Vikas Publishing, Pvt. Ltd., New Delhi, 1990.
3. S.H. Maron and J.B. Lando, Fundamentals of Physical Chemistry, Macmillan Publishers, New York, 1974
4. K.B. Ytsiimiriski, “Kinetic Methods of Analysis”, Pergamom Press,1996.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Explain the classical and statistical concepts of thermodynamics.	1,3	K2
CO-2	Compare and correlate the thermodynamic concepts to study the kinetics ofchemical reactions.	1,3	K2
CO-3	Discuss the various thermodynamic and kinetic determination.	2,3	K3
CO-4	Evaluate the thermodynamic methods for real gases ad mixtures.	1,2,3	K4
CO-5	Compare the theories of reactions rates and fast reactions.	2,3	K3

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PCCH22	PHYSICAL CHEMISTRY-I	75	5

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	2	3	-	-	3	-	3	1	1
CO-2	3	2	3	-	-	3	1	3	1	-
CO-3	3	3	3	-	-	3	-	3	2	2
CO-4	3	3	3	1	2	3	1	3	2	2
CO-5	3	3	3	1	2	3	-	3	2	-

S-Strong (3), M-Medium (2), L-Low (1)

Prepared by :Dr.Mohamed Khalith

Checked by: Dr.S.Brillians Revin
Head of the Department

Semester – II	INORGANIC CHEMISTRY PRACTICAL-I		24PCCH2P1			
Core-P-III			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :50	-	-	4	2

General Objective:

1. To understand and enhance the visual observation as an analytical tool for the quantitative estimation of ions.
2. To recall the principle and theory in preparing standard solutions.
3. To train the students for improving their skill in estimating the amount of ion a accurately present in the solution.

Learning outcome (LO)

LO	The learners will be able to:
LO-1	Identify the anions and cations present in a mixture of salts.
LO-2	Apply the principles of semi micro qualitative analysis to categorize acid radicals and basic radicals.
LO-3	Acquire the qualitative analytical skills by selecting suitable confirmatory tests and spot tests.
LO-4	Choose the appropriate chemical reagents for the detection of anions and cations.
LO-5	Identify the group for cations present in a mixture of salts.

UNIT I - Analysis of mixture of cations:

Analysis of a mixture of four cations containing two common cations and two rare cations. Cations to be tested.

Group-I : W, Tl and Pb.

Group-II : Se, Te, Mo, Cu, Bi and Cd.

Group-III: Tl, Ce, Th, Zr, V, Cr, Fe, Ti and U.

Group-IV : Zn, Ni, Co and Mn.

Group-V : Ca, Ba and Sr.

Group-VI : Li and Mg..

Textbooks:

1. Jeya Rajendran, Microanalytical Techniques in Chemistry: Inorganic Qualitative Analysis, United global publishers, 2021.
2. V. V. Ramanujam, *Inorganic Semimicro Qualitative Analysis*; 3rded., The National Publishing Company, Chennai, 1974.
3. *Vogel's Text book of Inorganic Qualitative Analysis,* 4thed., ELBS, London.

Reference Books:

1. G. Pass, and H. Sutcliffe, *Practical Inorganic Chemistry*; Chapman Hall, 1965.
2. W. G. Palmer, Experimental *Inorganic Chemistry*; Cambridge University Press, 1954.

Course Outcomes

CO	**Upon completion of this course, students would have learned to:**	**PSOs Addressed**	**Cognitive Level**
CO-1	Identify the anions and cations present in a mixture of salts.	1,3	K3
CO-2	Choose the appropriate chemical reagents for the detection of anions and cations.	3	K3
CO-3	Identify the group for cations present in a mixture of salts.	3	K3
CO-4	Apply the principles of semi micro qualitative analysis to categorize acid radicals and basic radicals.	1,3	K4
CO-5	Acquire the qualitative analytical skills by selecting suitable confirmatory tests and spot tests.	1,3	K5

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PCCH2P1	INORGANIC CHEMISTRY PRACTICAL-I	60	2

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	-	-	3	-	3	1	3
CO-2	3	3	3	-	-	3	-	3	-	3
CO-3	3	3	3	-	-	3	-	3	-	3
CO-4	3	3	3	2	1	3	-	3	3	1
CO-5	3	3	3	1	-	3	1	3	3	1

S-Strong (3), M-Medium (2), L-Low (1)

Prepared by :Dr.P.Anvar Kasim

Checked by: Dr.S.Brillians Revin
Head of the Department

Semester – II	ORGANIC CHEMISTRY PRACTICAL II		24PCCH2P2			
Core-P-IV			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :50	-	-	4	2

General Objective:

1. To understand the concept of quantitative estimation of Organic compounds.
2. To develop analytical skill in the estimation of Organic compounds.
3. To construct suitable experimental setup for the organic preparations involving two stages.
4. To experiment different purification and drying techniques for the compound processing.

Learning Objectives

LO	The learners will be able to:
LO-1	Understand the basic principles of organic quantitative analysis.
LO-2	Explain the method of estimation of organic compounds.
LO-3	Develop the skills to estimate organic compounds.
LO-4	Develop the skills to handle corrosive and toxic chemicals in organicpreparations.
LO-5	Categorize organic reactions and their mechanisms relevant to organicPreparations.

UNIT I - Estimations:

1. Estimation of Phenol (bromination)
2. Estimation of Aniline (bromination)
3. Estimation of Aromatic nitro groups (reduction)
4. Estimation of Glycine (acidimetry)
5. Estimation of Formalin
6. Estimation of Acetyl group in ester (alkalimetry).
7. Estimation of Hydroxyl group (acetylation)
8. Estimation of Amino group (acetylation)

UNIT II - Two stage preparations:

9. *p*-Bromoaniline from acetanilide
10. *p*-Nitroaniline from acetanilide
11. 1,3,5-Tribromobenzene from aniline
12. Benzilic acid from benzoin
13. *m*-Nitroaniline from nitrobenzene
14. *m*-Nitrobenzoic acid from methyl benzoate.
15. Acetyl salicylic acid from methyl salicylate

Note: All the students must submit the TLC for preparation and a photocopy must be pasted in records

Textbooks:

1. A.I. Vogel, Elementary Practical Organic Chemistry: Small Scale Preparations, Qualitative Organic Analysis, Quantitative Organic Analysis, Pearson Education, 2011.
2. F.G. Mann and B.C. Saunders, Practical Organic Chemistry, 4th edn, Pearson Education India, 2009.
3. K. Bansal Raj, Laboratory Manual of Organic Chemistry, New Age International, 2009.
4. V. Venkateswaran, R. Veeraswamy and A. R. Kulandaivelu, Basic Principles of Practical Chemistry, Sultan Chand & Sons, 2004.
5. V.K. Ahluwalia, and R. Aggarwal, Comprehensive Practical Organic Chemistry, Universities Press, 2004**.**

Reference Books:

1. R.G. Engel, D.L. Pavia, G.M. Lampman and G.S. Kriz, *A Microscale approach to Organic Laboratory*, 5th edition, Paperback – International Edition, 2012.
2. P.B. Cranwell, L.M. Harwood and C.J. Moody, *Experimental Organic Chemistry*, 3rd edn, Wiley-Blackwell**,** 2017.
3. J. Leonard, B. Lygo and G. Procter, *Advanced Practical Organic Chemistry*, 3rd edn, CRC Press, 2013.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand the basic principles of organic quantitative analysis.	2.3	K2
CO-2	Apply the skills to estimation of organic compounds.	2,3	K3
CO-3	Categorize organic reactions and their mechanisms relevant to organic Preparations.	2,3	K4
CO-4	Evaluate the skills to handle corrosive and toxic chemicals in organic preparations.	3	K5
CO-5	Develop the method of estimation of organic compounds	3	K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 – Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PCCH2P2	ORGANIC CHEMISTRY PRACTICAL II	60	2

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	2	3	3	3
CO-2	3	3	3	2	3	3	2	3	3	3
CO-3	3	3	3	2	2	3	2	3	3	3
CO-4	3	3	3	2	2	3	3	3	3	3
CO-5	3	3	3	3	2	3	3	3	3	3
Total	**15**	**15**	**15**	**12**	**12**	**15**	**12**	**15**	**15**	**15**
Average	**3**	**3**	**3**	**2.4**	**2.4**	**3**	**2.4**	**3**	**3**	**3**
	S-Strong (3), M-Medium (2), L-Low (1),									

S-Strong (3), M-Medium (2), L-Low (1)

Prepared by:Dr.M.Fathima Shahana

Checked by: Dr.S.Brillians Revin

Head of the Department

Semester – II	MATERIAL SCIENCE		24PECH21A			
EC-IIIA			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

1. To understand the crystal structure, growth methods and X-ray scattering.
2. To explain the optical, dielectric and diffusion properties of crystals.
3. To recognize the basis of semiconductors, superconductivity materials and magnets.
4. To study the synthesis, classification and applications of nanomaterials.
5. To learn about the importance of materials used for renewable energy conversion.

Learning Objectives

LO	The learners will be able to:
LO-1	Understand the important points of crystallography
LO-2	Analyze the new technologies of crystal growth
LO-3	Learn the properties of crystals
LO-4	Know the details of special materials and its applications
LO-5	Study about the materials which are useful for renewable energy

UNIT I - Crystallography: Symmetry - unit cell and Miller indices - crystal systems - Bravais lattices - point groups and space groups - X-ray diffraction-Laue equations-Bragg's law-reciprocal lattice and its application to geometrical crystallography. Crystal structure–powder and single crystal applications.

UNIT II - Crystal growth methods: Nucleation–equilibrium stability and metastable state. Single crystal –Low and high temperature, solution growth– Gel and sol-gel. Crystal growth methods- nucleation– equilibrium stability and metastable state. Melt growth - Bridgeman- Stockbarger and Czochralski methods.

UNIT III - Properties of crystals: Optical studies - Electromagnetic spectrum (qualitative) refractive index – reflectance – transparency, translucency and opacity. Types of luminescence – photo-, electro-, and injection luminescence, LEDs – organic, Inorganic and polymer LED materials - Applications. Dielectric studies- Polarisation - electronic, ionic, orientation, and space charge polarisation.

UNIT IV - Special Materials: Superconductivity: Meissner effect, Critical temperature and critical magnetic Field, Type I and II superconductors, BCS theory-Cooper pair, Applications. Soft and hard magnets – Domain theory -Hysteresis Loop-Applications. Magneto and gian magneto resistance. Ferro, ferri and antiferromagnetic materials- applications.

UNIT V - Materials for Renewable Energy Conversion: Solar Cells: Organic, bilayer, bulk heterojunction, polymer, perovskite based. Solar energy conversion: lamellar solids, thin films and dye-sensitized photo voltaic cells. Photochemical activation and splitting of water, CO2 and N2. Manganese based photo systems for water-splitting.

Textbooks:

1. S. Mohan and V. Arjunan, Principles of Materials Science, MJP Publishers, 2016.
2. Arumugam, Materials Science, Anuradha Publications, 2007.
3. Giacavazzo et. al., Fundamentals of Crystallography, International Union of Crystallography. Oxford Science Publications, 2010
4. Woolfson, An Introduction to Crystallography, Cambridge University Press, 2012.
5. James F. Shackelford and Madanapalli K. Muralidhara, Introduction to Materials Science for Engineers. 6th ed., PEARSON Press, 2007.

Reference Books:

1. Suggested Readings 1. M.G. Arora, Solid State Chemistry, Anmol Publications, New Delhi, 2001.
2. R.K. Puri and V.K. Babbar, Solid State Physics, S Chand and Company Ltd, 2001.
3. C. Kittel, Solid State Physics, John-Wiley and sons, NY, 1966.
4. H.P. Meyers, Introductory Solid State Physics, Viva Books Private Limited, 1998.
5. A.R. West, Solid State Chemistry and Applications, John-Wiley and sons, 1987.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand and recall the synthesis and characteristics of crystal structures, semiconductors, magnets, nanomaterials and renewable energy materials.	1,3	K2
CO-2	Integrate and assess the structure of different materials and their properties.	3	K4
CO-3	Analyze and identify new materials for energy applications.	2,3,5	K4
CO-4	Explain the importance of crystal structures, piezoelectric and pyroelectric materials, nanomaterials, hard and soft magnets, superconductors, solar cells, electrodes, LED uses, structures and synthesis.	3,5	K2
CO-5	Design and develop new materials with improved property for energy applications.	3	K5

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PECH21A	MATERIALSCIENCE	60	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	2	3	2	1	3	3	2	3	3
CO-2	3	3	3	2	3	3	2	3	3	3
CO-3	3	2	3	3	2	3	2	3	3	3
CO-4	3	3	3	3	2	3	3	2	3	3
CO-5	3	3	3	3	1	3	2	3	3	3

S-Strong (3), M-Medium (2), L-Low (1)

Prepared by :Dr.S.Brillians Revin

Checked by: Dr.S.Brillians Revin

Head of the Department

Semester – II	PHARMOCOGNOSY AND PHYTOCHEMISTRY		24PECH21B			
EC-IIIB			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

1. To develop the knowledge of natural products, biological functions and pharmacological uses.
2. To develop knowledge on primary and secondary metabolites and their sources.
3. To understand the concepts of isolation methods and separation of bioactive compounds.
4. To provide the knowledge on selected glycosides and marine drugs.
5. To familiarize the guidelines of WHO and different sampling techniques.

Learning Objectives (LO)

LO	The learners will be able to:
LO-1	Recall the sources of natural medicines and analysis of crude drugs.
LO-2	Understand the methods of evaluation based on various parameters.
LO-3	Analyze the isolated drugs.
LO-4	Apply various techniques to discover new alternative medicines.
LO-5	Evaluate the isolated drugs for various pharmacological activities.

UNIT-I: Pharmacognosy and Standardization of Herbal drugs:

Introduction, definition, development classification and Source of Drugs: Biological, mineral, marine, and plant tissue cultures. Study of pharmacognostic of a crude drug. Biosynthesis: Shikimic acid pathway and acetate pathway. Systematic analysis of Crude drugs. Standardization of Herbal drugs. WHO guidelines, Sampling of crude drug, Methods of drug evaluation. Determination of foreign matter, moisture Ash value. Phytochemical investigations-General chemical tests.

UNIT-II: Extraction Techniques:

General methods of extraction, types – maceration, Decoction, percolation, Immersion and soxhlet extraction. Advanced techniques- counter current, steam distillation, supercritical gases, sonication, Micro waves assisted extraction. Factors affecting the choice of extraction process.

UNIT-III: Drugs containing Terpenoids and volatile oils:

Terpenoids: Classification, Isoprene rule, Isolation and separation techniques, General properties Camphor, Menthol, Eucalyptol. Volatile Oils or Essential Oils: Method of Preparations, Classifications of Volatile oils, Camphor oil, Geranium oil, Citral- Structure uses. Pentacyclic triterpenoids: amyrines; taraxasterol: Structure and pharmacological applications.

UNIT-IV: Drugs containing Alkaloids:

Occurrence, function of alkaloids in plants, pharmaceutical applications. Isolation, Preliminary Qualitative tests and general properties. General methods of structural elucidation. Morphine, Reserpine, Papaverine - chemical properties, structure and uses. Papaverine - structure, chemical properties and uses.

UNIT-V: Plant Glycosides and Marine drugs:

Glycosides: Basic ring system, classification, isolation, properties, qualitative analysis. Pharmacological activity of Senna glycosides, Cardiac glycosides-Digoxin, digitoxin, Steroidal saponins glycosides- Diosgenin, hecogenin. Plant pigments: Occurrence and general methods of structure determination, isolation and synthesis of quercetin and cyanidin chloride. Marine drugs -Selected Drug Molecules: Cardiovascular active substances, Cytotoxic compounds, antimicrobial compounds, antibiotic compounds, Anti-inflammatory agents. Marine toxins.

Textbooks:

1. Gurdeep R Chatwal (2016), Organic chemistry of Natural products, Volume I&II, 5th edition, Himalaya publishing House, 2013.
2. S.V.Bhat, B.A. Nagasampagi, M.Sivakumar, Chemistry of Natural Products, Revised edition, Narosa Publishers. 2014.

Reference Books:

1. Jeffrey B. Harborne (2012), Phytochemical methods: A Guide to Modern Techniques of Plant Analysis, 4th edition, Indian reprint, Springer.
2. Ashutoshkar (2007), Pharmacognosy and Pharmacobiotechnology, 2nd edition, New age international (P) limited, New Delhi.

Course Outcomes (CO)

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Explain the sources of natural medicines and analysis of crude drugs.	2,3	K1
CO-2	How to analyze the isolated drugs.	2,3	K1
CO-3	How to apply various techniques to discover new alternative medicines.	2,3	K2
CO-4	Discus the methods of evaluation based on various parameters.	3	K3
CO-5	Evaluate the isolated drugs for various pharmacological activities.	2,3	K4

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PECH21B	PHARMOCOGNOSY AND PHYTOCHEMISTRY	60	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	3	3	3	2
CO-2	3	3	3	3	3	3	3	3	3	2
CO-3	3	3	3	3	2	3	3	3	2	2
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	3	3	2	2	2	3	3	3	2	3

S-Strong (3), M-Medium (2), L-Low (1)

Prepared by:Dr.Mohamed Khalith

Checked by: Dr.S.Brillians Revin
Head of the Department

Semester – II	CHEMISTRY OF NATURAL PRODUCTS		24PECH21C			
EC-IIIC			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

1. To learn the basic concepts and biological importance of biomolecules and natural products.
2. To explain various of functions of carbohydrates, proteins, nucleic acids, steroids and hormones.
3. To understand the functions of alkaloids and terpenoids.
4. To elucidate the structure determination of biomolecules and natural products.
5. To extract and construct the structure of new alkaloids and terpenoids from different methods.

Learning Objectives (LO)

LO	The learners will be able to:
LO-1	Understand the biological importance of chemistry of natural products.
LO-2	Scientifically plan and perform the isolation and characterization of synthesized natural products.
LO-3	Elucidate the structure of alkaloids, terpenoids, carotenoids, falvanoids and anthocyanins.
LO-4	Determine the structure of phytochemical constituents by chemical and physical methods.
LO-5	Interpret the experimental data scientifically to improve biological activity of active components.

UNIT-I: Alkaloids:

Introduction, occurrence, classification, isolation and functions of alkaloids. Classification, general methods of structural elucidation. Chemical methods of structure determination of Coniine, Piperine,

Nicotine, Papaverine. Atropine, Quinine, Belladine, Cocaine, Heptaphylline, Papaverine and Morphine.

UNIT-II: Terpenoids:

Introduction, occurrence, Isoprene rule, classification. General methods of determining structure.. Structure determination of Camphor, Abietic acid, Cadinene, Squalene, Zingiberine. Carotenoids: Introduction, geometrical isomerism, Structure, functions and synthesis of β-carotene and vitamin-A.

UNIT-III: Anthocyanines and flavones:

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

UNIT-IV: Purines and Steroids:

Purines: Introduction, occurrence and isolation of purines. Classification and spectral properties of steroids. biological importance, Structure and synthesis of Uric acid and Caffeine. Steroids: Steroids-Introduction, occurrence, nomenclature, configuration of substituents, Diels' hydrocarbon, stereochemistry, classification, Diels' hydrocarbon, biological importance, colour reactions of sterols, cholesterol-occurrence, tests, physiological activity, biosynthesis of cholesterol from squalene.

UNIT-V: Natural Dyes:

Occurrence, classification, isolation, purification, properties, colour and constitution. Structural determination and synthesis of indigoitin and alizarin.

Textbooks:

1. G. K. Chatwal, Organic Chemistry on Natural Products, Vol. 1, Himalaya Publishing House, Mumbai, 2009.
2. G. K. Chatwal, Organic Chemistry on Natural Products, Vol. 2, Himalaya Publishing House, Mumbai,2009.
3. O. P. Agarwal, Chemistry of Organic Natural Products, Vol. 1, Goel Publishing House, Meerut,1997.

4. O. P. Agarwal, Chemistry of Organic Natural Products, Vol. 2, Goel Publishing House, Meerut,1997.
5. I. L. Finar, Organic Chemistry Vol-2, 5th edition, Pearson Education Asia, 1975.

Reference Books:

1. L. Finar, Organic Chemistry Vol-1, 6thedition, Pearson Education Asia, 2004.
2. Pelletier, Chemistry of Alkaloids, Van Nostrand Reinhold Co,2000.
3. Shoppe, Chemistry of the steroids, Butterworthes, 1994.
4. I. A. Khan, and A. Khanum. Role of Biotechnology in medicinal & aromatic plants, Vol 1 and Vol 10, Ukkaz Publications, Hyderabad, 2004.

Course Outcomes (CO)

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Explain the biological importance of chemistry of natural products.	2,3	K1
CO-2	Determine the structure of phytochemical constituents by chemical and physical methods.	2,3	K2
CO-3	Predict and perform the isolation and characterization of synthesized natural products.	2,3	K3
CO-4	Clarify the structure of alkaloids, terpenoids, carotenoids, falvanoids and anthocyanins.	3	K3
CO-5	Interpret the experimental data scientifically to improve biological activity of active components.	2,3	K4

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PECH21C	CHEMISTRY OF NATURAL PRODUCTS	60	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	3	3	3	2
CO-2	3	3	3	3	3	3	3	3	3	2
CO-3	3	3	3	3	2	3	3	3	2	2
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	3	3	2	3	3	3	3	3	2	2

S-Strong (3), M-Medium (2), L-Low (1)

Prepared by:Dr.Mohamed Khalith

Checked by: Dr.S.Brillians Revin
Head of the Department

Semester – II	ANALYTICAL BIOCHEMISTRY		24PICH21			
EC-IV-IDC			L	T	P	C
Hrs./Week: 2	Hrs./Semester : 30	Marks :50	2	-	-	2

General Objective:

1. Understand the concepts of immunoassay
2. Outline the enzyme assay methods
3. Understand the carbohydrate analysis
4. Explain the aminoacid properties and analysis
5. Acquire the knowledge of general methods of protein quantification

Learning Objectives

LO	The learners will be able to:
LO-1	Understand the basic principles of analytical biochemistry
LO-2	Outline the principle of spectroscopy.
LO-3	Apply various separation methods using chromatography techniques
LO-4	Analyse the principle and application of various instruments
LO-5	Evaluate various types and detection of radioisotopes

UNIT I - PRINCIPLES OF ANALYTICAL BIOCHEMISTRY:

Selection of methods – Instrumental methods – Physiological methods, Assay kits. Quality of data – errors – Random and systematic errors – Assessment – Quality assurance – Calibration – Graphical representation.

UNIT II - SPECTROSCOPY

Principle and applications of Colorimetry, Spectrophotometry and Flame Photometry – Principle, Instrumentation and Applications.

UNIT-III: SEPARATION METHODS

Rf values, Factors affecting Rf values, Experimental procedures of Thin layer Chromatography and Paper Chromatography- Choice of paper- Choice of adsorbents- solvent systems- Preparation of plates- developments of chromatogram- Detection of the spots- Applications of

TLC and Paper inseparation of carbohydrates and amino acids.

UNIT IV - ELECTROANALYTICAL METHODS

Principle and applications – Conductometric, Columetry, voltammetry-cyclic voltammetry, differential pulse voltammetry, linear sweep voltammetry.

UNIT V - RADIOISOTOPES

Types of radioisotopes – detection and measurement – Geiger, scintillation – Autoradiography- biochemical uses- Traces, isotope dilution analysis, radio activation analysis.

Textbooks:

1. Analytical biochemistry, Third Edition, David, J. Holme and Hazel Peck,Pearson education, 1998.
2. Introduction to Practical Biochemistry, Gyorgy Hegyl Et.al., 2013.

Reference Books:

1. Principles and techniques of biochemistry and molecular biology, 7th Edition, Keith Wilson, John Walker, Cambridge University press, 2010.
2. Bioanalytical Techniques" by Abhilasha Shourie and Shilpa S Chapadgaonkar, 2015.
3. Bioanalytical Techniques" by M L Srivastava Immunoassay and Other Bioanalytical Techniques" by Jeanette M van Emon, 2015.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand the basic principles of analytical biochemistry	3	K2
CO-2	Outline the principle of spectroscopy.	2,3	K2
CO-3	Apply various separation methods using chromatography techniques	2,3	K3
CO-4	Analyse the principle and application of various instruments	2,3	K4
CO-5	Evaluate various types and detection of radioisotopes	3	K5

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course					Hours			Credits
II	24PICH21	ANALYTICAL BIOCHEMISTRY					30			2
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	3	3	3	3
CO-2	3	3	3	3	3	3	3	3	2	3
CO-3	3	3	3	3	3	3	3	3	2	2
CO-4	3	3	3	2	2	3	3	3	3	2
CO-5	3	3	3	2	2	3	3	3	3	3
Total	**15**	**15**	**15**	**13**	**13**	**15**	**15**	**15**	**13**	**3**
Average	**3**	**3**	**3**	**2.6**	**2.6**	**3**	**3**	**3**	**2.6**	**2.6**
	S-Strong (3), M-Medium (2), L-Low (1),									

S-Strong (3), M-Medium (2), L-Low (1)

Prepared by:Dr.S.Brillians Revin Checked by: Dr.S.Brillians Revin

Head of the Department

Semester – II	GREEN CHEMISTRY		24PSCH21			
SEC-I			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

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

Learning Objectives

LO	The learners will be able to:
LO -1	Expand the knowledge on the concept of Green Chemistry.
LO -2	Give broad understanding the usage of green solvents
LO -3	Develop in depth knowledge of catalytic processes.
LO -4	Apply the principles of green using organic synthesis
LO -5	Design and synthesize new organic compounds and characterize by various instrumentation

UNIT I – Principles of Green Chemistry

Introduction - Need for Green Chemistry. Goals of Green Chemistry. Limitations/ of Green Chemistry. Chemical accidents, terminologies, Internationall green chemistry organizations and Twelve principles of Green Chemistry with examples.

UNIT II – Green Synthesis, Catalyst and Reagent

Choice of starting materials, reagents, catalysts and solvents in detail, Green chemistry in day today life. Designing green synthesis- green

reagents: dimethyl carbonate. Green solvents: Water, Ionic liquids- criteria, general methods of preparation, effect on organic reaction. Supercritical carbon dioxide- properties, advantages, drawbacks and a few examples of organic reactions in sc CO_2. Green synthesis-adipic acid and catechol.

UNIT III – Green Synthesis Catalyst

Environmental pollution, Green Catalysis-Acid catalysts, Oxidation catalysts, Basic catalysts, Polymer supported catalysts- Polystyrene aluminum chloride, polymeric super acid catalysts, Poly supported photosensitizers.

UNIT IV – Chemical Reactions in Green

Phase transfer catalysis in green synthesis-oxidation using hydrogen peroxide, crown ethers-esterification, saponification, anhydride formation, Elimination reaction, Displacement reaction. Applications in organic synthesis.

UNIT V – Instrumentation method

Microwave induced green synthesis-Introduction, Instrumentation, Principle and applications. Sonochemistry – Instrumentation, Cavitation theory - Ultra sound assisted green synthesis and Applications.

Textbooks:

1. Ahluwalia, V.K. and Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers, 2005.
2. W. L. McCabe, J.C. Smith and P. Harriott, Unit Operations of Chemical Engineering, 7th edition, McGraw-Hill, NewDelhi, 2005.
3. J. M. Swan and D. St. C. Black, Organometallics in Organic Synthesis, Chapman Hall,1974.
4. V. K. Ahluwalia and R. Aggarwal, Organic Synthesis: Special Techniques, Narosa Publishing House, New Delhi,2001.
5. A. K. De, Environmental Chemistry, New Age Publications,2017.

Reference Books:

1. Anastas, P.T. and Warner, J.K. Oxford Green Chemistry -Theory and Practical, University Press, 1998
2. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker, 2001
3. Cann, M.C. and Connely, M.E. Real-World Cases in Green Chemistry, American Chemical Society, Washington, 2000
4. Ryan, M.A. and Tinnesand, M., Introduction to Green Chemistry, American Chemical Society Washington, 2002. Chandrakanta Bandyopadhyay, An Insight into Green Chemistry, Books and Allied (P) Ltd, 2019.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand the basic chemical techniques used in conventional industrial preparations andin green innovations.	1	K2
CO-2	Understand the various techniques used in chemical industries and in laboratory.	1,4	K2
CO-3	Compare the advantages of organic reactions assisted by renewable energy sourcesand non-renewable energy sources.	1,2,5	K3
CO-4	Evaluate the principles of PTC, ionic liquid, microwave and ultrasonic assisted organic synthesis.	3,4	K5
CO-5	Design and Synthesize new organic compounds by green methods.	3,5	K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 – Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PSCH21	GREENCHEMISTRY	60	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	1	3	2	3	3	3
CO-2	3	3	3	3	3	3	3	3	3	3
CO-3	3	2	3	3	2	3	3	3	3	3
CO-4	3	3	3	3	3	3	2	3	3	3
CO-5	3	1	3	3	3	3	3	3	3	3

S-Strong (3), M-Medium (2), L-Low (1)

Prepared by:Dr.S.Brillians Revin

Checked by: Dr.S.Brillians Revin

Head of the Department