HAJEE KARUTHA ROWTHER HOWDIA COLLEGE

(An Autonomous Institution Affiliated to Madurai Kamaraj University, Madurai.)

Re Accredited with A++ Grade by NAAC (3rd Cycle)

Uthamapalayam, Theni District. Pin Code: 625 533.

DEPARTMENT OF CHEMISTRY

MASTER OF SCIENCE – CHEMISTRY

SYLLABUS

Choice Based Credit System – CBCS

(As per TANSCHE/MKU Guidelines)

with

Outcome Based Education (OBE)

(with effect from Academic Year 2023 -2024

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College Vision and Mission

Vision

Our vision is to provide the best type of higher education to all, especially to students hailing from minority Muslim commUNITy, rural agricultural families and other deprived, under privileged sections of the society, inculcating the sense of social responsibility in them. Our college is committed to produce talented, duty-bound citizens to take up the challenges of the changing times.

Mission

Our mission is to impart and inculcate social values, spirit of service and religious tolerance as envisioned by our beloved Founder President Hajee Karutha Rowther.

The Vision beckons ..... the Mission continues forever.

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Department Vision and Mission

Vision

- Generate knowledgeable Chemists and scientists to enhance services to the society.

Mission

- Enable the students to excel in the subject, research and services.
- Elevate students to international standards.
- Encourage the students to take up competitive examinations.

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR UNDERGRADUATE EDUCATION	
Programme	**M.Sc.**
Programme Code	
Duration	**2 years for PG**
Programme Outcomes (Pos)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment.
	PO7: Entrepreneurial Skill Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society. **PO 9 Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures anda global perspective. **PO 10: Moral and ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one's life.
Programme Specific Outcomes(PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagementwith others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

Programme Scheme

Eligibility

A candidate who has passed B.Sc., Chemistry as the major subject with physics as one allied. The other allied subject may be Mathematics or Botany or Zoology is eligible for the Master of Science – Chemistry Degree.

Duration of the Course:

M.Sc., Chemistry – 2 years (4 Semesters).

Medium of instruction:

English.

For Programme Completion

A Candidate shall complete:

- Part III - Core papers in semesters I, II, III and IV respectively
- Part III - Elective papers in semesters I, II, III and IV respectively
- Part IV - Non- Major Elective papers in semester II and III respectively
- Part IV - Skill Enhancement Course papers in semester II, III and IV respectively
- Part V – Extension activity in semester IV respectively

Scheme of Examinations under Choice Based Credit System

Term End Examinations (TEE)	- 75 Marks
Continuous Internal Assessment Examinations (CIAE)	- 25 Marks
Total	- 100 Marks

Pattern of Continuous Internal Assessment Examinations (CIAE)

Average of Two Internal Tests (each 20 marks)	- 20 Marks
Seminar / Quiz	- 05 Marks
Total	- 25 Marks

Practical Examination

Internal	– 40 marks
External	– 60 marks
Total	- 100 Marks

Pattern of Term End Examinations

(Max. Marks: 75 / Time: 3 Hours)

External Examinations Question Paper Pattern

Section – A (10 X 1 = 10 Marks)

Answer ALL the questions.

- Questions 1 - 10
- Two questions from each UNIT

- Multiple choice questions and each question carries Four choices

Section – B (5 X 7 = 35 Marks)

Answer ALL the questions, choosing either a or b.

- Questions 11 - 15
- Two questions from each UNIT (either…. or…. type)
- Descriptive Type

Section – C (3 X 10 = 30 Marks)

- Answer ALL the questions, choosing either a or b.
- Questions 16 – 18
- Descriptive Type

Passing Marks

A Candidate passes the M.Sc., Chemistry degree by scoring a minimum of 50% of Marks (internal + external) in each course of the Programme. No minimum marks for internal assessment.

- Minimum 34 Marks (45%) for External Examination in Theory Courses.
- Minimum 27 Marks (45%) for External Examination in Practical

M.Sc., CHEMISTRY

Course Code	First Year Semester-I	Credit	Hours per week (L/T/P)
23PCHCC11	CC1 – Organic Reaction Mechanism-I	5	6(5L + 1T)
23PCHCC12	CC2 – Structure and Bonding in Inorganic Compounds	5	6(5L + 1T)
23PCHCC1P	CC3 – Organic Chemistry Practical	4	6(5L + 1T)
23PCHDE11	Elective I (Generic / Discipline Specific) (One from Group A) Nanomaterials and Nanotechnology	4	6(5L + 1T)
23PCHGE11	Elective II (Generic / Discipline Specific) (Onefrom Group B) Electrochemistry	4	6(5L + 1T)
23PCHGE12	Molecular Spectroscopy		
	Total	**22**	**30**

Course Code	Semester-II	Credit	Hours per week(L/T/P)
23PCHCC21	CC4 – Organic reaction mechanism-II	5	5(4L + 1T)
23PCHCC22	CC5 – Physical Chemistry-I	5	5(4L + 1T)
23PCHCC2P	CC6 – Inorganic Chemistry Practical	4	6(5L + 1T)
23PCHDE21	Elective III (Generic / Discipline Specific) (Onefrom Group C) Medicinal Chemistry	3	5(4L + 1T)
23PCHGE21	Elective-IV (Computer / IT related) (One from Group D) Bio Inorganic Chemistry	3	5 (4L+ 1 P)
23PCHSE21	Skill Enhancement Course -SEC 1 (One from Group G) Chemistry in everyday life	2	4
	Total	**22**	**30**

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PCHCC11	ORGANIC REACTION MECHANISM - I	Core	5	6	25	75	100

Learning Objectives		
L1	To understand the feasibility and the mechanism of various organicreactions.	
L2	To comprehend the techniques in the determination of reactionmechanisms.	
L3	To understand the concept of stereochemistry involved in organiccompounds.	
L4	To correlate and appreciate the differences involved in the various typesof organic reaction mechanisms.	
L5	To design feasible synthetic routes for the preparation of organic compounds.	
UNIT	**Contents**	**No. of Hours**
I	**Methods of Determination of Reaction Mechanism:** Reaction intermediates, The transition state, Reaction coordinate diagrams, Thermodynamic and kinetic requirements of reactions: Hammond postulate. Methods of determining mechanism: non-kinetic methods - product analysis, determination of intermediates-isolation, detection, and trapping. Cross-over experiments, isotopic labelling, isotope effects and stereo chemical evidences. Kinetic methods - relation of rate and mechanism. Effect of structure on reactivity: Hammett and Taft equations. Linear free energy relationship, partial rate factor, substituent and reaction constants.	18
II	**Aromatic and Aliphatic Electrophilic Substitution:** Aromaticity: Aromaticity in benzenoid, non-benzenoid, heterocyclic compounds and annulenes. Aromatic electrophilic substitution: Orientation and reactivity of di- and polysubstituted phenol, nitrobenzene and halobenzene. Reactions involving nitrogen electrophiles: nitration, nitrosation and diazonium coupling; Sulphur electrophiles: sulphonation; Halogen electrophiles: chlorination and bromination; Carbon electrophiles: Friedel-Crafts alkylation, acylation and arylation reactions. Aliphatic electrophilic substitution Mechanisms: SE2 and SEi, SE1- Mechanism and evidences.	18
III	**Aromatic and Aliphatic Nucleophilic Substitution:** Aromatic nucleophilic substitution: Mechanisms - S_NAr, S_N1 and Benzyne mechanisms - Evidences - Reactivity, Effect of structure, leaving group and attacking nucleophile. Reactions: Oxygen and Sulphur-nucleophiles, Bucherer and Rosenmund reactions, von Richter, Sommelet- Hauser and Smiles rearrangements. S_N1, ion pair, S_N2 mechanisms and evidences.Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon.S_N1, S_N2, S_Ni, and S_E1 mechanism and evidences,	18

	Swain- Scott, Grunwald-Winstein relationship - Ambident nucleophiles.	
IV	**Stereochemistry-I:** Introduction to molecular symmetry and chirality – axis, plane, center, alternating axis of symmetry. Optical isomerism due to asymmetric and dissymmetric molecules with C, N, S based chiral centers. Optical purity, prochirality, enantiotopic and diastereotopic atoms, groups, faces, axial and planar chirality, chirality due to helical shape, methods of determining theconfiguration. Racemic modifications: Racemization by thermal, anion, cation, reversible formation, epimerization, mutarotation. D, L system, Cram's and Prelog's rules: R, S-notations, proR, proS, side phase and re phase Cahn-Ingold- Prelog rules, absolute and relative configurations. Configurations of allenes, spiranes, biphenyls, cyclooctene, helicene, binaphthyls, ansa and cyclophanic compounds, exo-cyclic alkylidene-cycloalkanes. Topicity and prostereoisomerism, chiral shift reagents and chiral solvating reagents. Criteria for optical purity: Resolution of racemic modifications, asymmetric transformations, asymmetric synthesis, destruction. Stereoselective and stereospecific synthesis.	18
V	**Stereochemistry-II:** Conformation and reactivity of acyclic systems, intramolecular rearrangements, neighbouring group participation, chemical consequence of conformational equilibrium - Curtin-HammettPrinciple. Stability of five and six-membered rings: mono-, di- and polysubstituted cyclohexanes, conformation and reactivity in cyclohexane systems. Fused and bridged rings: bicyclic, poly cyclic systems, decalins and Brett's rule. Optical rotation and optical rotatory dispersion, conformational asymmetry, ORD curves, octant rule, configuration and conformation, Cotton effect, axial haloketone rule and determination of configuration.	18
	Total	**90**

Course Outcomes		**Programme Outcomes**
CO	**On completion of this course, students will**	
1	Recall the basic principles of organic chemistry.	K1,K2,K3,K4,K5
2	Understand the formation and detection of reaction intermediates of organicreactions.	K1,K2,K3,K4,K5
3	Predict the reaction mechanism of organic reactions and stereochemistry oforganic compounds.	K1,K2,K3,K4,K5,K6
4	Apply the principles of kinetic and non-kinetic methods to determine themechanism of reactions.	K1,K2,K3,K4,K5,K6
5	Design and synthesize new organic compounds by correlating thestereochemistry of organic compounds.	K1,K2,K3,K4,K5,K6

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, NewAge 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-Aand 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-McGrawHill, 2000.
5.	L. Finar, Organic chemistry, Vol-1 & 2, 6th edition, PearsonEducation Asia, 2004.
Web Resources	
1.	https://sites.google.com/site/chemistryebookscollection02/home/organic-chemistry/organic
2.	https://www.organic-chemistry.org/

Mapping with Programme Outcomes:

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
CO 1	3	3	3	3	2	3	3	3	3	2
CO 2	2	3	3	3	3	2	3	3	3	3
CO 3	3	3	2	3	3	3	3	2	3	3
CO 4	2	3	3	3	3	2	3	3	3	3
CO 5	2	3	2	3	3	2	3	2	3	3

Strong-3 Medium-2 Low-1

Level of Correlation between PSO's and CO's

CO /PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PCHCC12	STRUCTURE AND BONDING IN INORGANIC COMPOUNDS	Core	5	6	25	75	100

Learning Objectives		
L1	To determine the structural properties of main group compounds and clusters.	
L2	To gain fundamental knowledge on the structural aspects of ioniccrystals.	
L3	To familiarize various diffraction and microscopic techniques.	
L4	To study the effect of point defects and line defects in ionic crystals.To evaluate the structural aspects of solids.	
L5	To determine the structural properties of main group compounds and clusters.	
UNIT	**Contents**	**No. of Hours**
I	**Structure of main group compounds and clusters:** VBtheory – Effect of lone pair and electronegativity of atoms (Bent's rule) on the geometry of the molecules; Structure of silicates - applications of Paulings rule of electrovalence - isomorphous replacements in silicates – ortho, meta and pyro silicates – one dimensional, two dimensional and three-dimensional silicates. Structure of silicones, Structural and bonding features of B-N, S-N and P-N compounds; Poly acids – types, examples and structures; Borane cluster: Structural features of closo, nido, arachano and klado; carboranes, hetero and metalloboranes; Wade's rule to predict the structure of borane cluster; main group clusters –zintl ions and mno rule.	18
II	**Solid state chemistry – I:** Ionic crystals: Packing of ions in simple, hexagonal and cubic close packing, voids in crystal lattice, Radius ratio, Crystal systems and Bravis lattices, Symmetry operations in crystals, glide planes and screw axis; point group and space group; Solid state energetics: Lattice energy – Born-Lande equation - Kapustinski equation, Madelung constant.	18
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 -normaland inverse types and perovskite structures. Crystal Growth methods: From melt and solution (hydrothermal, sol-gel methods) – principles and examples.	18
IV	**Techniques in solid state chemistry:** X-ray diffraction technique: Bragg's law, Powder diffraction method – Principle	18

	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.	
V	**Band theory and defects in solids** Band theory – features and its application of conductors, insulators and semiconductors, Intrinsic and extrinsic semiconductors; Defects in crystals – point defects (Schottky, Frenkel, metal excess and metal deficient) and their effect on the electrical and optical property, laser and phosphors; Linear defects and its effects due to dislocations.	18
	Total	**90**

Course Outcomes		**Programme Outcomes**
CO	**On completion of this course, students will**	
1	Predict the geometry of main group compounds and clusters.	K1,K2,K3,K4,K5
2	Explain about the packing of ions in crystals and apply the radius ratio rule to predictthe coordination number of cations.	K1,K2,K3,K4,K5
3	Understand the various types of ionic crystal systems and analyze their structuralfeatures.	K1,K2,K3,K4,K5,K6
4	Explain the crystal growth methods.	K1,K2,K3,K4,K5,K6
5	To understand the principles of diffraction techniques and microscopic techniques.	K1,K2,K3,K4,K5,K6

Textbooks

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

Reference Books

1.	D. E. Douglas, D.H. McDaniel and J. J. Alexander, Concepts andModels in Inorganic Chemistry, 3rd Ed, 1994.
2.	R J D Tilley, Understanding Solids - The Science of Materials, 2ndedition, Wiley Publication, 2013.
3.	C N R Rao and J Gopalakrishnan, New Directions in Solid StateChemistry,

	2nd Edition, Cambridge University Press, 199.
4.	T. Moeller, Inorganic Chemistry, A Modern Introduction; JohnWiley: New York, 1982.
5.	D. F. Shriver, P. W. Atkins and C.H. Langford; InorganicChemistry; 3rd ed.; Oxford University Press: London, 2001.
Web Resources	
1.	https://ocw.mit.edu/courses/3-091-introduction-to-solid-state-chemistry-fall-2018/video_galleries/lecture-videos/

Mapping with Programme Outcomes:

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
CO 1	3	3	3	3	2	3	3	3	3	2
CO 2	2	3	3	3	3	2	3	3	3	3
CO 3	3	3	2	3	3	3	3	2	3	3
CO 4	2	3	3	3	3	2	3	3	3	3
CO 5	2	3	2	3	3	2	3	2	3	3

Strong-3 Medium-2 Low-1

Level of Correlation between PSO's and CO's

CO /PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PCHCC1P	**ORGANIC CHEMISTRY PRACTICAL**	**Core**	**4**	**6**	**40**	**60**	**100**

Learning Objectives		
L1	To understand the concept of separation, qualitative analysis and preparation of organic compounds.	
L2	To develop analytical skill in the handling of chemical reagents for separation of binary and ternary organic mixtures.	
L3	To analyze the separated organic components systematically and derivatize them suitably.	
L4	To construct suitable experimental setup for the organic preparations involving two stages.	
L5	To experiment different purification and drying techniques for the compound processing.	
UNIT	**Contents**	**No. of Hours**
I	**Separation and analysis:** A. Two component mixtures. B. Three component mixtures.	30
II	**Estimations:** a) Estimation of Phenol (bromination) b) Estimation of Aniline (bromination) c) Estimation of Ethyl methyl ketone (iodimetry) d) Estimation of Glucose (redox) e) Estimation of Ascorbic acid (iodimetry) f) Estimation of Aromatic nitro groups (reduction) g) Estimation of Glycine (acidimetry) h) Estimation of Formalin (iodimetry) i) Estimation of Acetyl group in ester (alkalimetry) j) Estimation of Hydroxyl group (acetylation) k) Estimation of Amino group (acetylation)	30
III	**Two stage preparations:** a) *p*-Bromoacetanilide from aniline b) *p*-Nitroaniline from acetanilide c) 1,3,5-Tribromobenzene from aniline d) Acetyl salicyclic acid from methyl salicylate e) Benzilic acid from benzoin f) *m*-Nitroaniline from nitrobenzene *g) m*-Nitrobenzoic acid from methyl benzoate	30
	Total	**90**

Course Outcomes		**Programme Outcomes**
CO	**On completion of this course, students will**	
1	Recall the basic principles of organic separation,	K1,K2,K3,K4,K5

	qualitative analysis andpreparation.	
2	Explain the method of separation and analysis of separated organic mixtures and convert them as derivatives by suitable preparation method.	K1,K2,K3,K4,K5
3	Determine the characteristics of separation of organic compounds by variouschemical reactions.	K1,K2,K3,K4,K5,K6
4	Develop strategies to separate, analyze and prepare organic compounds.	K1,K2,K3,K4,K5,K6
5	Formulate a method of separation, analysis of organic mixtures and designsuitable procedure for organic preparations.	K1,K2,K3,K4,K5,K6
Textbooks		
1	A R West, Solid state Chemistry and its applications, 2ndEdition(Students Edition), John Wiley & Sons Ltd., 2014.	
2	A K Bhagi and G R Chatwal, A textbook of inorganic polymers,Himalaya Publishing House, 2001.	
3	L Smart, E Moore, Solid State Chemistry – An Introduction, 4thEdition, CRC Press, 2012.	
Reference Books		
1.	D. E. Douglas, D.H. McDaniel and J. J. Alexander, Concepts andModels in Inorganic Chemistry, 3rd Ed, 1994.	
2.	R J D Tilley, Understanding Solids - The Science of Materials, 2ndedition, Wiley Publication, 2013.	
3.	C N R Rao and J Gopalakrishnan, New Directions in Solid StateChemistry, 2nd Edition, Cambridge University Press, 199.	
Web Resources		
1.	https://ocw.mit.edu/courses/3-091-introduction-to-solid-state-chemistry-fall-2018/video_galleries/lecture-videos/	

Mapping with Programme Outcomes:

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
CO 1	3	3	3	3	2	3	3	3	3	2
CO 2	2	3	3	3	3	2	3	3	3	3
CO 3	3	3	2	3	3	3	3	2	3	3
CO 4	2	3	3	3	3	2	3	3	3	3
CO 5	2	3	2	3	3	2	3	2	3	3

Strong-3 Medium-2 Low-1

Level of Correlation between PSO's and CO's

CO /PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PCHDE11	NANO MATERIALS AND NANO TECHNOLOGY	Elective	4	6	25	75	100

Learning Objectives		
L1	To understand the concept of nano materials and nano technology.	
L2	To understand the various types of nano materials and their properties. To understand the applications of synthetically important nanomaterials.	
L3	To correlate the characteristics of various nano materials synthesized by	
L4	new technologies.	
L5	To design synthetic routes for synthetically used new nano materials.	
UNIT	**Contents**	**No. of Hours**
I	Introduction of nanomaterials and nanotechnologies, Introduction-role of size, classification-0D, 1D, 2D, 3D. Synthesis- Bottom –Up, Top–Down, consolidation of Nano powders. Features of nanostructures, Background of nanostructures. Techniques of synthesis of nanomaterials, Tools of the nanoscience. Applications of nanomaterials and technologies.	18
II	Bonding and structure of the nanomaterials, Predicting the Type of Bonding in a Substance crystal structure. Metallic nanoparticles, Surfaces of Materials, Nanoparticle Size and Properties. Synthesis- Physical and chemical methods - inert gas condensation, arc discharge, laser ablation, sol-gel, solvothermal and hydrothermal-CVD-types, metallo organic, plasma enhanced, and low-pressure CVD. Microwave assisted and electrochemical synthesis.	18
III	Mechanical properties of materials, theories relevant to mechanical properties. Techniques to study mechanical properties of nanomaterials, adhesion and friction, thermal properties of nanomaterials Nanoparticles: gold and silver, metal oxides: silica, iron oxide and alumina - synthesis and properties.	18
IV	Electrical properties, Conductivity and Resistivity, Classification of Materials based on Conductivity, magnetic properties,electronic properties of materials. Classification of magnetic phenomena. Semiconductor materials – classification-Ge, Si, GaAs,SiC, GaN, GaP, CdS,PbS. Identification of materials as p and n –type semiconductor-Hall effect - quantum and anomalous, Hall voltage - interpretation of charge carrier density. Applications of semiconductors: p-n junction as transistors and rectifiers, photovoltaic and	18

	photogalvanic cell.	
V	Nano thin films, nanocomposites. Application of nanoparticles in different fields. Core-shell nanoparticles - types, synthesis, and properties. Nanocomposites - metal-, ceramic- and polymer-matrix composites-applications. Characterization – SEM, TEM and AFM - principle, instrumentation and applications.	18
	Total	**90**

Course Outcomes		**Programme Outcomes**
CO	**On completion of this course, students will**	
1	Explain methods of fabricating nanostructures.	K1,K2,K3,K4,K5
2	Relate the unique properties of nanomaterials to reduce dimensionality of thematerial.	K1,K2,K3,K4,K5
3	Describe tools for properties of nanostructures.	K1,K2,K3,K4,K5,K6
4	Discuss applications of nanomaterials.	K1,K2,K3,K4,K5,K6
5	Understand the health and safety related to nanomaterial.	K1,K2,K3,K4,K5,K6

Textbooks

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

Web Resources

1.	http://xrayweb.chem.ou.edu/notes/symmetry.html.
2.	http://www.uptti.ac.in/classroom-content/data/unit%20cell.pdf.

Mapping with Programme Outcomes:

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
CO 1	3	3	3	3	2	3	3	3	3	2
CO 2	2	3	3	3	3	2	3	3	3	3
CO 3	3	3	2	3	3	3	3	2	3	3
CO 4	2	3	3	3	3	2	3	3	3	3
CO 5	2	3	2	3	3	2	3	2	3	3

Strong-3 Medium-2 Low-1

Level of Correlation between PSO's and CO's

CO /PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PCHGE11	ELECTROCHEMISTRY	Elective	4	6	25	75	100

Learning Objectives		
L1	To understand the behavior of electrolytes in terms of conductance, ionic atmosphere, interactions.	
L2	To familiarize the structure of the electrical double layer of different models.	
L3	To compare electrodes between current density and over potential.	
L4	To discuss the mechanism of electrochemical reactions.	
L5	To highlight the different types of over voltages and its applications in electroanalytical techniques.	
UNIT	**Contents**	**No. of Hours**
I	**Ionics**: Arrhenius theory -limitations, van't Hoff factor and its relation to colligative properties. Deviation from ideal behavior. Ionic activity, mean ionic activity and mean ionic activity coefficient-concept of ionic strength, Debye Huckel theory of strong electrolytes, activity coefficient of strong electrolytes Determination of activity coefficient ion solvent and ion-ion interactions. Born equation. Debye-Huckel Bjerrum model. Derivation of Debye-Huckel limiting law at appreciable concentration of electrolytes modifications and applications. Electrolytic conduction-Debye-Huckel Onsager treatment of strong electrolyte-qualitative and quantitative verification and limitations. Evidence for ionic atmosphere. Ion association and triple ion formations.	18
II	**Electrode-electrolyte interface:** Interfacial phenomena - Evidences for electrical double layer, polarizable and non-polarizable interfaces, Electrocapillary phenomena - Lippmann equation electro capillary curves. Electro-kinetic phenomena electro-osmosis, electrophoresis, streaming and sedimentation potentials, colloidal and poly electrolytes. Structure of double layer: Helmholtz -Perrin, Guoy- Chapman and Stern models of electrical double layer. Zeta potential and potential at zero charge. Applications and limitations.	18
III	**Electrodics of Elementary Electrode Reactions:** Behavior of electrodes: Standard electrodes and electrodes at equilibrium. Anodicand Cathodic currents, condition for the discharge of ions. Nernst equation, polarizable and non-polarizable electrodes. Model of three electrode system, over potential. Rate of electro chemical reactions: Rates of simple elementary reactions. Butler-Volmer equation- significance of exchange current density, net current density and symmetry factor. Low	18

	and high field approximations. symmetry factor and transfer coefficient Tafel equations and Tafel plots.	
IV	**Electrodics of Multistep Multi Electron System:** Rates of multi-step electrode reactions, Butler - Volmer equation for a multi-step reaction. Rate determining step, electrode polarization and depolarization. Transfer coefficients, its significance and determination, Stoichiometric number. Electro-chemical reaction mechanisms-rate expressions, order, and surface coverage. Reduction of I^{3-}, Fe^{2+}, and dissolution of Fe to Fe^{2+}. Overvoltage - Chemical and electro chemical, Phase, activation and concentration over potentials. Evolution of oxygen and hydrogen at different pH. Pourbiax and Evan's diagrams.	18
V	**Concentration Polarization, Batteries and Fuel cells:** Modes of Transport of electro active species - Diffusion, migration and hydrodynamic modes. Role of supporting electrolytes. Polarography- principle and applications. Principle of square wave polarography. Cyclic voltammetry- anodic and cathodic stripping voltammetry and differential pulse voltammetry. Sodium and lithium-ion batteries and redox flow batteries. Mechanism of charge storage: conversion and alloying. Capacitors- mechanism of energy storage, charging at constant current and constant voltage. Energy production systems: Fuel Cells: classification, alkaline fuel cells, phosphoric acid fuel cells, high temperature fuel cells.	18
	Total	**90**

Course Outcomes		**Programme Outcomes**
CO	**On completion of this course, students will**	
1	Find the behaviour of electrolytes in solution and compare the structures ofelectrical double layer of different models.	K1,K2,K3,K4,K5
2	Predict the kinetics of electrode reactions applying Butler-Volmer and Tafelequations	K1,K2,K3,K4,K5
3	Differentiate thermodynamic mechanism of corrosion,	K1,K2,K3,K4,K5,K6
4	Discuss the theories of electrolytes, electrical double layer, electrodics andactivity coefficient of electrolytes	K1,K2,K3,K4,K5,K6
5	Construct storage devices and understand electrochemical reaction mechanism.	K1,K2,K3,K4,K5,K6

Textbooks

1	D. R. Crow, Principles and applications of electrochemistry,4thedition, Chapman & Hall/CRC, 2014.
2	J. Rajaram and J.C. Kuriakose, Kinetics and Mechanism ofchemical transformations Macmillan India Ltd., New Delhi, 2011.
3	S. Glasstone, Electro chemistry, Affiliated East-West Press, Pvt.,Ltd., New Delhi, 2008.
4	B. Viswanathan, S. Sundaram, R. Venkataraman, K. Rengarajanand P.S. Raghavan, Electrochemistry-Principles and applications,
5	Joseph Wang, Analytical Electrochemistry, 2nd edition, Wiley,2004.

Reference Books	
1.	J.O.M. Bockris and A.K.N. Reddy, Modern Electro chemistry,vol.1 and 2B, Springer, Plenum Press, New York, 2008.
2.	J.O.M. Bockris, A.K.N. Reddy and M.G. Aldeco Morden Electrochemistry, vol. 2A, Springer, Plenum Press, New York, 2008.
3.	Philip H. Rieger, Electrochemistry, 2nd edition, Springer, NewYork, 2010.
4.	L.I. Antropov, Theoretical electrochemistry, Mir Publishers, 1977.
5.	K.L. Kapoor, A Text book of Physical chemistry, volume-3,Macmillan, 2001.
Web Resources	
1.	https://www.pdfdrive.com/modern-electrochemistry-e34333229.

Mapping with Programme Outcomes:

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
CO 1	3	3	3	3	2	3	3	3	3	2
CO 2	2	3	3	3	3	2	3	3	3	3
CO 3	3	3	2	3	3	3	3	2	3	3
CO 4	2	3	3	3	3	2	3	3	3	3
CO 5	2	3	2	3	3	2	3	2	3	3

Strong-3 Medium-2 Low-1

Level of Correlation between PSO's and CO's

CO /PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PCHGE12	**MOLECULAR SPECTROSCOPY**	**Elective**	**4**	**6**	**25**	**75**	**100**

Learning Objectives		
L1	To understand the influence of rotation and vibrations on the spectra of the polyatomic molecules.	
L2	To study the principle of Raman spectroscopy, ESR spectroscopy, EPR spectroscopy and fragmentation patterns in Mass spectroscopy.	
L3	To highlight the significance of Franck-Condon principle to interpret the selection rule, intensity and types of electronic transitions.	
L4	To interpret the first and second order NMR spectra in terms of splitting and coupling patterns using correlation techniques such as COSY, HETCOR, NOESY.	
L5	To carry out the structural elucidation of molecules using different spectral techniques.	
UNIT	**Contents**	**No. of Hours**
I	**Rotational and Raman Spectroscopy:** Rotational spectra of diatomic and polyatomic molecules. Intensities of rotational spectral lines, effect of isotopic substitution. Non-rigid rotators. Classical theory of the Raman effect, polarizability as a tensor, polarizability ellipsoids, quantum theory of the Raman effect, Pure rotational Raman spectra of linear and asymmetric top molecules, Stokes and anti-Stokes lines. Vibrational Raman spectra, Raman activity of vibrations, rule of mutual exclusion, rotational fine structure-O and S branches, Polarization of Raman scattered photons.	18
II	**Vibrational Spectroscopy:** Vibrations of molecules, harmonic and anharmonic oscillators- vibrational energy expression, energy level diagram, vibrational wave functions and their symmetry, selection rules, expression for the energies of spectral lines, computation of intensities, hot bands, effect of isotopic substitution. Diatomic vibrating rotor, vibrational-rotational spectra of diatomic molecules, P, R branches, breakdown of the Born-Oppenheimer approximation. Vibrations of polyatomic molecules – symmetry properties, overtone and combination frequencies. Influence of rotation on vibrational spectra of polyatomic molecule, P, Q, R branches, parallel and perpendicular vibrations of linear and symmetric top molecules.	18
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	18

	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.	
IV	**NMR and ESR spectroscopy:** Chemical shift, Factors influencing chemical shifts: electronegativity and electrostatic effects; Mechanism of shielding and deshielding. Spin systems: First order and second order coupling of AB systems, Simplification of complex spectra. Spin-spin interactions: Homonuclear coupling interactions - AX, AX2, AB types. Vicinal, germinal and long-range coupling-spin decoupling. Nuclear Overhauser effect (NOE), Factors influencing coupling constants and Relative intensities. 13CNMR and structural correlations, Satellites. Brief introduction to 2D NMR – COSY, NOESY. Introduction to 31P, 19F NMR. ESR spectroscopy Characteristic features of ESR spectra, line shapes and line widths; ESR spectrometer. The g value and the hyperfine coupling parameter (A), origin of hyperfine interaction. Interpretation of ESR spectra and structure elucidation of organic radicals using ESR spectroscopy; Spin orbit coupling and significance of g-tensors, zero/non-zero field splitting, Kramer's degeneracy, application to transition metal complexes (having one to five unpaired electrons) including biological molecules and inorganic free radicals. ESR spectra of magnetically dilute samples.	18
V	**Mass Spectrometry, EPR and Mossbauer Spectroscopy:** Ionization techniques- Electron ionization (EI), chemical ionization (CI), desorption ionization (FAB/MALDI), electrospray ionization (ESI), isotope abundance, molecular ion, fragmentation processes of organic molecules, deduction of structure through mass spectral fragmentation, high resolution. Effect of isotopes on the appearance of mass spectrum. EPR spectra of anisotropic systems - anisotropy in g-value, causes of anisotropy, anisotropy in hyperfine coupling, hyperfine splitting caused by quadrupole nuclei. Zero-field splitting (ZFS) and Kramer's degeneracy. Applications of EPR to organic and inorganic systems. Structural elucidation of organic compounds by combined spectral techniques. Principle of Mossbauer spectroscopy: Doppler shift, recoil energy. Isomer shift, quadrupole splitting, magnetic interactions. Applications: Mossbauer spectra of high and low-spin Fe and Sn compounds.	18
	Total	**90**

Course Outcomes		**Programme Outcomes**
CO	**On completion of this course, students will**	
1	Find the importance of rotational and Raman spectroscopy.	K1,K2,K3,K4,K5
2	apply the vibrational spectroscopic techniques to diatomic and polyatomic molecules.	K1,K2,K3,K4,K5
3	evaluate different electronic spectra of simple	K1,K2,K3,K4,K5,K6

	molecules using electronic spectroscopy.	
4	outline the NMR, ^{13}C NMR, 2D NMR – COSY, NOESY, Introduction to ^{31}P, ^{19}F NMR and ESR spectroscopic techniques.	K1,K2,K3,K4,K5,K6
5	develop the knowledge on principle, instrumentation and structural elucidation of simple molecules using Mass Spectrometry, EPR and Mossbauer Spectroscopy techniques	K1,K2,K3,K4,K5,K6
Textbooks		
1	C. N. Banwell and E. M. McCash, *Fundamentals of Molecular Spectroscopy*, 4th Ed., Tata McGraw Hill, New Delhi, 2000.	
2	R. M. Silverstein and F. X. Webster, *Spectroscopic Identification of Organic Compounds*, 6th Ed., John Wiley & Sons, New York, 2003.	
3	W. Kemp, *Applications of Spectroscopy*, English Language Book Society, 1987.	
4	D. H. Williams and I. Fleming, *Spectroscopic Methods in Organic Chemistry,* 4th Ed., Tata McGraw-Hill Publishing Company, New Delhi, 1988.	
5	R. S. Drago, *Physical Methods in Chemistry*; Saunders: Philadelphia, 1992.	
Reference Books		
1.	P.W. Atkins and J. de Paula, *Physical Chemistry*, 7th Ed., Oxford University Press, Oxford, 2002.	
2.	I. N. Levine, *Molecular Spectroscopy*, John Wiley & Sons, New York, 1974.	
3.	A. Rahman, *Nuclear Magnetic Resonance-Basic Principles*, Springer-Verlag, New York,1986.	
4.	K. Nakamoto, *Infrared and Raman Spectra of Inorganic and coordination Compounds*, PartB: 5th ed., John Wiley& Sons Inc., New York, 1997.	
5.	J. A. Weil, J. R. Bolton and J. E. Wertz, *Electron Paramagnetic Resonance*; Wiley Interscience, 1994.	
Web Resources		
1.	https://onlinecourses.nptel.ac.in/noc20_cy08/preview	
2.	https://www.digimat.in/nptel/courses/video/104106122/L14.html	

Mapping with Programme Outcomes:

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
CO 1	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**
CO 2	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**
CO 3	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**3**
CO 4	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**
CO 5	**2**	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**

Strong-3 Medium-2 Low-1

Level of Correlation between PSO's and CO's

CO /PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PCHCC21	ORGANIC REACTION MECHANISM-II	Core	5	5	25	75	100

Learning Objectives		
L1	To understand the concept of aromaticity in benzenoid, non-benzenoid, heterocyclic and annulene compounds.	
L2	To understand the mechanism involved in various types of organic reactions with evidences.	
L3	To understand the applications of synthetically important reagents.	
L4	To correlate the reactivity between aliphatic and aromatic compounds.	
L5	To design synthetic routes for synthetically used organic reactions.	
UNIT	**Contents**	**No. of Hours**
I	**Elimination and Free Radical Reactions:** Mechanisms: E2, E1, and E1cB mechanisms. Syn- and anti-eliminations. Orientation of the double bond: Hoffmann and Saytzeff rules. Reactivity: Effect of substrate, attacking bases, leaving group and medium. Stereochemistry of eliminations in acyclic and cyclic systems, pyrolytic elimination. Long lived and short-lived radicals – Production of radicals by thermal and photochemical reactions, Detection and stability of radicals, characteristics of free radical reactions and free radical, reactions of radicals; polymerization, addition, halogenations, aromatic substitutions, rearrangements. Reactivity: Reactivity on aliphatic, aromatic substrates, reactivity in the attacking radical, effect of solvent.	15
II	**Oxidation and Reduction Reactions:** Mechanisms: Direct electron transfer, hydride transfer, hydrogen transfer, displacement, addition-elimination, oxidative and reductive coupling reactions. Mechanism of oxidation reactions: Dehydrogenation by quinones, selenium dioxides, ferricyanide, mercuric acetate lead tetraacetate, permanganate, manganese dioxide, osmium tetroxide, oxidation of saturated hydrocarbons, alkyl groups, alcohols, halides and amines. Reactions involving cleavage of C-C bonds - cleavage of double bonds, oxidative decarboxylation, allylic oxidation, oxidation by chromium trioxide-pyridine, DMSO-Oxalyl chloride (Swern oxidation) and Corey-Kim oxidation, dimethyl sulphoxide- dicyclohexyl carbodiimide (DMSO-DCCD). Mechanism of reductionreactions: Wolff-Kishner, Clemmenson, Rosenmund, reduction with Trialkyl and triphenyltin hydrides, McFadyen-Steven's reduction, Homogeneous hydrogenation, Hydroboration with cyclic systems, MPV and Bouveault-Blanc reduction.	15
III	**UNIT-III: Rearrangements:** Rearrangements to electron	15

	deficient carbon: Pinacol-pinacolone and semi-pinacolone rearrangements -applications and stereochemistry, Wagner-Meerwein, Demjanov, Dienone-phenol, Baker- Venkataraman, Benzilic acid and Wolff rearrangements. Rearrangements to electron deficient nitrogen: Hofmann, Curtius, Schmidt, Lossen, Beckmann and abnormal Beckmann rearrangements. Rearrangements to electron deficient oxygen: Baeyer-Villiger oxidation and Dakin rearrangements. Rearrangements to electron rich atom: Favorskii, Quasi-Favorskii, Stevens, [1,2]-Wittig and [2,3]-Wittig rearrangements. Fries and Photo Fries rearrangement. Intramolecular rearrangements – Claisen, abnormal Claisen, Cope, oxy-Cope Benzidine rearrangements.	
IV	**Addition to Carbon Multiple Bonds:** Mechanisms: (a)Addition to carbon-carbon multiple bonds- Addition reactions involving electrophiles, nucleophiles, free radicals, carbenes and cyclic mechanisms- Orientation and reactivity, hydrogenation of double and triple bonds, Michael reaction, addition of oxygen and Nitrogen; (b) Addition to carbon- hetero atom multiple bonds: Mannich reaction, acids, esters, nitrites, addition of Grignard reagents, Wittig reaction, Prins reaction. Stereochemical aspects of addition reactions. Addition to Carbon-Hetero atom Multiplebonds: Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Mechanism of condensation reactions involving enolates –Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.	15
V	**Reagents and Modern Synthetic Reactions:** Lithium diisopropylamine (LDA), Azobisisobutyronitrile (AIBN), Sodium cyanoborohydride ($NaBH_3CN$), *meta*-Chloroperbenzoic acid (m-CPBA), Dimethyl aminiopyridine (DMAP), n-Bu_3SnD, Triethylamine (TEA), Diazobicyclo[5.4.0]undec-7-ene (DBU), Diisopropylazodicarboxylate (DIAD), Diethylazodicarboxylate (DEAD), *N*-bromosuccinimide (NBS), Trifluoroacetic acid (TFA), Tetramethyl piperiridin-1-oxyl (TEMPO), Phenyltrimethylammonium tribromide (PTAB). Diazomethane and Zn-Cu, Diethyl maleate (DEM), Copper diacetylacetonate ($Cu(acac)_2$), $TiCl_3$, $NaIO_4$, Pyridinium chlorochromate (PCC), Pyridinium dichromate (PDC), Meisenheimer complex**.** Suzuki coupling, Heck reaction, Negishi reaction, Baylis-Hillman reaction.	15
	Total	**75**

Course Outcomes		**Programme Outcomes**
CO	**On completion of this course, students will**	
1	Recall the basic principles of aromaticity of organic and heterocyclic compounds.	K1,K2,K3,K4,K5
2	Identify the mechanism of various types of organic reactions.	K1,K2,K3,K4,K5

3	Predict the suitable reagents for the conversion of selective organic compounds.	K1,K2,K3,K4,K5,K6
4	Correlate the principles of substitution, elimination, and addition reactions.	K1,K2,K3,K4,K5,K6
5	Design new routes to synthesis organic compounds.	K1,K2,K3,K4,K5,K6
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*, 8thedn, NewAge International Publishers, 2015.	
4	P. Y.Bruice, *Organic Chemistry*, 7thedn.,Prentice Hall, 2013.	
5	R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee*OrganicChemistry*, 7th edn., Pearson Education, 2010.	
Reference Books		
1.	S. H. Pine, *Organic Chemistry*, 5thedn, McGraw HillInternational Editionn, 1987.	
2.	L. F. Fieser and M. Fieser, *Organic Chemistry*, Asia PublishingHouse, Bombay, 2000.	
3.	E.S. Gould, *Mechanism and Structure in Organic Chemistry*, Holt,Rinehart and Winston Inc., 1959.	
4.	T. L. Gilchrist, *Heterocyclic Chemistry*, Longman Press, 1989.	
5.	J. A. Joule and K. Mills, *Heterocyclic Chemistry*, 4thed., John-Wiley, 2010.	
Web Resources		
1.	https://sites.google.com/site/chemistryebookscollection02/home/organ ic-chemistry/organic	
2.	https://www.organic-chemistry.org/	

Mapping with Programme Outcomes:

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
CO 1	3	3	3	3	2	3	3	3	3	2
CO 2	2	3	3	3	3	2	3	3	3	3
CO 3	3	3	2	3	3	3	3	2	3	3
CO 4	2	3	3	3	3	2	3	3	3	3
CO 5	2	3	2	3	3	2	3	2	3	3

Strong-3 Medium-2 Low-1

Level of Correlation between PSO's and CO's

CO /PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PCHCC22	**PHYSICAL CHEMISTRY-I**	**Core**	**5**	**5**	**25**	**75**	**100**

Learning Objectives		
L1	To recall the fundamentals of thermodynamics and the composition of partial molar quantities.	
L2	To understand the classical and statistical approach of the functions	
L3	To compare the significance of Maxwell-Boltzman, Fermi-Dirac andBose-Einstein	
L4	To correlate the theories of reaction rates for the evaluation of thermodynamic parameters.	
L5	To study the mechanism and kinetics of reactions.	
UNIT	**Contents**	**No. of Hours**
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.	15
II	**Statistical thermodynamics:** Introduction of statistical thermodynamics concepts of thermodynamic and mathematical probabilities-distribution of distinguishable and non-distinguishable particles. Assemblies, ensembles, canonical particles. Maxwell -Boltzmann, Fermi Dirac & Bose-Einstein Statistics- comparison and applications. Partition functions-evaluation of translational, vibrational and rotational partition functions for monoatomic, diatomic and polyatomic ideal gases. Thermodynamic functions in terms of partition functions-calculation of equilibrium constants. Statistical approach to Thermodynamic properties: pressure, internal energy, entropy, enthalpy, Gibb's function, Helmholtz function residual entropy, equilibrium constants and equipartition principle. Heat capacity of mono and di atomic gases-ortho and para hydrogen. Heat capacity of solids-Einstein and Debye models.	15
III	**Irreversible Thermodynamics:** Theories of conservation of mass and energy entropy production in open systems by	15

	heat, matterand 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.	
IV	**Kinetics of Reactions:** Theories of reactions-effect of temperature on reaction rates, collision theory of reaction rates, Unimolecular reactions -Lindeman and Christiansen hypothesis- molecular beams, collision cross sections, effectiveness of collisions, Potential energy surfaces. Transition state theory-evaluation of thermodynamic parameters of activation-applications of ARRT to reactions between atoms and molecules, time and true order-kinetic parameter evaluation. Factors determine the reaction rates in solution - primary salt effect and secondary salt effect, Homogeneous catalysis- acid- base catalysis-mechanism of acid base catalyzed reactions- Bronsted catalysis law, enzyme catalysis-Michelis-Menton catalysis.	15
V	**Kinetics of complex and fast reactions:** Kinetics of complex reactions, reversible reactions, consecutive reactions, parallel reactions, chain reactions. Chain reactions-chain length, kinetics of H_2 – Cl_2 & H_2 – Br_2 reactions (Thermal and Photochemical reactions) - Rice Herzfeld mechanism. Study of fast reactions-relaxation methods- temperature and pressure jump methods electric and magnetic field jump methods - stopped flow flash photolysis methods and pulse radiolysis. Kinetics of polymerization-free radical, cationic, anionic polymerization - Polycondensation.	15
	Total	**75**

Course Outcomes		**Programme Outcomes**
CO	**On completion of this course, students will**	
1	Explain the classical and statistical concepts of thermodynamics.	K1,K2,K3,K4,K5
2	Compare and correlate the thermodynamic concepts to study the kinetics of chemical reactions.	K1,K2,K3,K4,K5
3	Discuss the various thermodynamic and kinetic determination.	K1,K2,K3,K4,K5,K6
4	Evaluate the thermodynamic methods for real gases ad mixtures.	K1,K2,K3,K4,K5,K6
5	Compare the theories of reactions rates and fast reactions.	K1,K2,K3,K4,K5,K6

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, 6thedition, 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 ofchemical 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, VikasPublishing, Pvt. Ltd., New Delhi, 1990.
3.	S.H. Maron and J.B. Lando, Fundamentals of PhysicalChemistry, Macmillan Publishers, New York, 1974
4.	K.B. Ytsiimiriski, "Kinetic Methods of Analysis", PergamomPress,1996.
5.	Gurdeep Raj, Phase rule, Goel Publishing House, 2011.
Web Resources	
1.	https://nptel.ac.in/courses/104/103/104103112/
2.	https://bit.ly/3tL3GdN

Mapping with Programme Outcomes:

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
CO 1	3	3	3	3	2	3	3	3	3	2
CO 2	2	3	3	3	3	2	3	3	3	3
CO 3	3	3	2	3	3	3	3	2	3	3
CO 4	2	3	3	3	3	2	3	3	3	3
CO 5	2	3	2	3	3	2	3	2	3	3

Strong-3 Medium-2 Low-1

Level of Correlation between PSO's and CO's

CO /PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PCHCC2P	INORGANIC CHEMISTRY PRACTICAL	Core	4	6	40	60	100

Learning Objectives		
L1	To understand and enhance the visual observation as an analytical toolfor the quantitative estimation of ions.	
L2	To recall the principle and theory in preparing standard solutions.	
L3	To train the students for improving their skill in estimating the amountof ion accurately present in the solution	
L4	To estimate metal ions, present in the given solution accurately without using instruments.	
L5	To determine the amount of ions, present in a binary mixture accurately.	
UNIT	**Contents**	**No. of Hours**
I	**Analysis of mixture of cations:** Analysis of a mixture of four cations containing two common cations and two rare cations. Cations tobe 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.	30
II	**Preparation of metal complexes:** Preparation of inorganic complexes: a. Preparation of tristhioureacopper(I)sulphate b. Preparation of potassium trioxalate chromate(III) c. Preparation of tetramminecopper(II) sulphate d. Preparation of Reineck's salt e. Preparation of hexathioureacopper(I) chloridedihydrate f. Preparation of *cis*-Potassium tri oxalate diaquachromate(III) g. Preparation of sodium trioxalatoferrate(III) h. Preparation of hexathiourealead(II) nitrate	30
III	**Complexometric Titration:** 1. Estimation of zinc, nickel, magnesium, and calcium. 2. Estimation of mixture of metal ions-pH control, masking anddemasking agents. 3. Determination of calcium and lead in a mixture (pH control). 4. Determination of manganese in the presence of iron. 5. Determination of nickel in the presence of iron.	30
	Total	**90**

Course Outcomes		Programme Outcomes
CO	**On completion of this course, students will**	
1	Identify the anions and cations present in a mixture of	K1,K2,K3,K4,K5

	salts.	
2	Apply the principles of semi micro qualitative analysis to categorize acid radicalsand basic radicals.	K1,K2,K3,K4,K5
3	Acquire the qualitative analytical skills by selecting suitable confirmatory tests andspot tests.	K1,K2,K3,K4,K5,K6
4	Choose the appropriate chemical reagents for the detection of anions and cations.	K1,K2,K3,K4,K5,K6
5	Synthesize coordination compounds in good quality.	K1,K2,K3,K4,K5,K6
Textbooks		
1	A. JeyaRajendran, Microanalytical Techniques in Chemistry:Inorganic Qualitative Analysis, United global publishers, 2021.	
2	V. V. Ramanujam, *Inorganic Semimicro Qualitative Analysis*;3rded., The National Publishing Company, Chennai, 1974.	
3	*Vogel's Text book of Inorganic Qualitative Analysis,* 4thed., ELBS,London.	
Reference Books		
1.	G. Pass, and H. Sutcliffe, *Practical Inorganic Chemistry*; ChapmanHall, 1965.	
2.	W. G. Palmer, Experimental *Inorganic Chemistry*; CambridgeUniversity Press, 1954.	

Mapping with Programme Outcomes:

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
CO 1	3	3	3	3	2	3	3	3	3	2
CO 2	2	3	3	3	3	2	3	3	3	3
CO 3	3	3	2	3	3	3	3	2	3	3
CO 4	2	3	3	3	3	2	3	3	3	3
CO 5	2	3	2	3	3	2	3	2	3	3

Strong-3 Medium-2 Low-1

Level of Correlation between PSO's and CO's

CO /PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PCHDE21	MEDICINAL CHEMISTRY	Elective	3	5	25	75	100

Learning Objectives		
L1	To study the chemistry behind the development of pharmaceutical materials.	
L2	To gain knowledge on mechanism and action of drugs.	
L3	To understand the need of antibiotics and usage of drugs.	
L4	To familiarize with the mode of action of diabetic agents and treatmentof diabetes.	
L5	To identify and apply the action of various antibiotics.	
UNIT	**Contents**	**No. of Hours**
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.	15
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.	15
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.	15
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.	15
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.	15
	Total	**75**

Course Outcomes		Programme Outcomes
CO	**On completion of this course, students will**	
1	Predict a drugs properties based on its structure.	K1,K2,K3,K4,K5

2	Describe the factors that affect its absorption, distribution, metabolism, and excretion,and hence the considerations to be made in drug design.	K1,K2,K3,K4,K5
3	Explain the relationship between drug's chemical structure and its therapeuticproperties.	K1,K2,K3,K4,K5,K6
4	Designed to give the knowledge of different theories of drug actions at molecularlevel.	K1,K2,K3,K4,K5,K6
5	Identify different targets for the development of new drugs for the treatment ofinfectious and GIT.	K1,K2,K3,K4,K5,K6
Textbooks		
1	Wilson and Gisvold's textbook of organic medicinal andpharmaceutical chemistry,	
2	Wilson, Charles Owens: Beale, John Marlowe; Block, John H,Lipincott William, 12th edition, 2011.	
3	Graham L. Patrick, An Introduction to Medicinal Chemistry, 5th edition, Oxford University Press, 2013. Jayashree Ghosh, A text book of Pharmaceutical Chemistry, S. Chand and Co. Ltd, 1999,1999 edn.	
4	O. LeRoy, Natural and synthetic organic medicinal compounds,Ealemi, 1976.	
5	S. Ashutosh Kar, Medicinal Chemistry, Wiley Eastern Limited, NewDelhi, 1993, New edn.	
Reference Books		
1.	Foye's Princles of Medicinal Chemistry, Lipincott Williams, SeventhEdition, 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.	
Web Resources		
1.	https://www.ncbi.nlm.nih.gov/books/NBK482447/	
2.	https://training.seer.cancer.gov/treatment/chemotherapy/types.html	
3.	https://www.classcentral.com/course/swayam-medicinal-chemistry-12908	

Mapping with Programme Outcomes:

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
CO 1	3	3	3	3	2	3	3	3	3	2
CO 2	2	3	3	3	3	2	3	3	3	3
CO 3	3	3	2	3	3	3	3	2	3	3
CO 4	2	3	3	3	3	2	3	3	3	3
CO 5	2	3	2	3	3	2	3	2	3	3

Strong-3 Medium-2 Low-1

Level of Correlation between PSO's and CO's

CO /PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PCHGE21	BIO-INORGANIC CHEMISTRY	Elective	3	5	25	75	100

Learning Objectives		
L1	To understand the role of trace elements.	
L2	To understand the biological significance of iron, sulpur.	
L3	To study the toxicity of metals in medicines.	
L4	To have knowledge on diagnostic agents.	
L5	To discuss on various metalloenzymes properties.	
UNIT	**Contents**	**No. of Hours**
I	**Essential trace elements:** Selective transport and storage of metal ions: Ferritin, Transferrin and sidorphores; Sodium and potassium transport, Calcium signalling proteins. Metalloenzymes: Zinc enzymes– carboxypeptidase and carbonic anhydrase. Iron enzymes–catalase, peroxidase. Copper enzymes – superoxide dismutase, Plast ocyanin, Ceruloplasmin, Tyrosinase. Coenzymes - Vitamin-B12 coenzymes.	15
II	**Transport Proteins:** Oxygen carriers -Hemoglobin and myoglobin - Structure and oxygenation Bohr Effect. Binding of CO, NO, CN– to Myoglobin and Hemoglobin. Biological redox system: Cytochromes-Classification, cytochrome a, b and c. Cytochrome P-450. Non-heme oxygen carriers-Hemerythrin and hemocyanin. Iron-sulphur proteins- Rubredoxin and Ferredoxin- Structure and classification.	15
III	**Nitrogen fixation**-Introduction, types of nitrogen fixing microorganisms. Nitrogenase enzyme - Metal clusters in nitrogenase- redox property - Dinitrogen complexes transition metal complexes of dinitrogen - nitrogen fixation via nitride formation and reduction of dinitrogen to ammonia. Photosynthesis: photosystem-I and photosystem-II-chlorophylls structure and function.	15
IV	**Metals in medicine:** Metal Toxicity of Hg, Cd, Zn, Pb, As, Sb. Therapeutic Compounds: Vanadium-Based Diabetes Drugs; Platinum-Containing Anticancer Agents.Chelation therapy; Cancer treatment. Diagnostic Agents: Technetium Imaging Agents; Gadolinium MRI Imaging Agents. temperature and critical magnetic Field.	15
V	**Enzymes -**Introduction and properties -nomenclature and classification. Enzyme kinetics, free energy of activation and	15

	the effects of catalysis. Michelis - Menton equation - Effect of pH, temperature on enzyme reactions. Factors contributing to the efficiencyof enzyme.	
	Total	**75**

Course Outcomes		**Programme Outcomes**
CO	**On completion of this course, students will**	
1	Analyze trace elements.	K1,K2,K3,K4,K5
2	Explain the biological redox systems.	K1,K2,K3,K4,K5
3	Analyzing the toxicity in metals.	K1,K2,K3,K4,K5,K6
4	Understand the role of diagnostic agents	K1,K2,K3,K4,K5,K6
5	Intrepret nitrogen fixation and photosynthetic mechanism.	K1,K2,K3,K4,K5,K6

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

Mapping with Programme Outcomes:

CO /PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO**10
CO 1	3	3	3	3	2	3	3	3	3	2
CO 2	2	3	3	3	3	2	3	3	3	3
CO 3	3	3	2	3	3	3	3	2	3	3
CO 4	2	3	3	3	3	2	3	3	3	3
CO 5	2	3	2	3	3	2	3	2	3	3

Strong-3 Medium-2 Low-1

Level of Correlation between PSO's and CO's

CO /PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Strong-3 Medium-2 Low-1

Course Code	Course Title	Category	Credits	Hours	Marks		
					CIAE	External	Total
23PCHSE21	CHEMISTRY IN EVERYDAY LIFE	SEC	2	4	25	75	100

Learning Objectives		
L1	To understand the food pyramid, hygiene and nutrition.	
L2	To explain the food and water chemistry	
L3	To study the types of drugs.	
L4	To learn about the antibiotics and vitamins.	
UNIT	**Contents**	**No. of Hours**
I	**Health**: Definition - Food Pyramid – Health – Hygiene - mal, under and over nutrition, their causes and remedies, sanitation.	12
II	**Food chemistry:** Food - classification and functions - Digestion in mouth, stomach and intestine. Absorption - spoilages, preservation techniques (canning, dehydration, freeze-drying. salting, pickling, pasteurizing, fermenting and carbonating).	12
III	**Water Chemistry**: Characteristics of water, soft water and hard water - removal of hardness - Purification of water by ion exchange and reverse osmosis methods. Water pollution**:** Sources and effects of water pollution (Domestic, Industrial, Agricultural) -Eutrophication.	12
IV	**Drugs:** Types of drugs-depressant, anticonvulsant, narcotics, antipyretics, antibiotics, antiseptics, analgesics, muscle relaxants and cardiovascular and vasodepressants, steroids (Only Applications).	12
V	**Antibiotics:** Definition - uses of Antibiotics - Ampicillin, streptomycin, tetracycl in, Erythromycin. **Vitamins**: Classifications of vitamins - vitamins deficiency diseases. (Vitamins A, B1, B2, B3, B6, B12, C, D, E and K).	12
	Total	**60**

Course Outcomes		Programme Outcomes
CO	On completion of this course, students will	
1	Understand mal, under and over nutrition.	K1,K2,K3,K4,K5
2	Acquire the knowledge of Digestion.	K1,K2,K3,K4,K5
3	Design the different methods for the Purification of water.	K1,K2,K3,K4,K5,K6
4	Apply knowledge of different types of drugs.	K1,K2,K3,K4,K5,K6

5	Analyze the basics principles of vitamins and Antibiotics.	K1,K2,K3,K4,K5,K6
Textbooks		
1	Donald J. Abraham ***Burger Medicinal Chemistry***, Wiley, Publisher. April 2021.	
2	G. R. Chatwal, ***Pharmaceutical chemistry***, Himalaya Publishing House, 2022.	
Reference Books		
1.	Singh and VK Kapoor, ***Organic Pharmaceutical Chemistry***, Vallabh Publications, 1996.	
2.	S. Lakshmi, ***Pharmaceutical Chemistry***, S. Chand Publishing, 2010.	
Web Resources		
1.	https://handoutset.com/wp-content/uploads/2022/07/Burgers-Medicinal-Chemistry-and-Drug-Discovery-Drug-Discovery-Volume-1-Donald-J.-Abraham.pdf	
2.	https://books.google.co.in/books/about/Medicinal_and_Pharmaceutical_Chemistry.html?id=VYklcAAACAAJ&redir_esc=y	
3.	https://www.schandpublishing.com/books/tech-professional/medical/a-textbook-pharmaceutical-chemistry/9788121915083/	

Mapping with Programme Outcomes:

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
CO 1	3	3	3	3	2	3	3	3	3	2
CO 2	2	3	3	3	3	2	3	3	3	3
CO 3	3	3	2	3	3	3	3	2	3	3
CO 4	2	3	3	3	3	2	3	3	3	3
CO 5	2	3	2	3	3	2	3	2	3	3

Strong-3 Medium-2 Low-1

Level of Correlation between PSO's and CO's

CO /PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Strong-3 Medium-2 Low-1