PERIYAR UNIVERSITY

NAAC 'A++' Grade with CGPA 3.61 (Cycle - 3)

SALEM-636011, Tamil Nadu, India.

SYLLABUS FOR M.Sc., CHEMISTRY

DEGREE OF MASTER OF SCIENCE

CHOICE BASED CREDIT SYSTEM

(For candidate admitted in the college affiliated to Periyar University from 2026-2027 onwards)

PERIYAR UNIVERSITY
Members of the Board

S.NO	Name & Address	Designation of the Board
1	Dr. A. Loganathan Associate Professor, Department of Chemistry Thiruvalluvar Government Arts College Rasipuram — 637 401, Namakkal -Dt. Ph.9840952195 E-Mail: loghunadan@gmail.com	Chairman
2	Dr.S.Sankar Associate Professor, Department of Chemistry Kandaswami Kandar's College P.Velur - 638 182, Namakkal Dt.	Member
3	Dr. K. Bharathi Associate Professor, Department of Chemistry Sri Sarada College for Women (Autonomous) Salem - 636 016. Ph. 9789320566 E-mail: bharathianbu00@gmail.com	Member
4	Dr. E. Krishnan Assistant Professor, Department of Chemistry Sri Moogambigai Arts & Science College(Women), Mahendramangalam Panchayat Thimmarayana Halli village, Palacode (Tk) Dharmapuri- 636805. E.Mail: sirkrishnan1982@gmail.com	Member
5	Dr.D.Gopi Professor, Department of Chemistry Periyar University, Salem-636011, Ph.9865538787, e-mail:gopi@periyaruniversity.ac.in	University Nominee
6	Dr.K.P.Elango Senior Professor and Head, Dept. of Chemistry The Gandhigram Rural Institute (Deemed to be University), Gandhigram-624302 Ph.9442636725, e-Mail:drkpelango@rediffmail.com	External Member
7	Dr.S.Thirumaran Professor., Department of Chemistry Annamalai University, Annamalainagar (PO) Chidambaram-608002. Ph.No:9842897597 E.Mail: sthirumaran@yahoo.com	External Member
8	Mr.Bharat Patel Head QC, Globesynth Pharma Tech, 147/4, A2, Bungalow Thottam, Uthamacholapuram, Salem-635010. Ph.9115796473, e-Mail:bharat.patel@gspharma.tech	Industrial Personal
9	Dr.S.Anbuselvi Associate Professor, Department of Chemsitry Sri Sarada College for Women Fairlands, Salem-636016. Ph.No:9894326374 E.Mail: selvisarachem80@gmail.com	Alumni

REGULATIONS

1. OBJECTIVES OF THECOURSE:

The objectives of this course are the following:

(a) To impart knowledge in advanced concepts and applications in various fields of Chemistry.

(b) To provide wide choice of elective subjects with updated and new areas in various branches of Chemistry to meet the needs of all students.

2. COMMENCEMENT OF THISREGULATION:

These regulations shall take effect from the academic year 2026-2027, that is, for students who are admitted to the first year of the course during the academic year 2026-2027 and thereafter.

3. ELIGIBILITY FORADMISSION:

A candidate who has passed B.Sc., Chemistry degree of this University or any other University accepted by the Syndicate equivalent thereto, subject to such condition as may be prescribed therefore are eligible for admission to M.Sc., Degree Programme and shall be permitted to appear and qualify for the Master of Science (M.Sc.) Degree Examination in Chemistry of this University.

4. DURATION OF THECOURSE:

The programme for the degree of Master of Science in Chemistry shall consist of two Academic years divided into four semesters.

5. EXAMINATIONS:

The examination shall be of three hours duration for each course at the end of each semester. The candidate failing in any subject(s) will be permitted to appear in the subsequent examination.

The practical / project should be an individual work. The University examination for practical / project work will be conducted by the internal and external examiners jointly at the end of every year.

Grading:

Conversion of marks to Grade points and letter grade (Performance in a course / paper)

Range of marks	Grade Points	Letter Grade	Description
90-100	9.0-10.0	O	Outstanding
80-89	8.0-8.9	D+	Excellent
75-79	7.5-7.9	D	Distinction
70-74	7.0-7.4	A+	Very Good
60-69	6.0-6.9	A	Good
50-59	5.0-5.9	B	Average
40-49	4.0-4.9	C	Satisfactory
00-39	0.0	U	Re-appear
ABSENT	0.0	AAA	ABSENT

Ci = Credits earned for course I in any semester

Gi = Grade point obtained for course I in any semester

N = Refers to the semester in which such course was credited

Grade point average (for a Semester):

Calculation of grade point average semester wise and partwise is as follows:

GRADE POINT AVERAGE [GPA] = $\Sigma i Ci\ Gi/\Sigma i Ci$

$$GPA = \frac{\text{Sum of the multiplication of grade points by the credits of the courses offered under each part}}{\text{Sum of the credits of the courses under each part in a semester}}$$

Calculation of grade point average (CGPA) (for the entire programme)

A candidate who has passed all the examinations under different parts is eligible for the following part wise computed final grades based on the range of CGPA.

CUMULATIVE GRADE POINT AVERAGE [CGPA] = $\Sigma n \Sigma i Cni Gni / \Sigma n \Sigma i Cni$

$$CGPA = \frac{\text{Sum of the multiplication of grade points by the credits of the entire programme under each part}}{\text{Sum of the credits of the courses of the entire programme under each part}}$$

Classification of successful candidates:

A candidate who passes all the examinations in all Part securing following CGPA and Grades shall be declared as follows :

CGPA	GRADE	Classification of Final Result
9.5-10.0	O+	First Class – Exemplary
9.0 and above but below 9.5	O	
8.5 and above but below 9.0	D++	First Class with Distinction
8.0 and above but below 8.5	D+	
7.5 and above but below 8.0	D	
7.0 and above but below 7.5	A++	First Class
6.5 and above but below 7.0	A+	
6.0 and above but below 6.5	A	
5.5 and above but below 6.0	B+	Second Class
5.0 and above but below 5.5	B	
4.5 and above but below 5.0	C+	Third Class
4.0 and above but below 4.5	C	

1. Ranking

Candidates who pass all the examinations prescribed for the course in the first instance and within a period of three academic years from the year of admission to the course only are eligible for University Ranking.

M.Sc., CHEMISTRY- Students admitted From 2026-2027 Onwards

Structure, course work, contact hours, credits and maximum internal and external marks

Course	Title of the Paper	Contact Hrs./Week	Credit	Exam. Hrs.	Int. Marks	Ext. Marks	Total Marks
SEMESTER –I							
Core course-I	Organic Chemistry-I	5	5	3	25	75	100
Core course-II	Inorganic Chemistry - I	5	5	3	25	75	100
Core course-III	Physical Chemistry- I	5	5	3	25	75	100
Elective-I	Polymer Chemistry(OR)	4	4	3	25	75	100
	Nanochemistry						
	Organic Chemistry Practical-I	3	-	-	-	-	-
	Inorganic Chemistry Practical-I	3	-	-	-	-	-
	Physical Chemistry Practical-I	3	-	-	-	-	-
Skill enhancement course-I	Industrial Chemistry	2	1	-	INTERNAL ASSESSMENT		
		30	20				**400**
SEMESTER –II							
Core course-IV	Organic Chemistry-II	5	5	3	25	75	100
Core course-V	Inorganic Chemistry - II	5	5	3	25	75	100
Core course-VI	Spectroscopy	5	5	3	25	75	100
Core course-VII	Organic Chemistry Practical-I	3	3	6	40	60	100
Core course-VIII	Inorganic Chemistry Practical-I	3	3	6	40	60	100
Core course-IX	Physical Chemistry Practical-I	3	3	6	40	60	100
NMEC		4	4	3	25	75	100
	Human Rights	2	1	3	25	75	100
		30	**26**				**800**
SEMESTER-III							
Core course-X	Organic Chemistry-III	5	5	3	25	75	100
Core course-XI	Inorganic Chemistry - III	5	5	3	25	75	100
Core course-XII	Physical Chemistry- II	5	5	3	25	75	100
Elective-II	Analytical Chemistry (OR)	4	4	3	25	75	100
	Medicinal Chemistry						
	Organic Chemistry Practical-II	3	-	-	-	-	-
	Inorganic Chemistry Practical-II	3	-	-	-	-	-
	Physical Chemistry Practical-II	3	-	-	-	-	-
Skill enhancement course-I	Professional Competency Skill Enhancement Course	2	1	-	INTERNAL ASSESSMENT		
	Carried out in summer vacation at the end of I year-30 Hrs		2				
		30	22				**400**
SEMESTER-IV							
Core course-XIII	Organic Chemistry-IV	5	5	3	25	75	100
Core course-XIV	Electro Chemistry	5	5	3	25	75	100
Core course-XV	Organic Chemistry Practical-II	3	3	6	40	60	100
Core course-XVI	Inorganic Chemistry Practical-II	3	3	6	40	60	100
Core course-XVII	Physical Chemistry Practical-II	3	3	6	40	60	100
Core course-XVIII	Project Work	11	6	6	-	200	200
	Extension Activity	-	1	-	-	-	-
		30	26				**700**
			94				**2300**

Semester	Part	Paper Type	Course	Course Code	Page No.
I	Part- A	Theory	Organic Chemistry-I	26PCH01	
		Theory	Inorganic Chemistry - I	26PCH02	
		Theory	Physical Chemistry- I	26PCH03	
		Theory	Polymer Chemistry(OR)	26PCHE01	
		Theory	Nanochemistry	26PCHE02	
	Part-B	SEC	Industrial Chemistry	26PCHS01	
II	Part- A	Theory	Organic Chemistry-II	26PCH04	
		Theory	Inorganic Chemistry - II	26PCH05	
		Theory	Spectroscopy	26PCH06	
		Practical	Organic Chemistry Practical-I	26PCHP01	
		Practical	Inorganic Chemistry Practical-I	26PCHP02	
		Practical	Physical Chemistry Practical-I	26PCHP03	
III	Part- A	Theory	Organic Chemistry-III	26PCH07	
		Theory	Inorganic Chemistry - III	26PCH08	
		Theory	Physical Chemistry- II	26PCH09	
		Theory	Analytical Chemistry (OR)	26PCHE03	
		Theory	Medicinal Chemistry	26PCHE04	
	Part-B	SEC	Professional Competency Skill Enhancement Course	26PCHS02	
IV	Part- A	Theory	Organic Chemistry-IV	26PCH10	
		Theory	Electro Chemistry	26PCH11	
		Practical	Organic Chemistry Practical-II	26PCHP04	
		Practical	Inorganic Chemistry Practical-II	26PCHP05	
		Practical	Physical Chemistry Practical-II	26PCHP06	
		Project	Project Work	26PCHPR01	
	Part- C		Extension Activity		

PO AND PSO DESCRIPTIONS

LEARNING OUTCOMES-BASED ON CURRICULUM FRAMEWORK GUIDELINES AND REGULATIONS FOR POSTGRADUATE PROGRAMME	
Programme:	**M.Sc., Chemistry**
Duration:	**2 Years**
Programme Outcomes:	**PO1: Disciplinary Knowledge** Demonstrate comprehensive knowledge and understanding of fundamental and advanced concepts in Organic, Inorganic, Physical, Analytical, and Applied Chemistry. **PO2: Critical Thinking and Problem Solving** Apply scientific principles, analytical reasoning, and problem-solving skills to address complex chemical problems in academic, research, and industrial settings. **PO3: Experimental and Laboratory Competence** Design, conduct, and interpret chemical experiments using standard and advanced laboratory techniques while maintaining accuracy, precision, and safety. **PO4: Modern Tool Usage** Utilize modern chemical instrumentation, computational methods, and digital technologies for chemical analysis, data processing, and research applications. **PO5: Research and Innovation** Plan and execute independent research projects, analyze scientific literature, generate new knowledge, and contribute to innovation in chemical sciences. **PO6: Environment and Sustainability** Apply principles of green chemistry and sustainable development to minimize environmental impact and promote responsible use of chemical resources. **PO7: Ethics and Professional Responsibility** Adhere to ethical principles, professional standards, laboratory safety practices, and regulatory guidelines in research, industry, and society. **PO8: Communication Skills** Communicate scientific concepts, experimental findings, and research outcomes effectively through oral presentations, technical reports, publications, and digital media. **PO9: : Entrepreneurship and Employability** Develop entrepreneurial skills and professional competence for careers in chemical industries, research organizations, educational institutions, quality control laboratories, and allied sectors. **PO10: Societal Contribution** Apply chemical knowledge to address societal challenges related to health, energy, environment, agriculture, and sustainable development for the benefit of society.

Programme Specific Outcomes:	On successful completion of Master of Chemistry programme, the student should be able to: **PSO1: Advanced Chemical Knowledge** Acquire in-depth knowledge of Organic, Inorganic, Physical, Analytical, and Materials Chemistry, enabling understanding of advanced chemical concepts, theories, and applications. **PSO2: Laboratory and Instrumentation Skills** Develop proficiency in modern laboratory techniques, chemical synthesis, characterization, separation methods, and operation of advanced analytical instruments such as UV-Visible, IR, NMR, Mass Spectrometry, XRD, AAS, and chromatographic techniques. **PSO3: Problem Solving and Research Competence** Apply chemical principles and scientific methodologies to identify, analyze, and solve complex chemical problems through experimentation, data interpretation, and research-oriented approaches. **PSO4: Computational and Data Analysis Skills** Utilize computational tools, statistical methods, and chemical software for molecular modeling, data analysis, interpretation of experimental results, and scientific reporting. **PSO5: Environmental and Industrial Applications** Understand the role of chemistry in environmental protection, sustainable development, green chemistry, pollution control, energy resources, and industrial processes.

DISTRIBUTION OF MARKS

THEORY

University Examination (External): 75 marks

Internal Assessment: 25marks

Distribution of Internal Assessment mark

Test:	10marks
Attendance:	5 marks
Assignment:	5 marks
Seminar:	5marks
Total:	**25marks**

Passing Minimum: External Assessment: 50% - 38 marks

Total Passing Minimum: 50 marks

PRACTICAL

University Examination (External): 60 marks

Internal Assessment: 40 marks

Calculation of Internal Assessment mark

Number of Experiments:	10marks
Experimental skill:	10marks
Model Practical	20marks
Total: 40marks	

Passing Minimum: External Assessment: 50% - 30 marks

Total Passing Minimum - 50marks

Everything should be supported by proper record separate passing minimum is necessary for Internal and External

QUESTION PAPER PATTERN THEORY

Time: 3Hours Max. Marks: 75

Part - A: 15 X 1 = 15

Answer all questions

Three multiple choice questions from each unit

Part - B: 2 X 5 = 10

Answer any two questions

One question from each unit

Part – C: 5X 10 = 50

Answer all questions

One question from each unit with internal choice

PRACTICAL

Distribution of marks for practical

Experiment	45 marks
Viva-voce in practical	10 marks
Record	5 marks
Total	60 marks
Duration	6 Hours
PROJECT	
Dissertation / Project	150 marks
Viva - voce	50 marks
Total	200 marks

SEMESTER-I

CORE-I

ORGANIC CHEMISTRY –I

Unit	Content	No. of Hours
I	**Effect of structure on reactivity:** Kinetic and non-kinetic methods of determining reaction mechanism: isotopic effect, study of intermediates, isotopic labelling and cross over experiments. Hammond's postulates. Linear free energy relationship - Hammet equation. Thermodynamically and kinetically controlled reactions, **Aromaticity:** Benzenoid and non-benzenoid aromatics, ferrocene, azulene and annulenes (synthesis not required). Alternant and non-alternant hydrocarbons homoaromaticity- antiaromaticity. Frost-Musulin circle method. Möbius aromaticity. Aromatic stabilization energy and aromaticity criteria.	15
II	**Stereochemistry I:** Wedge, Fischer, Newmann and Saw-horse formulae and their inter conversion, R and S notation, axial chirality (allenes, spiranes and biphenyls), planar chirality (trans cyclooctene, cyclophanes and ansa compounds), chirality due to helical shape, stereo selective and stereo specific reactions, asymmetric synthesis- Cram's rule. Enantiomers and diastereomers, Enantiomeric excess and optical purity. Homotopic, enantiotopic and diastereotopic atoms, groups in organic molecules.	15
III	**Stereochemistry-II:** Conformational analysis of simple cyclic (chair and boat cyclohexanes) and acyclic (n-butane) systems, conformation of simple 1,2-disubstituted derivatives(ethylene chlorohydrin and ethylene glycol), Conformational analysis and stereochemical features of disubstituted cyclohexanes (1,2 ; 1,3 ; 1,4 dialkyl cyclo hexanes), conformation and stereochemistry of cis and trans decalins, Fused and bridged rings: bicyclic, poly cyclic systems and Brett's rule. Optical rotation and optical rotatory dispersion, conformational asymmetry, ORD curves, octant rule, Cotton effect, axial haloketone rule and determination of configuration.	15
IV	**Aromatic electrophilic substitution reactions:** Arenium ion mechanism orientation and reactivity of mono and di-substituted benzenes. Friedel-Crafts alkylation, acylation, Vilsmeier-Haack reaction, Fries rearrangement, Diazonium coupling, Hoffmann Maritus and Jacobsons reactions. **Aromatic nucleophilic substitution reactions:** Intermediate complex mechanism, Benzyne mechanism - Structure reactivity relationship. Ziegler alkylation and Chichibabin reaction. Cine and tele substitution. SRN1 mechanism. Nucleophilic aromatic substitution in heteroaromatic systems.	15
V	**Aliphatic nucleophilic substitution reactions:** S_N1, S_N2, S_Ni, mechanisms, The neighbouring group mechanism, neighbouring group participation by σ and π- bonds. Nucleophilic substitution at an allylic, aliphatic trigonal and vinylic carbon. Stereo chemistry of nucleophilic substitution reactions, effect of substrate structure, solvent, leaving group and nucleophilicity. Ambident nucleophiles. **Aliphatic electrophilic substitution reactions:** S_E1, S_E2 and S_Ei mechanisms - Structure reactivity relationship.	15

TEXT BOOKS

1. J. March and M. Smith, Advanced Organic Chemistry, 9th edition, John-Wiley and Sons.2025.
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, 8th edn, Prentice Hall, 2016.
5. J.Clayden, N. Greeves, S. Warren, Organic Compounds, 2ndedition, Oxford University Press, 2014.
6. Francis A. Carey, Organic Chemistry, 11th Edition, The McGraw-Hill Companies, Inc., 2020.

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.
6. P.S. Kalsi, Organic Reactions and Mechanisms, 6th Edition, New Age International Publishers, 2020.

Course Outcomes (COs)

CO1: Explain the influence of molecular structure on organic reaction mechanisms using kinetic and non-kinetic methods, isotopic studies, Hammond postulate, Hammett equation, and kinetic/thermodynamic control concepts.

CO2: Analyze aromaticity and antiaromaticity in benzenoid, non-benzenoid, homoaromatic, alternant, non-alternant, Möbius, and organometallic aromatic systems using theoretical criteria and Frost-Musulin method.

CO3: Apply stereochemical principles to determine configuration, chirality, conformational behavior, stereoselectivity, stereospecificity, and asymmetric synthesis in organic molecules.

CO4: Evaluate conformational effects, ring stability, neighboring group participation, rearrangements, optical activity, ORD studies, and stereochemical aspects of cyclic and acyclic systems.

CO5: Interpret mechanisms, stereochemistry, and structure-reactivity relationships of aromatic and aliphatic electrophilic and nucleophilic substitution reactions.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

CORE-II

INORGANIC CHEMISTRY –I

Unit	Content	No. of Hours
I	**Structure and Bonding:** Hard and Soft acids and bases-classifications, Acid-Base strength, hardness, symbiosis, Theoretical basis of Hardness and Softness, applications of HSAB. Rings-Phosphazenes- Structure, Craig and Peddock model, Dewar model, polyorgano phosphazenes, Polysulphur –nitrogen compounds. Inorganic polymers-Silicates-structure, Pauling's rule, properties, correlation and application; Molecular sleves. Polyacids- Isopolyacids of V, Cr, Mo and W; Heteropolyacids of Mo and W (only structural aspects)	15
II	**Bioinorganic chemistry** Bioinorganic chemistry- Biological significances of metals- alkali and alkaline earth metals, Na/K pump, Transition metal storage and transport of Fe, Cu, Zn, Biological oxygen transport systems, Structure and function of heme and non-heme proteins (Mb, Hb, Hc, Hr), Non-redox metalloenzymes- carboxy peptidase and carbonic anhydrase. Functions of Fe,Cu, Fe, sulphur proteins, cytochrome C and cytochrome P-450, Fundamental reactions of metals with nucleic acids and nitrogen fixation.	15
III	**Boron compounds and Clusters** Boron hydrides – polyhedral boranes, hydroborate ions, preparation, properties and structures; styx numbers and Wade-Mingos rules. Carboranes – closo, nido, arachno and hypho systems; preparation, properties and structures. Metallaboranes and Metallocarboranes – general study. Metal Clusters – low nuclearity metal clusters; structure of Re_2Cl_8, metal-metal multiple bonding. Cluster Electron Counting Rules – Wade's rules, Jemmis mno rule and isolobal analogy. Applications of cluster compounds in catalysis and materials chemistry.	15
IV	**Nuclear Chemistry – I** Structure of nucleus – subatomic particles and their properties, mass defect, binding energy, neutron/proton ratio in stable nuclei. Nuclear forces. Liquid drop model and shell model. Magic numbers and nuclear stability. Radioactive decay – α, β and γ decay theories, orbital electron capture, positron emission, nuclear isomerism and internal conversion. Detection and measurement of radioactivity – GM counter, scintillation counter, Cherenkov counter and semiconductor detectors. Particle accelerators – Linear accelerator, cyclotron, synchrotron, betatron and bevatron. Principles and applications in nuclear research. Detailed engineering aspects of accelerator design.	15
V	**Nuclear Chemistry – II** Nuclear reactions – Q value, Coulomb barrier, nuclear cross section, projectile capture, particle emission, spallation, fission and fusion reactions. Product distributions and theories of fission. Fissile and fertile isotopes – U-235, U-238, Pu-239 and Th-232. Nuclear reactors and breeder reactors. Stellar nucleo synthesis and synthesis of super heavy elements. Radioisotopes – tracer techniques, neutron activation analysis, isotope dilution analysis, applications in structure elucidation and mechanistic studies. Carbon dating and radio pharmacology. Radiation chemistry – interaction of radiation with matter, G-value and radiation effects. Radiation protection, safety measures, disposal of nuclear waste and environmental impact of nuclear energy.	15

TEXT BOOKS

1. F.A Cotton & Wilkinson, Advanced Inorganic Chemistry, 6th Edition (1999, Wiley India)
2. Emelius and Sharpe, Modern Aspects of Inorganic Chemistry, 6th Edition (1999, Wiley India).
3. J.D. Lee, Concise Inorganic Chemistry, 5th Edition (2008, Oxford University Press).
4. S.F.A. Kettle, Physical Inorganic Chemistry, 2nd Edition (1996, Oxford University Press)
5. J.E.Huheey, E.A.Keiter and R.L.Keiter, Inorganic chemistry-principles of structure and reactivity, 5th edition, Pearson-Education,2022
6. H.J. Arnikar, Essentials of nuclear Chemistry, 5nd edition, Wiley easternCo.,2022.
7. S. Glasstone, Source Book on Atomic Energy. 3rd Edition (1967, D. Van Nostrand Company)

REFERENCE BOOKS

1. H.A.O. Hill and P.Day, Physical methods in advanced Inorganic chemistry, John Wiley. 1968
2. G.S. Manku, Inorganic Chemistry, T.M.H. Co., 1984.
3. K.F. Purcell and J.C. Kotz, Inorganic Chemistry, WB Saunders Co., USA, 1977.
4. G. Friedlander, J.W.Kennedy and J.M. Miller, Nuclear and Radio Chemistry, Wiley, 1964.
5. Aayjay kumarbhagi and G.R.Chatwal,Bioinorganic and Supramolecular Chemistry, Himalaya Publishing House. 2003.
6. Gurdeep Raj, Advanced Inorganic Chemistry-II Goel PublishingHouse, 1996-97.
7. M.N.Hughes,The Inorganic Chemistry and Biological Processes,Wiley London, IIEdition, 1981.
8. A.K. Srivatsava and P.C. Jain, Elements of Nuclear Chemistry, S.Chand and Co, 1989.

Course Outcomes (COs)

CO1: Explain the concepts of HSAB theory, phosphazenes, inorganic polymers, silicates, polyacids, and their structural features, properties, and applications.

CO2: Analyze the role of metal ions in biological systems, oxygen transport, metalloenzymes, electron transfer proteins, and nitrogen fixation processes.

CO3: Interpret the structures, bonding, electron counting rules, and reactivity of boranes, carboranes, metallaboranes, metallocarboranes, and metal cluster compounds.

CO4: Apply principles of nuclear structure, radioactive decay, radiation detection, and particle accelerators in nuclear chemistry and research.

CO5: Evaluate nuclear reactions, reactor technologies, radioisotope applications, radiation chemistry, nuclear safety, and environmental impacts of nuclear energy.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	M	S	M	S	S	M	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

CORE- III

PHYSICAL CHEMISTRY –I

Unit	Content	No. of Hours
I	**Classical Thermodynamics – I** Concept of chemical potential – determination of chemical potential by direct method and intercept method. Variation of chemical potential with temperature and pressure. Fugacity – determination of fugacity and variation with temperature and pressure. Standard states for gases, liquids, solids and components of solutions. Solutions of electrolytes – ionic strength, mean ionic activity and mean ionic activity coefficient. Determination of activity coefficients of electrolyte using freezing point, EMF and solubility measurements. Debye-Hückel theory. Excess thermodynamic functions and partial molar properties. Gibbs-Duhem equation and applications. Non-ideal solutions and activities.	15
II	**Statistical Thermodynamics – I** Concept of mathematical probability and thermodynamic probability. States of maximum thermodynamic probability. Distinguishable and indistinguishable particles. Microstates and macrostates. Ensembles – microcanonical, canonical and grand canonical ensembles. Maxwell-Boltzmann distribution law of molecular velocities – derivation and applications. Evaluation of average velocity, root mean square velocity and most probable velocity. Molecular velocities and energies of ideal gases. Boltzmann distribution law and population of energy levels. Relationship between entropy and probability (Boltzmann equation). Phase space concept. Introduction to partition function and its significance.	15
III	**Chemical Kinetics – I** Theories of reaction rates – collision theory and transition state theory. Comparison of collision theory and activated complex theory. Lindemann and Hinshelwood theories of unimolecular reactions. Potential energy surfaces and reaction coordinates. Reactions in solution – comparison between gas-phase and solution-phase reactions. Cage effect. Influence of solvent, ionic strength and pressure on reaction rates. Kinetic isotope effects. Bronsted-Bjerrum equation. Primary and secondary salt effects. Diffusion-controlled reactions. Marcus theory of electron transfer (elementary treatment). Enzyme kinetics – Michaelis-Menten equation and Lineweaver-Burk plot.	15
IV	**Quantum Chemistry – I** Planck's theory of black body radiation. Photoelectric effect. de Broglie equation. Heisenberg uncertainty principle. Compton effect. Operators and commutation relations. Quantum mechanical postulates. Schrödinger equation and its application to particle in one-dimensional and three-dimensional boxes. Harmonic oscillator. Eigen functions and eigen values. Normalisation and orthogonality of wave functions.	15
V	**Group Theory – I** Symmetry elements and symmetry operations. Matrix representation of symmetry operations. Character of a matrix. Point groups. Multiplication of symmetry operations. Group multiplication tables. Similarity transformations and classification of symmetry operations. Matrix representations of point groups. Reducible and irreducible representations. Great Orthogonality Theorem (GOT) and rules derived from GOT. Character tables of C_{2v}, C_{3v} and C_{2h} point groups. Construction and reduction of reducible representations. Direct products and their applications. Projection operator concept. Applications of group theory to molecular vibrations and hybrid orbitals. Symmetry adapted linear combinations (SALCs) – elementary treatment.	15

TEXTBOOKS

1. S.Glasstone, Thermodynamics for chemists, Affiliated East West press, New Delhi,1990.
2. J. Rajaram and J.C. Kuriacose, Thermodynamics for students of chemistry, Lal Nagin Chand, New Delhi, 1986.
3. J. Rajaram and J.C. Kuriacose, Kinetics and mechanism of chemical transformation, Macmillan India Ltd., 1993.
4. K.J.Laidler, Chemical Kinetics, Harper and Row, Newyork, 2008.
5. R.K. Prasad, Quantum Chemistry, Wiley Eastern, New Delhi, 6th Edition, 2020.
6. V.Ramakrishnan and M.S.Gopinathan, Group theory in chemistry, Vishal Publications, 1988.
7. K.V.Raman, Group theory and its application to chemistry, Tata McGraw Hill Publishing Co., 1990.
8. Gurudeep Raj, Advanced Physical Chemistry, Goel Publishing House, Meerut , 2022.

REFERENCE BOOKS

1. W.J. Moore, Physical Chemistry, Orient Longman, London, 5th edition, 2023.
2. J.W. Moore and R.G. Pearson, Kinetics and Mechanism, 1981.
3. A.K. Chandra, Introductory Quantum Chemistry, Tata Mc GrawHill. 4th edition, 2017.
4. P.W.Atkins, Molecular Quantum Mechanics, Oxford University Press, Oxford.6th edition, 2023.
5. I.N.Levine, Quantum chemistry, Allyn and Bacon, Boston,7th edition, 2014.
6. F.A. Cotton, Chemical Application of Group Theory, John Wiley and Sons Inc., Newyork, 3rd Edition, 1990.

Course Outcomes (COs)

CO1: Explain chemical potential, fugacity, standard states, activity coefficients, Debye-Hückel theory, excess thermodynamic functions, Gibbs-Duhem equation, and non-ideal solution behavior in electrolyte and non-electrolyte systems.

CO2: Apply statistical concepts such as probability, ensembles, molecular velocity distributions, Boltzmann distribution, entropy-probability relationships, phase space, and partition functions to thermodynamic systems.

CO3: Analyze reaction mechanisms and reaction rates using collision theory, transition state theory, unimolecular reaction theories, solvent effects, ionic strength effects, diffusion-controlled reactions, Marcus theory, and enzyme kinetics.

CO4: Interpret quantum mechanical principles including wave-particle duality, Schrödinger equation, quantum operators, particle-in-a-box and harmonic oscillator.

CO5: Apply symmetry and group theoretical methods to molecular systems, including point groups, representations, character tables, SALCs, molecular vibrations, and hybrid orbital analysis.

CO-PO Mapping (Course Articulation Matrix)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	M
CO 5	S	S	M	S	S	M	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	**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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

ELECTIVE- I

POLYMER CHEMISTRY

Unit	Content	No. of Hours
I	**Basic Concepts** Monomers, repeat units, degree of polymerization, Linear, branched and network polymers, Addition polymerization, Condensation polymerization, Mechanism of free radical, cationic and anionic polymerization and co-ordination polymerization. Ziegler-Natta catalyst. Kinetics of free radical, cationic, anionic and co-polymerisation. Determination of reactivity ratio and co-polymerisation behavior.	12
II	**Molecular Weight and Physical Properties** Concept of Average molecular weight, number- average, weight-average molecular weight and viscosity- average molecular weights. Determination of molecular weight - viscosity, light scattering, osmotic and ultracentrifugation methods. Physical properties- crystalline melting point, glass transition temperature, relationship between Tm and Tg and Determination of Tg.	12
III	**Polymer Processing and Polymerization Techniques** Polymers processing- Plastics, elastomers and fibres. Compounding, Processing techniques- calendaring, die casting, injection molding, thermo foaming and fibre spinning. Polymerization techniques- Bulk polymerization, solution polymerization, suspension polymerization, emulsion polymerization and melt polycondensation.	12
IV	**Commercial Polymers** Synthesis and applications of polyethylene, polyvinyl chloride, polyamide, polyester, phenol resins, epoxy resins, silicone polymers, polybenoxazoles, polyimidazole, polyurethane, polymethyl methacrylate, poly (tetrafluoro ethylene) and polyacrylonitrile.	12
V	**Conducting Polymers** Conducting polymers- Introduction, Electrochemical doping, Electrochemical synthesis and applications of polypyrrole, polythiophene, polyindole, polyaniline, polyacetylene and poly(p-phenylene).	12

REFERENCE BOOKS

1. F.W. Billmeyer, Textbook of Polymer Science, Wiley Student Edition, 3rdEdition. 1984
2. L. Gupta, Pragathi PrakashanPolymer Science, Publication. 3rdEdition, 2021.
3. V.R. Gowariker, N.V. Viswanathan, J. Sreedhar, Polymer Science, New Age International Private Limited, Revised Edition, 2015
4. P.J. Flory, Principles of Polymer Chemistry, Asian Books, 1stEdition, 2006.
5. George Odian, Principles of Polymerization, John Wiley, 4th Edition, 2007.
6. V.K.Ahluwalia & Anuradha Mishra, Polymer Science: A Text Book, Ane Books, 1st Edition, 2010.
7. A. Skotheim, L. Elsenbaumer, R.Reynolds, Handbook of Conducting Polymers, 3rd Edition, 2007.
8. Hari SinghNalwa, Textbook of Organic Conductive Molecules and Polymers. 1997.

Course Outcomes (COs)

CO1: Understand polymer fundamentals including monomers, polymer structures, polymerization mechanisms, kinetics, and copolymerization behavior.

CO2: Apply molecular weight determination techniques and correlate molecular weight with physical properties such as Tg and Tm.

CO3: Explain polymer processing operations and various polymerization techniques used in industrial manufacturing.

CO4: Discuss synthesis, properties, and applications of important commercial polymers.

CO5: Analyze conducting polymers, their synthesis, doping mechanisms, and technological applications in electronic and energy-related devices.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

ELECTIVE- II

NANOCHEMISTRY

Unit	Content	No. of Hours
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, Background of nanostructures. Techniques of synthesis of nanomaterials, Tools of the nanoscience. Applications of nanomaterials and technologies.	12
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.	12
III	**Carbon Clusters and Nanostructures** Nature of carbon bond − new carbon structures − carbon clusters-carbon nanotubes – synthesis − single walled carbon nanotubes. Structure and characterization − mechanism of formation − chemically modified carbon nanotubes − doping − functionalizing nanotubes − applications of carbon nanotubes. Nanowires −synthetic strategies − gas phase and solution phase growth− growth control − properties. Nanoparticles: gold and silver, metal oxides: silica, iron oxide and alumina – synthesis and properties.	12
IV	**Electrical properties** Conductivity and Resistivity, Classification of Materials based on Conductivity, magnetic properties, electronic properties of materials. Classification of magnetic phenomena. Semiconductor materials – classification-Ge, Si, GaAs, SiC, GaN, GaP, CdS, PbS. Identification of materials as p and n –type semiconductor-Hall effect - quantum and anomalous, Hall voltage - interpretation of charge carrier density. Applications of semiconductors: p-n junction as transistors and rectifiers, photovoltaic and photogalvanic cell.	12
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.	12

Text books:

1. S.Mohan and V. Arjunan, Principles of Materials Science, MJP Publishers, 2nd edition, 2021.

2. Arumugam, Materials Science, Revised Edition, Anuradha Publications, Chennai, 2018.

3. Giacavazzo et. al., Fundamentals of Crystallography, International Union of

Crystallography. Oxford Science Publications, 2011.

4. Woolfson, An Introduction to Crystallography, Cambridge University Press, 2015.

5. James F. Shackelford and Madanapalli K. Muralidhara, Introduction to Materials Science for Engineers. 9th ed., Pearson Press, 2020.

Course Outcomes (COs)

CO1: Explain the fundamental concepts of nanomaterials, nanotechnology, size-dependent properties, classifications (0D, 1D, 2D, and 3D nanostructures), and synthesis approaches including top-down and bottom-up methods.

CO2: Describe the bonding, structure, surface characteristics, and synthesis techniques of nanomaterials using physical and chemical methods such as CVD, sol-gel, hydrothermal, solvothermal, laser ablation, microwave-assisted, and electrochemical methods.

CO3: Analyze the structure, synthesis, functionalization, properties, and applications of carbon nanostructures including carbon nanotubes, nanowires, metallic nanoparticles, and metal oxide nanoparticles.

CO4: Evaluate the electrical, magnetic, and semiconductor properties of nanomaterials, Hall effect phenomena, charge carrier behavior, and applications in electronic and photovoltaic devices.

CO5: Demonstrate understanding of nano thin films, core-shell nanoparticles, nanocomposites, and characterization techniques such as SEM, TEM, and AFM for advanced material applications.

CO-PO Mapping (Course Articulation Matrix)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	**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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

SKILL ENHANCEMENT COURSE-I

INDUSTRIAL CHEMISTRY

Unit	Content	No. of Hours
I	**Glass and Ceramics** Glass: Introduction- Raw materials, manufacture and applications. Some special glasses-fused silica glass, optical glass, glass wool, photosensitive glass-composition and uses. Ceramics: Definition, Manufacture and applications.	6
II	**Cement** Cement: Introduction, Types of cement- High alumina cement, Slag cement, Acid resisting cement, White cement, Types of Portland cement, Raw materials, Manufacture of cement, Setting of cement, factors affecting quality of cement, Cement industries in Tamilnadu.	6
III	**Dyes and Paints** Dyes: Classifications of dyes, application of dyes in other areas-medicine, chemical analysis, cosmetics, colouring agents, Food and beverages. Paints: Constituents of paints, Manufacture of paints, Setting of paints, requirement of a good paint, paint failure.	6
IV	**Synthetic fibres and Plastics** Synthetic fibres: Difference between natural and synthetic fibres, Synthesis and applications of Rayon, Terylene, Nylon and Taflon. Plastics: Classification, properties and applications of plastics.	6
V	**Fats and Waxes** Classification of oils, fats and waxes, distinction between oils, fats and waxes, Uses of essential oils and fats. Soap and its manufacture -toilet and transparent soaps, cleansing action of soap. Detergent – classification and uses.	6

TEXT BOOKS:

1. Mukhlynov (ed.), Chemical Technology, Vol.1, Mir Publication, Moscow, III edn., 1979.
2. A. K. De, Environmental Chemistry, Wiley Eastern Ltd., 9 edn., Meerut 2022.
3. R.K. Goel, Process know-how and material of construction for Chemical Industries, S.B. Publ., Delhi, 2007.
4. B.N. Chakrabarthy, Industrial Chemistry, Oxford and IBH Publ., Now Delhi, 2014.
5. R. Norris Shreve and J.A. Brink, Jr. Chemical Process Industries, V edn., McGraw Hill, Tokyo, 1984.
6. Industrial Safety and Environment – A.K. Gupta –University Science press, New Delhi.2014.

SEMESTER-II

CORE-IV

ORGANIC CHEMISTRY –II

Unit	Content	No. of Hours
I	**Addition Reactions:** Electrophilic, nucleophilic and free radical addition reactions to double and triple bonds, hydration, hydroboration, Michael addition, epoxidation and hydroxylation. Hydroboration–oxidation and oxymercuration-demercuration **Addition reactions to carbonyl compounds:** Mannich reaction, aldol condensation. Perkin reaction, Tollen's reaction, Dieckmann, Stobbe, Prins reaction, Darzen, Wittig, Thorpe and Ritter reactions. Knoevenagel condensation. Claisen-Schmidt reaction.	15
II	**Elimination reactions:** The E1, E2,E1CB mechanisms, orientation of the double bond- Hofmann, Zaitsev's and Bredt rules, mechanism of pyrolytic elimination, Chugaev and Cope Elimination reactions. Syn and anti eliminations **Free radicals Reactions:** polymerization, addition, halogenation, aromatic substitution and rearrangement. Reactivity - reactivity on aliphatic, aromatic substrate, reactivity in the attacking radical and effect of solvents. Radical chain reactions and inhibition. Barton reaction. Minisci reaction.	15
III	**Oxidation:** Study of the following reactions with mechanism- Oxidation of alcohols by CrO_3, $K_2Cr_2O_7$, CrO_2Cl_2, DCC, $KMnO_4$, MnO_2, DMSO alone, DMSO in combination with DCC, Acetic anhydride and oxalyl chloride, Oxidation of aryl methane, oxidation of methylene group alpha to carbonyl, allylic oxidation of olefins, oxidative cleavage of glycols, ozonolysis, hydroxylation of olefins -OsO4, KMnO4, Prevost and Woodward dihydroxylation. **Reduction:** Hydride transfer reagents – NaBH4, Luche reduction, Red-Al, DIBAL-H, trialkylsilanes and trialkylstannane. Enantio selective reduction (chiral boranes, Corey-Bakshi-Shibata). Birch reduction, MPV reduction and its stereochemistry.	15
IV	**Molecular rearrangements:** Nucleophilic, electrophilic and free radical rearrangements-intramolecular and intermolecular rearrangements - migratory aptitudes - memory effects. Study of the following rearrangements with mechanism Pinacol-Pinacolone Wagner-Meerwin, Demjanov, Dienone-phenol, Favorski, Baeyer-Villiger, Wolff, Stevens, Von-Richter, Beckmann, Smiles, Neber and Hofmann- Martius. Applications of rearrangements in organic synthesis.	15
V	**Pericyclic Reactions** Classification and basic concepts of orbital symmetry. Woodward-Hoffmann rules. Electrocyclic reactions – conrotation and disrotation; cyclization of butadiene and 1, 3, 5-hexatriene using correlation diagram and frontier molecular orbital (FMO) approaches. Cycloaddition reactions – suprafacial and antarafacial additions; (2+2), (4+2), (3+2) cycloaddition reactions. Diels-Alder reaction and stereochemical aspects. Sigmatropic rearrangements involving hydrogen and carbon. Sommelet-Hauser, Cope and Claisen rearrangements. Ene reactions. Chelotropic reactions. Möbius and Hückel transition states. Applications of pericyclic reactions in natural product synthesis.	15

TEXT BOOKS

1. Jerry March, Advanced Organic Chemistry-Reactions, Mechanisms and Structure, 8th Edition, John Wiley & Sons (2020)
2. Francis A. Carey, Organic Chemistry,11th Edition, The McGraw-Hill Companies, Inc., 2023.
3. P.S. Kalsi, Organic Reactions and Mechanisms, 11th Edition, New Age International Publishers, 2019.
4. Charles H.Depuy, molecular reactions and photochemistry, Orville L.Chapman. Prentice Hall of India Pvt Ltd. New Delhi, 2010.
5. S.M. Mukherji and S.P. Singh, Reaction Mechanism in Organic Chemistry, III Edn. MacMillan, 2012.
6. V.K. Ahluwalia, Organic Reaction Mechanism, Narosa Publishing House, 5thEdition, 2019.

REFERENCE BOOKS

1. S. H. Pine, J.B. Hendrickson, D.J. Cram and G.S. Hammond, Organic Chemistry, IV Edn., McGraw Hill Company,2012.
2. R.T. Morrison and R.N. Boyd, Organic Chemistry, Prentice-Hall, 7^{th} edn. 2010.
3. R.O.C. Norman, Principles of Organic Synthesis, 3rd Edition, Chapman and Hall, 1993.
4. L.F.Fieser and M.Fieser, Organic Chemistry, Asia Publishing House, Bombay,5^{th} edn. 2007.
5. R.K. Bansal, Organic Reaction Mechanism, Tata McGraw Hill Publications, 3rd Edition, 2017.

Course Outcomes (COs)

CO1: Explain the mechanisms, stereochemistry, and regioselectivity of electrophilic, nucleophilic, and free-radical addition reactions involving alkenes, alkynes, carbonyl compounds, and conjugated systems.

CO2: Analyze the mechanisms and synthetic applications of condensation, carbonyl addition, elimination, oxidation and reduction reactions, including reagent selection and reaction optimization.

CO3: Interpret free-radical reactions, chain processes, inhibition mechanisms, and the influence of substrate structure, substituents, and solvents on radical reactivity.

CO4: Evaluate molecular rearrangements and predict migration tendencies, stereochemical outcomes, and synthetic utility of important nucleophilic, electrophilic, and radical rearrangement reactions.

CO5: Apply orbital symmetry principles, Woodward–Hoffmann rules, and FMO concepts to explain electrocyclic, cycloaddition, sigmatropic, ene, and chelotropic reactions in organic synthesis.

CO-PO Mapping (Course Articulation Matrix)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	**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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

CORE-V

INORGANIC CHEMISTRY –II

Unit	Content	No. of Hours
I	**Solid State - I** Electrical properties of solids: Conductors and non-conductors, Conductivity in pure metals and alloys– superconductors –Occurrence of superconductivity- BCS theory-Type-I and Type-II and High temperature (HT) superconductors- Preparation of HT superconductors-critical temperature– persistent currents- Meissner effect. Magnetic properties – dia, para, ferro, antiferro and ferrimagnetism; hysterisis; Optical properties –solid – state lasers and Inorganic phosphors. Reactions in solid state and phase transitions – diffusion coefficient, diffusion mechanism, vacancy and interstitial diffusions, formation of spinels; solid solutions, order-disorder transformations and super structure.	15
II	**Solid State–II** Types of solids-close packing of atoms and ions-bcc, fcc and hcp, voids and their types- Goldschmidt radius ratio-derivation-its influence on structures. Structures of NaCl, NiAs, CdI2 ,Pervoskite, rutile, fluorite and antifluorite-zinc blende and wurtzite. Defects in solids- Point defects, line defects and surface defects; Dislocations-Non- stoichiometric compounds; Use of X-ray powder data in identifying inorganic crystalline solids.	15
III	**Theories of coordination compounds** VB theory-CFT-Splitting of d orbital in ligand field and different symmetries-CFSE-Factors affecting the magnitude of 10 DQ-Evidence for crystal field stabilization (Structural and thermodynamic effects) - Spectrochemical series – Site selection in spinels - tetragonal distortion from octahedral symmetry-John Teller distortion - Nephelauxetic effect-Mo theory octahedral-tetrahedral and Square planar complexes-pi bonding and molecular orbital theory- experimental evidence for pi bonding.	15
IV	**Reaction of transition metal complexes** Energy profile of a reaction-reactivity of metal complexes- inert and labile complexes-kinetic application of valence bond and crystal field theories. Kinetics of octahedral substitutions- acid hydrolysis- factors affecting acid hydrolysis- base hydrolysis- conjugate base mechanism- direct and indirect evidences in favour of conjugate mechanism- anation reactions- reactions without metal ligand bond cleavage.	15
V	**Mechanism of transition metal complexes** Substitution reactions in square planar complexes- the trans effect-mechanism of the substitution reactions. Redox reactions- electron transfer reactions- mechanism of one electron transfer reactions- outer sphere type reactions- cross reactions and Marcus-Hush theory, inner sphere type reactions.	15

TEXT BOOKS:

1. Gurdeep Chatwal, Yadav, M.S., *Coordination Chemistry,* 5th Ed., Himalaya Publishing House, 2014.
2. Lasley Smart, Elain Moore, *Solid State Chemistry an Introduction, 4th* Ed., Replica Press Pvt. Ltd. 2021.
3. Anthony R. West, *Solid State Chemistry and its Application, 3*nd Ed., John Wiley & Sons, 2022.
4. Huheey J. E., Keiter, E. A., Keiter, R. L., *Inorganic Chemistry: Principles of Structure and Reactivity, 6*th Ed., Harpercollins College Publishers, 2014.
5. Lee J.D., *Concise Inorganic Chemistry, 6*th Ed., Blackwell Science, 2020.
6. F. A.Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, *Advanced Inorganic Chemistry*, Sixth Edition, Wiley, 2018.
7. Gurudeep Raj, *Advanced Inorganic Chemistry*, Vol. 1, Krishna Prakashan Media Pvt. Ltd., 33rd Edition**,** 2021.

REFERENCE BOOKS:

1. Shriver, Atkins, *Inorganic Chemistry*, 6th Ed., Oxford University Press, 2014.
2. Cotton, F.A., Wilkinson, G., *Advanced Inorganic Chemistry*. 6th Ed., John Wiley & Sons, 2018.
3. Sathya Prakash, Tuli, G.D., Basu, S.K., Madan, R.D., *Advanced Inorganic Chemistry 6*th Ed., S. Chand & Co. Ltd., 2020.
4. G. L. Miessler and D. A. Tarr, *Inorganic Chemistry*, 5th Edition, Pearson, India, 2014.
5. P. Atkins, T. Overton, J. Rourke, Mark T. Weller and F. Armstrong, Shriver & Atkins' *Inorganic Chemistry*, 6 th Edition, Oxford University Press, 2014.
6. K. F. Purcell and J. C. Kotz, *Inorganic Chemistry*, Cengage, 5th Edition**,** Pearson, 2014**.**

Course Outcomes (COs)

CO1: Explain the structural features, packing arrangements, defects, electrical, magnetic, optical, and superconducting properties of crystalline solids and correlate them with material behavior.

CO2: Analyze crystal structures, radius ratio rules, solid-state reactions, diffusion mechanisms, phase transitions, and the role of defects in determining the properties of inorganic solids.

CO3: Apply crystal field theory, valence bond theory, and molecular orbital theory to interpret bonding, electronic structures, magnetic properties, spectra, and stability of coordination compounds.

CO4: Evaluate ligand field effects, crystal field stabilization energy, Jahn–Teller distortion, nephelauxetic effect, and π-bonding in transition metal complexes using theoretical and experimental evidence.

CO5: Interpret kinetic and mechanistic aspects of substitution and electron-transfer reactions in transition metal complexes, including trans effect, hydrolysis reactions, and Marcus–Hush theory.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

CORE-VI

MOLECULAR SPECTROSCOPY

Unit	Content	No. of Hours
I	**Ultraviolet and Visible Spectroscopy**- Basic principle- types of electronic transitions – Transition probability- solvent effects- factors affecting position and intensity of absorption bands, ultraviolet bands for carbonyl compounds, dienes and conjugated polyenes. Fischer-Woodward rules for conjugated dienes, enones and carbonyl compounds, Fischer Kuhn rules for calculating absorption maximum in polyenes, ultraviolet spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls- Applications of UV- Visible spectroscopy –Study of keto-enol tautomerism- geometrical isomerism- equatorial & equatorial axial conformers and hydrogen bonding- Photometric titrations.	15
II	**Infrared and Raman Spectroscopy** Molecular vibrations, Hooke's law, vibrational frequencies, force constants and factors influencing vibrational frequencies. Fundamental vibrations and normal modes of polyatomic molecules. IR spectrometer and sample preparation techniques. Characteristic group frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, amines and carbonyl compounds. Detailed study of ketones, aldehydes, esters, amides, acids and anhydrides. Overtones, combination bands, Fermi resonance and FT-IR spectroscopy. **Raman Spectroscopy** – Theory, Raman effect, Stokes and anti-Stokes lines, mutual exclusion principle, instrumentation and applications.	15
III	**NMR spectroscopy:** Magnetic properties of nuclei – theory of NMR - FT NMR, chemical shift – factors affecting chemical shifts, chemical shift values and correlation for protons bonded to carbon -aliphatic, olefinic, aldehydic and aromatic and other nuclei -alcohols, phenols, enols, carboxylic acids, amines & amides, effect of deuteration, complex spin- spin interaction between two, three, four and five nuclei (first order spectra), Chemical equivalent and spin – spin coupling – shielding and deshielding mechanisms – chemical exchange – applications of NMR to simple organic molecules, Nuclear magnetic double resonance technique – NDMR and INDOR. Two-dimension NMR spectroscopy – COSY and NOESY.	15
IV	**Carbon -13 NMR Spectroscopy:** 13C nucleus, chemical shifts, Types of 13C NMR spectra - proton noise decoupled (fully decoupled), off resonance decoupled spectrum, 13C relaxation mechanisms. **Mass spectrometry**: Principle, types of peaks. Determination of molecular formula – nitrogen rule – isotopic abundance – Metastable ions – Retro Diels – Alder rearrangement – Mclafferty rearrangement, fragmentation processes of organic molecules, fragmentation associated with functional groups – aliphatic compounds, aldehydes – ketones – carboxylic acid- ester – amides – alcohols and halides. Ionization methods- ESI-MS and MALDI-MS.	15
V	**Electron Spin Resonance Spectroscopy (ESR):** Theory- factors affecting the „g" value. Isotropic and Anisotropic systems, Hyperfine splitting- Zero field splitting and Krammer"s degeneracy spin Hamiltonian, spin density, application to structure determination of inorganic complexes and study of free radicals. **Mossbauer spectroscopy** - Principle, Doppler effect and Isomer shift – Quadrupole interactions – nuclear Zeeman splitting and applications**.** **Spectroscopic applications:** Structural elucidation of organic molecules using combined UV-Visible, IR, Raman, ^{1}H NMR, ^{13}C NMR and Mass Spectral data. Multi-spectral problem solving and interpretation of unknown compounds.	15

TEXT BOOKS:

1. C. N. Banwell and E. M. McCash, *Fundamentals of Molecular Spectroscopy*, 4th Ed., Tata McGraw Hill, New Delhi, 2011.
2. R. M. Silverstein and F. X. Webster, *Spectroscopic Identification of Organic Compounds*, 8th Ed., John Wiley & Sons, New York, 2015.
3. W. Kemp, *Applications of Spectroscopy*, English Language Book Society, 3rd Edition**,** 2017.
4. D. H. Williams and I. Fleming, *Spectroscopic Methods in Organic Chemistry*, *6*th Ed., Tata McGraw-Hill Publishing Company, New Delhi, 2008.
5. R. S. Drago, *Physical Methods in Chemistry*; Saunders: Philadelphia, revised reprint edition, 2013.

REFERENCE BOOKS:

1. P.W. Atkins and J. de Paula, *Physical Chemistry*, 11th Ed., Oxford University Press, Oxford, 2018.
2. I. N. Levine, *Molecular Spectroscopy*, John Wiley & Sons, New York, 7th Edition, Pearson, 2014.
3. A. Rahman, *Nuclear Magnetic Resonance-Basic Principles*, New York, 2nd Edition**,** Springer, 2016**.**
4. K. Nakamoto, *Infrared and Raman Spectra of Inorganic and coordination Compounds*, Part B: 6 th ed., John Wiley& Sons Inc., New York, 2008.
5. J. A. Weil, J. R. Bolton and J. E. Wertz, *Electron Paramagnetic Resonance*; Wiley , 2007.

Course Outcomes (COs)

CO1: Explain the principles, instrumentation, and applications of UV-Visible, IR, Raman, NMR, ESR, Mössbauer spectroscopy, and Mass Spectrometry for molecular characterization.

CO2: Interpret UV-Visible spectra using electronic transitions, solvent effects, Woodward–Fieser rules, Fischer–Kuhn rules, and apply them to determine structural features, conjugation, tautomerism, stereochemistry, and hydrogen bonding.

CO3: Analyze IR and Raman spectra to identify functional groups, molecular vibrations, force constants, normal modes, and characterize organic compounds and materials.

CO4: Interpret ^{1}H NMR and ^{13}C NMR spectra, including chemical shifts, spin-spin coupling, multidimensional NMR techniques (COSY, NOESY), and use spectral data for structural elucidation of organic molecules.

CO5: Apply mass spectrometric principles, fragmentation patterns, rearrangement reactions, isotopic abundance analysis, and modern ionization methods (ESI-MS, MALDI-MS) for molecular formula and structure determination.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

CORE-VII

ORGANICCHEMISTRYPRACTICAL-I

OBJECTIVES

To develop analytical skill in

1. Separation of organic mixture
2. Organic qualitative analysis
3. Preparation of organic compound involving in single stage.

I. Organic analysis

Separation of two & three component mixtures-identification of components and preparation of their derivatives.

II. Preparation.

1. Beta glucose penta acetate from glucose
2. Resacetophenone from resorcinol
3. Para - nitrobenzoic acid from para nitrotoluene
4. Methyl orange from sulphanilic acid
5. Anthraquinone from anthracene
6. Benzhydrol from benzophenone.

REFERENCE BOOKS

1. B.S.Furniss, A.J.Hannaford, P.W.G.Smith and A.R.Tatchell, Vogel's Practical Organic Chemistry.6th Edn., ELBS,2008.
2. Raj K.Bansal, Laboratory manual of Organic Chemistry, III Edn., New Age International (P)Ltd.12017.
3. Gnanapragasam, Ramamurthy, Organic lab Manual, Viswanathan, S., Printers & Publishers Pvt Ltd, 2010.

Course Outcomes (COs)

CO1: Apply systematic qualitative analysis techniques to separate and identify components present in two- and three-component organic mixtures.

CO2: Determine the physical properties of organic compounds and prepare suitable derivatives for confirmation of identified compounds.

CO3: Perform the synthesis of important organic compounds such as β-glucose pentaacetate, resacetophenone, p-nitrobenzoic acid, methyl orange, anthraquinone, and benzhydrol using appropriate laboratory methods.

CO4: Demonstrate skills in purification, recrystallization, isolation, yield calculation, and characterization of synthesized organic compounds.

CO5: Interpret reaction mechanisms involved in oxidation, reduction, acetylation, electrophilic substitution, diazotization, coupling, and other organic transformations.

CO-PO Mapping (Course Articulation Matrix)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	**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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

CORE-VIII

INORGANIC CHEMISTRY PRACTICAL I

OBJECTIVES

1. To improve the skill in the qualitative analysis of mixture of four cations containing two common and two rare.

2. To impart the skill in estimation of metal ions by colorimetric method.

1. Qualitative analysis:

Semimicro qualitative analysis of mixtures containing the following cations to be tested W, Tl, Pb, Se, Te, Mo, Cu, Bi, Cd, Tl, Ce, Th, Zr, V, Cr, Fe, Ti, Zn, Ni, Co, Mn, Ca, Ba, Sr, Li and Mg.

2. Quantitative analysis:

2.1. Complexometric titrations: Estimations of Zn, Ca, Mg, Ni and Hardness of water.

2.2. Cerimetry: Cerimetric estimation of Fe (II) and oxalic acid

3. Demonstration experiments:

3.1. Photocolourimetry- Estimation of Fe, Ni, Mn, Ti and Co (II)

3.2. Flame photometry-Estimation of Na and K

3.3. Estimation of Iron in Iron tablets

3.4. Estimation of Ca in calcium tablets

BOOKS FOR REFERENCE:

1. Venkateswaran, V., Veeraswamy, R., Kulandaivelu, A.R., *Basic Principles of Practical Chemistry*, 6th Ed., S. Chand & Sons, 2002.
2. Ramanujam, V. V., *Inorganic Semi Micro Qualitative Analysis*, 3rd Ed., The National Publishing Co., 2010.
3. G.Svehla, Vogel's qualitative Inorganic analysis, 7th Edition, Orient Longman, 2011.

Course Outcomes (COS)

CO1: Perform systematic semimicro qualitative analysis and identify cations present in unknown inorganic mixtures using group separation and confirmatory tests.

CO2: Estimate metal ions such as Zn^{2+}, Ca^{2+}, Mg^{2+}, Ni^{2+} and determine water hardness using EDTA complexometric titration techniques.

CO3: Determine Fe(II) and oxalic acid concentrations through cerimetric titration and evaluate redox reactions quantitatively.

CO4: Operate photocolourimetric instruments and estimate trace metal ions such as Fe, Ni, Mn, Ti, and Co(II) based on absorbance measurements.

CO5: Analyze sodium and potassium concentrations using flame photometry and interpret instrumental data accurately.

CO-PO Mapping (Course Articulation Matrix)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	S	S	M	S	M	S	S	M	S	S
CO 2	S	S	S	M	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	S	M	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	**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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

CORE-IX

PHYSICAL CHEMISTRY PRACTICAL-I

OBJECTIVES

Enable the students to

1) Understand the principle of conductivity experiments and carry out conductometric titrations.

2) Determine the rate constant for acid hydrolysis of esters.

3) Apply kinetics to different reactions.

1. Conductivity experiments

Conductometric Titrations

i) Mixture of HCl and CH_3COOH Vs NaOH.

ii) Mixture of halides Vs $AgNO_3$.

iii) $BaCl_2$ Vs. $MgSO_4$

iv) Buffer Vs. Strong acid.

v) Buffer Vs. Strong base.

Electric conductance of Electrolytes

vi) Comparison of the relative strength of chloroacetic acid and acetic acid

vii) Verification of Kohlrausch's Law for weak electrolytes.

viii) Determination of equivalent conductance of a strong electrolyte & the verification of DHO equation.

ix) Verification of Ostwald's Dilution Law & Determination of pKa of a weak acid.

x) Determination of solubility of a sparingly soluble salt.

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 to iodine and acetone.

3. Study the primary salt effect on the kinetics of ionic reactions and test the bronsted relationship (iodide ion is oxidsed by persulphate ion)

Text Books:

1. V. Venkateswaran, R. Veeraswamy & A.R. Kulandaivelu, *Basic Principles of Practical Chemistry*, 2nd Edition, Sultan Chand & Sons Publishers, 2012.
2. B.Viswanathan & P. S. Raghavan, *Practical Physical Chemistry*, 3rd Edition, Viva Books Publishers, 2009.
3. J. B.Yadav, *Advanced Practical Physical Chemistry*, Krishna Prakashan Media, 2016.

Reference Books:

1. S.R. Palit and S.K. De, *Practical Physical Chemistry*, Science Book Agency, Calcutta, 2003.
2. G. Palmer, *Experimental Physical Chemistry*, 1st Edition, Cambridge University Press, 1964.
3. CarlW. Garland, Joseph W. Nibler & David P. Shoemaker, *Experiments in Physical Chemistry*, 8th Edition, McGraw-Hill Education, 2008.

Course Outcomes (CO)

CO1: Perform conductometric titrations involving acid-base, buffer, and precipitation systems and interpret conductivity changes during chemical reactions.

CO2: Verify fundamental laws of electrolytic conductance such as Kohlrausch's Law, Onsager's Equation, and Ostwald's Dilution Law through experimental measurements.

CO3: Determine relative strengths of weak acids and analyze ionic equilibria using conductometric methods.

CO4: Investigate reaction kinetics, determine rate constants, reaction orders, temperature coefficients, and activation energies of chemical reactions.

CO5: Examine the effect of ionic strength on reaction rates and validate the Brønsted-Bjerrum relationship for ionic reactions.

CO-PO Mapping (Course Articulation Matrix)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	**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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

NON- MAJOR ELECTIVE

FOOD AND MEDICINAL CHEMISTRY

Unit	Content	No. of Hours
I	**Food and its constituents** Sources of food, types, advantages and disadvantages, constituents of foods, carbohydrates, proteins, fats and oils, colours, flavours, natural toxicants. Food poisoning- Sources, causes and remedy. Causes and remedies for acidity, gastritis, indigestion and constipation and food adulterations. Food spoilage- causes of food spoilage, types of food spoilage, food preservation.	12
II	**Vitamins and minerals** Vitamins: Sources, requirement, deficiency diseases of A, B,C, H and K. Minerals: Mineral elements in food-principal mineral elements - Source- Function - Deficiency and daily requirements- Na, K, Mg, Fe, S, P and I.	12
III	**Antibiotics, sulphonamides and analgesics** Antibiotics: Definition, Classification as broad and narrow spectrum, mode of action and uses of penicillin, Chloramphenicol, tetracyclines, ciphalosporin, ampicillin and erythromycin. Sulphonamides: Mechanism and action of sulpha drugs, preparation and uses of sulphadiazine, sulphathiazole, sulphapyridine and sulphafurazole. Analgesics- definition- narcotic and non- narcotic- morphine and its derivatives- pethidine and methodone - pharmacological action- uses and abuses. Heroin and codinine. Antipyretic analgesics- Preparation and uses of aspirin and paraacetamol.	12
IV	**Antiseptics, Disinfectants and anaesthetics** Antiseptics and disinfectants- definition and distinction- phenol coefficient, phenol as disinfectant, chlorhexidine, formaldehyde and nitrofurazone-uses. Anaesthetics- definition- classification- local and general- volatile, nitrous oxide,ether, chloroform, cyclopropane- uses and disadvantages- nonvolatile- intravenous thiopental sodium, methohexitone, propanidid, local anaesthetics- cocaine and benzocaine- uses and disadvantages.	12
V	Drugs affecting CNS- Definition and one example for tranquilisers, sedatives, hypnotics, psychedelic drugs- chlorpromazine and barbitone- uses. Hypoglycemic agents- Diabetes- types- causes- symptoms- Insulin- uses. Oral hypoglycemic agents- sulphonyl ureas- action and uses. Antineoplastic drugs- Causes of cancer, Antineoplastic agents, cytotoxic. anti-metabolites, plant products, harmones- one example and uses AIDS-causes, prevention and control. Indian medicinal plants and uses- tulasi, kilanelli, mango, semparuthi, adadodai and thoothuvalai.	12

TEXT BOOKS:

1. Lakshmi, S., *Pharmaceutical Chemistry*, Sultan Chand & Sons, 3rd Ed., 2004.
2. Jayashree Ghosh., *Fundamental Concepts of Applied Chemistry*, 1st Ed., S. Chand, 2006.
3. Patrick, G.L., *An Introduction to Medicinal Chemistry*, 5th Ed., Oxford University Press, 2013.
4. Wilson, Charles Owens: Beale, John Marlowe; Block, John H, Lipincott William, 12th edition, 2011.
5. Graham L. Patrick, An Introduction to Medicinal Chemistry, 5th edition, Oxford University Press, 2013.
6. O.Le Roy, Natural and synthetic organic medicinal compounds, Ealemi, 1976.
7. Seema Yadav. Food Chemistry. Anmol publishing (P) Ltd, New Delhi. 2.B.Sirlakshmi, Nutrition Science, 6th Edition, New Age International Publishers.

REFERENCE BOOKS:

1. Jayashree Ghosh., *A Text Book of Pharmaceutical Chemistry*, 3rd Ed., S. Chand, 2003.
2. Nogrady, T., & Weaver, D. F., *Medicinal Chemistry-A Molecular and Biochemical Approach*, Oxford University Press, 2005.
3. Foye's Princles of Medicinal Chemistry, Lipincott Williams, Seventh Edition, 2012
4. Burger's Medicinal Chemistry, Drug Discovery and Development, Donald J. Abraham, David P. Rotella, Alfred Burger, Academic press, 2010.
5. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, John M.Beale Jr and John M. Block, Wolters Kluwer, 2011, 12thedn.
6. P.Parimoo, AText book of Medical Chemistry, NewDelhi: CBSPublishers.1995.
7. S.Ramakrishnan, K.G.Prasannanand R. Rajan, Text book of Medical Biochemistry, Hyderabad: OrientLongman.3rd edition, 2001.
8. B. Sivasankar, Food Processing and Preservation-PHI Learning Private Ltd., NewDelhi.2013.

Course Outcomes (CO)

CO1: Explain the sources, composition, nutritional value, adulteration, spoilage, preservation, and toxicological aspects of food and food products.

CO2: Describe the functions, sources, daily requirements, and deficiency diseases associated with vitamins and essential minerals.

CO3: Understand the classification, mechanism of action, preparation, uses, and therapeutic importance of antibiotics, sulphonamides, analgesics, and antipyretics.

CO4: Explain the principles, classification, uses, advantages, and limitations of antiseptics, disinfectants, anaesthetics, and drugs affecting the central nervous system.

CO5: Discuss hypoglycemic agents, antineoplastic drugs, AIDS, and the medicinal importance of selected Indian medicinal plants.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

NON- MAJOR ELECTIVE

WATER CHEMISTRY

Unit	Content	No. of Hours
I	**Introduction** Sources of Water; Physical and chemical characteristics of water; Water analysis; Potable water – WTO standard: uses of water	12
II	**Water Pollution** Water pollution – wastewater generation - classification of water pollutants; constituents and characteristics of wastewater; measurement techniques – sampling, colour & odour, dissolved oxygen, BOD, COD, TOC, N & P, suspended solids and bacteriological measurements.	12
III	**Waste water Treatment** Wastewater treatment: Pretreatment – screening, grit removal and pre-chlorination; Primary treatment – settling and sedimentation; Secondary treatment – trickling filter process, activated sludge process; Aeration.	12
IV	**Industrial Wastewater Treatment** Industrial wastewater treatment: Activated sludge treatment plants – mass balances, with and without recycle plants; Types of plants – single tank, contact stabilization, biosorption plants. Biofilters: Hydraulic film diffusion, two component diffusion; Types of plants – trickling filters, submerged filters and rotating disc; removal of particulate organic matter.	12
V	**Treatment Plants** Treatment plants for nitrification – mass balances, nitrifying plants and types of plants. Treatment plant for denitrification - mass balances, denitrifying plants and types of plants; redox zones in the biomass. Anaerobic wastewater treatment: Plant types – pretreatment, plant with suspended sludge and filter process.	12

TEXT BOOKS:

1. De, A. K., *Environmental Chemistry*, Wiley Eastern Co., 2016.

2. Banerji, S. K., *Environmental Chemistry*, 2nd Ed., Prentice Hall of India, New Delhi, 2007.

REFERENCE BOOKS:

1. Saxena, M. M., *Environmental Analysis of Water, Soil and Air*, Agro Botanica, 2nd Ed., Bikaner, 1990.
2. Ghosh, B., Bajaj, J. C., Hasan, R., & Singh. D., *Soil and Water Testing Methods, A Laboratory Manual*, IARI, New Delhi, 1983.

Course Outcomes (COs)

CO1: Explain the sources, characteristics, uses, and quality standards of water, including potable water standards and water quality analysis techniques.

CO2: Classify water pollutants and determine wastewater characteristics using parameters such as DO, BOD, COD, TOC, nutrients, suspended solids, and bacteriological measurements.

CO3: Describe the principles and operations of preliminary, primary, and secondary wastewater treatment processes including screening, sedimentation, aeration, trickling filters, and activated sludge systems.

CO4: Perform mass balance calculations and evaluate the performance of activated sludge treatment plants with and without sludge recycle systems.

CO5: Analyze the design and operation of biofilters, trickling filters, submerged filters, and rotating biological contactors for organic matter removal.

CO-PO Mapping (Course Articulation Matrix)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	**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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

SEMESTER-III

CORE-X

ORGANIC CHEMISTRY –III

Unit	Content	No. of Hours
I	**Protecting Groups and Synthetic Strategy** Introduction to protecting groups and chemo selectivity in organic synthesis. Protection and deprotection of alcohols – acetals, ketals, tetrahydro pyranyl (THP) ethers, silyl ethers (TMS, TBDMS and TBDPS). Protection of carbonyl compounds – acyclic and cyclic acetals and ketals. Protection of carboxylic acids – methyl, benzyl and tert-butyl esters. Protection of amino groups – formyl, acetyl, benzoyl, carbobenzyloxy (Cbz) and tert-butyloxycarbonyl (Boc) groups. Orthogonal protection strategies.	15
II	**Reagents and Modern Organic Synthesis** Synthetic applications and mechanisms of the following reagents: Gilman reagents, 1,3-dithianes, ozone, lithium diisopropylamide (LDA), dicyclohexylcarbodiimide (DCC), osmium tetroxide, DDQ, phase-transfer catalysts, trimethylsilyl iodide, tributyltin hydride, crown ethers and Sharpless asymmetric epoxidation. Woodward-Prevost hydroxylation and Peterson olefination. Modern reagents – PCC, PDC, Dess-Martin periodinane, Swern oxidation,	15
III	**Alkaloids and Vitamins:** Synthesis and structural elucidation of morphine, quinine, papaverine and reserpine. **Vitamins:** Synthesis, Structural elucidation and biochemical function of Vitamin A_1, Vitamin B_2 and Vitamin C.	15
IV	**Steroids and steroid hormones:** Cholesterol = structural elucidation and synthesis. Synthesis of ergosterol, oesterone, testosterone and progesterone Conversion of cholesterol into testosterone and progesterone. Ergosterol - Structural elucidation, Synthesis of artificial hormones- stilbestrol and hexoestrol.	15
V	**Terpenoids and Biosynthetic Pathways** Isoprene rule and special isoprene rule. Classification of terpenoids based on carbon skeleton. Structural elucidation and synthesis of zingiberene, β-eudesmol, caryophyllene and abietic acid. Biosynthesis of terpenoids through mevalonate and non-mevalonate pathways. Biomimetic synthesis. Polyterpenes and carotenoids. Applications of terpenoids in pharmaceuticals, fragrances and natural products chemistry. Introduction to combinatorial and diversity-oriented synthesis.	15

Text Books:

1. O.P.Agarwal, *Organic Chemistry of Natural Products (Vol 1),* Krishna Prakashan Media, 2015.
2. Dr.Jagdamba Singh and L.D.S Yadav, *Organic Synthesis*, Visionias, 2020.
3. Stuart Warren, *Organic synthesis: The Disconnection Approach*, First edition, Wiley India, 2007.
4. Gurdeep R. Chatwal, *Organic chemistry of Natural Products (Vol 1 and 2)*, Himalaya,2000.
5. Jerry March, Advanced Organic Chemistry-Reactions, Mechanisms and Structure, 8th Edition, John Wiley & Sons (2020)
6. V.K.Ahluwalia, Organic Reaction Mechanism, Narosa Publishing House, 4th Edition, 2013.
7. Mary Fieser and Louis Fieser, Reagents in Organic Synthesis, Wiley Interscience, Volume 26, 2011.

Reference Books:

1. I.L.Finar, *Organic Chemistry (Vol 2), 6*th Edition, Pearson Education India. Publishing House, 2011.
2. Sujata V.Bhat, B.A. Nagasampagi, S.Meenakshi, *Natural Products*, Narosa Publishing House, 2011.
3. George S. Zweifel, Micheal H. Nantz, Peter Somfai, *Modern Organic Synthesis: An Introduction,* Second Edition, Wiley Publishing House, 2017.
4. S. H. Pine, J.B. Hendrickson, D.J. Cram and G.S. Hammond, Organic Chemistry, IV Edn., McGraw Hill Company,1980.
5. S.M. Mukherji and S. P. Singh, Reaction Mechanism in Organic Chemistry, Macmillan,1984.
6. Paul de Mayo, Molecular Rearrangements, Vol I, Vol II, Interscience, NY.1963.
7. Fisher and Fisher, Steroids, Reinhold, 1959.
8. R.O.C.Norman, Principles of Organic Synthesis, 2nd Edition, Chapman and Hall,

Course Outcomes (COs)

CO1: Explain the concept of chemoselectivity and the importance of protecting groups in organic synthesis.Apply suitable protection and deprotection methods for alcohols, carbonyl compounds, carboxylic acids, and amino groups. Design multistep syntheses using orthogonal protection strategies.

CO2: Describe the mechanisms and synthetic applications of important reagents such as Gilman reagents, LDA, DCC, PCC, PDC, Dess–Martin periodinane, Swern oxidation,

DDQ, and osmium tetroxide. Predict reaction outcomes involving oxidation, reduction, olefination, hydroxylation, and asymmetric epoxidation reactions.

CO3: Classify alkaloids and explain their occurrence, biosynthesis, and biological importance. Elucidate the structures and synthetic routes of morphine, quinine, papaverine, and reserpine. Discuss the structure and synthesis of major anthocyanidin derivatives such as pelargonidin chloride, cyanidin chloride, delphinidin chloride, and peonidin chloride.

CO4: Explain the structural features and elucidation of cholesterol and ergosterol. Describe the synthesis and interconversion of steroid hormones including testosterone and progesterone. Analyze the preparation and significance of artificial hormones such as stilbestrol and hexoestrol.

CO5: Classify terpenoids based on the isoprene rule and carbon skeleton. Explain the structural elucidation and synthesis of important terpenoids such as zingiberene, β-eudesmol, caryophyllene, and abietic acid. Compare mevalonate and non-mevalonate biosynthetic pathways and evaluate the applications of terpenoids in pharmaceuticals, fragrances, and natural products chemistry.

CO-PO Mapping (Course Articulation Matrix)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	**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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

CORE-XI

INORGANIC CHEMISTRY –III

Unit	Content	No. of Hours
I	**Bonding in Organometallic Complexes and metal carbonyls:** Definition of organometallic compound - 18 electron rule - effective atomic number rule - classification of organometallic compounds - the metal carbon bond types – ionic bond – sigma covalent bond - electron deficient bond - delocalised bond - dative bond -metal carbonyl complexes - synthesis - structure and reactions of metal carbonyls -the nature of M-CO bonding- binding mode of CO and IR spectra of metal carbonyls - metal carbonyl anions - metal carbonyl hydrides - metal carbonyl halides - metal carbonyl clusters – Wade's rule and isolobal relationship.	15
II	**Organometallic and Organometallic Sandwich complexes** Alkene complexes - synthesis of alkene complexes -bonding of alkenes to transition metals - bonding in diene complexes - reactivity of alkene complexes – Alkyne complexes – synthesis, structure and reactions of alkyne complexes. Arene complexes-synthesis–structure and reactivity of arene complexes-multidecker complexes. Cyclopentadienyl complexes - metallocenes - synthesis of metallocenes - bonding in metallocenes - reactions of metallocenes - Cp2Fe/Cp2Fe+ couples in biosensors -bent sandwich complexes - bonding in bent sandwich complexes.	15
III	**Catalysis** Hydrogenation of olefins (Wilkinson's catalyst)- hydroformylation of olefins using Cobalt or Rhodium catalysts (oxo process)- Oxidation of olefins to aldehydes and ketones (Wacker process); polymerization (Zeigler- Natta catalyst)- Cyclooligomerization of acetylene using Nickel catalyst (Reppe's catalyst)- polymer bound catalysts - metallocene and stereospecific polymerisation of 1-alkenes.	15
IV	**Electronic Spectra and Magnetic Properties of Coordination Compounds** Spectroscopic term symbols for d^n ions – derivation of term symbols and ground-state term symbols. Hund's rules. Selection rules and breakdown of selection rules. Spin-orbit coupling and band intensities. Weak-field and strong-field limits. Correlation diagrams and energy-level diagrams. Orgel and Tanabe-Sugano diagrams. Effect of distortion and spin-orbit coupling on spectra. Evaluation of Dq and Racah parameter B for octahedral complexes of nickel. Charge-transfer spectra. Nephelauxetic effect. Magnetic properties of transition metal complexes. Spin crossover phenomena. Spectral properties of lanthanides and actinides. Luminescence properties of lanthanide complexes.	15
V	**Nanomaterials and Advanced Functional Materials** Introduction to nanomaterials and size-dependent properties. Semiconductor nanomaterials – zinc oxide and titanium dioxide. Ceramic nanomaterials – aluminium oxide and aluminium hydroxide nanoparticles. Metal nanoparticles – silver, gold, iron and copper nanoparticles. Polymers, nanocomposites and biomaterials. Carbon nanomaterials – fullerenes, carbon nanotubes and graphene. Quantum dots. Nanofabrication techniques – Top-down methods (arc discharge, laser ablation) and Bottom-up methods (homogeneous nucleation, microwave synthesis). Synthesis of solid-state materials using co-precipitation, sol-gel, hydrothermal, combustion and chemical vapour deposition (CVD). Green synthesis of nanomaterials.	15

TEXT BOOKS

1. J.E. Huheey, E.A. Keiter and R.L. Keiter, Inorganic Chemistry – Principles of structure and reactivity, 4th Edition, Pearson – Education,2002.
2. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, Wiley Eastern, 6th Edition, 1999.
3. S.F.A. Kettle, Coordination compounds, ELBS, 1996.
4. Basic organometallic chemistry, J.Haiduc and J. J.Zuckerman, Walter de Gruyter, Brelin, 1991.
5. A.W.Adamson and P.Fleischauer, Concepts of Inorganic Photochemistry, Wiley,2014.
6. K.F. Purcell and J.C. Kotz, Inorganic Chemistry, WB. Sanders Co. USA. 2024.
7. D.F. Shriver, P. W. Atkins and C.H. Longford, Inorganic Chemistry, ELBS, 7nd Edition, 2024.
8. Supramolecular chemistry- Concepts & Perspectives, J.M. Lehn; Wiley- VCH Publications, 2022.
9. C.N.R. Rao and J.R. Ferraro, Spectroscopy in Inorganic Chemistry, Vol I and Vol II, Academic Press, 2009.
10. Willard, Merit, Dean and Settle, Instrumental Methods of Analysis, CBS Publishers and Distributors, VII Edn., 2004.

REFERENCE BOOKS

1. Organometallics 1, complexes with transition metal-carbon -bonds, Bockmann, Oxford science publications, Oxford, 2006.
2. G.W. King, Spectroscopy and Molecular Structure, Holt Rienehart and Winston, 2004
3. Supramolecular chemistry, P,D Beer, P.A. Gale & D.K. Smith, Oxford university Press,2021
4. S. Zing& Zimmerman, Dendrimers- Structure, properties & applications. Chemical Review, 2005.
5. W. Adamson & P. Fleischauer, Concepts of Inorganic Photo chemistry, Wiley, 2014

Course Outcomes (COs)

CO1: Explain the fundamental concepts of organometallic chemistry, including the 18-electron rule, effective atomic number rule, classification of organometallic compounds, metal–carbon bonding, synthesis, structure, bonding, spectra, and reactivity of metal carbonyls, clusters, and sandwich complexes.

CO2: Analyze the synthesis, structure, bonding, and reactivity of alkene, alkyne, diene, arene, cyclopentadienyl, metallocene, and multidecker complexes, including their applications in catalysis and biosensors.

CO3: Interpret electronic spectra and magnetic behavior of coordination compounds using term symbols, Hund’s rules, selection rules, correlation diagrams, Orgel diagrams, Tanabe–

Sugano diagrams, charge-transfer spectra, spin crossover phenomena, and lanthanide/actinide spectroscopy.

CO4: Describe the synthesis, structure, properties, and applications of nanomaterials including semiconductor, ceramic, metallic, polymeric, carbon-based nanomaterials, quantum dots, and advanced functional materials.

CO5: Apply modern characterization techniques such as SEM, TEM, AFM, STM, XRD, DLS, BET, and XPS to evaluate nanomaterials and assess their applications in catalysis, energy storage, environmental remediation, electronics, and biomedicine.

CO-PO Mapping (Course Articulation Matrix)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	S	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	S	S	M	S	S	S	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	**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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

CORE-XII

PHYSICAL CHEMISTRY –II

Unit	Content	No. of Hours
I	**Statistical Thermodynamics – II** Classical statistics – Stirling's approximation, Maxwell-Boltzmann distribution law: assumptions and derivation for systems having degenerate and non-degenerate energy levels. Quantum statistics – Bose-Einstein and Fermi-Dirac statistics. Comparison of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac distributions. Entropy of bosons and fermions. Applications of quantum statistics – black body radiation, photon gas, electron gas and Fermi energy of free electrons at absolute zero. Density of states function. Degeneracy pressure and applications. Statistical interpretation of entropy and residual entropy.	15
II	**Partition Functions, Thermodynamic Applications:** Definition and significance of partition functions. Molecular and molar partition functions. Relationship between partition functions and thermodynamic properties – internal energy, entropy, enthalpy, free energy, equilibrium constant and heat capacities. Translational, rotational, vibrational and electronic partition functions. Sackur-Tetrode equation. Equipartition principle of energy and its limitations. Calculation of heat capacities of ideal gases. Einstein and Debye theories of heat capacities of solids. Comparison of Einstein and Debye models. Statistical thermodynamics of diatomic gases. Nuclear partition functions (elementary treatment).	15
III	**Chemical Kinetics – II** Kinetics of complex reactions – reversible, consecutive, parallel and chain reactions. Rice-Herzfeld mechanism for hydrogen-bromine reaction, gas-phase pyrolysis of methane and formation of phosgene. Explosion limits. Steady-state approximation and pre-equilibrium approximation. Branched chain reactions and chain inhibition. Fast reaction techniques – relaxation methods, temperature jump, pressure jump methods, stopped-flow technique, flash photolysis and crossed molecular beam methods. Photochemical kinetics. Elementary treatment of oscillating reactions (Belousov-Zhabotinsky reaction). Introduction to surface reaction kinetics and catalytic kinetics.	15
IV	**Quantum Chemistry – II** Application of Schrödinger equation to rigid rotator and hydrogen atom. Origin of quantum numbers and probability distribution of electrons. Radial distribution functions. Approximation methods – perturbation and variation methods. Applications to hydrogen and helium atoms. Spin-orbit interaction, LS coupling and JJ coupling. Ground-state term symbols for simple atoms. Hartree and Hartree-Fock methods (elementary treatment). Born-Oppenheimer approximation. Introduction to Molecular Orbital Theory and Hückel Molecular Orbital (HMO) theory. Computational chemistry and Density Functional Theory (DFT) – basic concepts and applications.	15
V	**Group Theory – II and Spectroscopic Applications** Symmetry selection rules for vibrational, electronic and Raman spectra. Determination of vibrational modes in non-linear molecules such as H_2O, NH_3, CH_4 and XeF_4. Symmetry of hybrid orbitals in H_2O, NH_3, CH_4, XeF_4 and PCl_5. Electronic spectra of formaldehyde. Direct product representations and transition moment integrals. Construction of symmetry-adapted linear combinations (SALCs). Applications of group theory to molecular orbital formation and spectroscopy. Vibrational spectroscopy using group theoretical methods. Problem solving involving character tables and spectroscopic selection rules.	15

TEXT BOOOKS:

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.Benjamin Publishers, California, 2022.
3. M.C. Gupta, Statistical Thermodynamics, New Age International, Pvt. Ltd.,New Delhi, 2000.
4. K.J. Laidler, Chemical Kinetics, 3rd edition, Pearson, Reprint - 2013.
5. J. Rajaram and J.C. Kuriokose, Kinetics and Mechanisms of chemical transformation, Macmillan India Ltd, Reprint - 2011.
6. V.Ramakrishnan and M.S.Gopinathan, Group theory in chemistry, Vishal Publications,1988.
7. K.V.Raman, Group theory and its application to chemistry, Tata McGraw Hill Publishing Co., 1990.

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, 12th Edition, Oxford University Press, 2023.
4. K.B. Ytsiimiriski, “Kinetic Methods of Analysis”, Pergamom Press, 2020.
5. Gurdeep Raj, Phase rule, Goel Publishing House, 2011.
6. R.K. Prasad, Quantum Chemistry, Wiley Eastern, NewDelhi,1992.
7. M.W. Hanna, Quantum Mechanics in Chemistry, W.A. Benjamin Inc, London, 2022.
8. F.A. Cotton, Chemical Application of Group Theory, John Wiley and Sons Inc., Newyork, 1990.

Course Outcomes (COs)

CO1: Explain the principles of classical and quantum statistics, derive Maxwell–Boltzmann, Bose–Einstein and Fermi–Dirac distribution laws, and apply them to physical systems such as black body radiation, photon gas, electron gas and degeneracy pressure.

CO2: Analyze molecular and molar partition functions and relate them to thermodynamic properties including internal energy, entropy, enthalpy, free energy, equilibrium constants and heat capacities, and evaluate Einstein and Debye models of solids.

CO3: Apply kinetic theories and mechanistic approaches to complex reactions, including reversible, consecutive, parallel, chain, photochemical and catalytic reactions, utilizing steady-state and pre-equilibrium approximations and modern fast reaction techniques.

CO4: Solve quantum mechanical problems involving rigid rotators and hydrogen atoms, interpret quantum numbers and electron probability distributions, and apply

approximation methods, molecular orbital theory and computational chemistry concepts including DFT.

CO5: Utilize group theoretical methods to determine molecular symmetry, vibrational modes, spectroscopic selection rules, SALCs and molecular orbital formation, and solve problems related to vibrational, Raman and electronic spectroscopy.

CO-PO Mapping (Course Articulation Matrix)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	**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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

ELECTIVE-II

ANALYTICAL CHEMISTRY

Unit	Content	No. of Hours
I	**Data Analysis, Statistics and Chemometrics:** Errors in chemical analysis – systematic and random errors. Accuracy, precision, mean, median, mode and standard deviation. Frequency distributions, binomial, Poisson and normal distributions. Confidence limits and confidence intervals. Improving analytical accuracy – standard deviation, relative standard deviation, propagation of errors, Q-test. Comparison of results using least squares method, Student's t-test, F-test and Chi-square test. Sampling methods – sample size determination, sampling of gases, liquids, solids and particulates.	12
II	**Modern Instrumental Analytical Techniques:** Non-destructive analytical techniques – Wavelength Dispersive and Energy Dispersive X-ray Fluorescence Spectroscopy (WDXRF and EDXRF), X-ray Absorption Spectroscopy (XANES and EXAFS), Thermal Desorption Spectroscopy (TDS). Destructive analytical techniques – Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES). Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). Atomic Absorption Spectroscopy (AAS **Chromatographic techniques** – Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC), Ion Chromatography and Hyphenated Techniques (GC-MS, LC-MS). Applications in environmental, pharmaceutical and materials analysis.	12
III	**Surface and Electron Spectroscopic Methods:** Photoelectron spectroscopy – principles, chemical shifts, instrumentation, X-ray sources, sample handling, detectors and data acquisition. Applications of X-ray Photoelectron Spectroscopy (XPS/ESCA). Koopmans' theorem. Auger Electron Spectroscopy (AES) and Ultraviolet Photoelectron Spectroscopy (UPS/PES) – principles and applications. Surface analytical methods – Secondary Ion Mass Spectrometry (SIMS) and Scanning Probe Techniques (overview). Applications in nanomaterials, catalysis and corrosion studies.	12
IV	**Artificial Intelligence, Machine Learning and Computational Tools in Chemistry:** Introduction to Artificial Intelligence (AI), Machine Learning (ML) and Data Science in Chemistry. Fundamentals of supervised and unsupervised learning. Applications of AI in Physical, Organic, Inorganic, Analytical and Materials Chemistry. Reaction prediction and retrosynthetic analysis. Materials discovery and high-throughput screening. Prediction of molecular and material properties. AI in drug discovery and molecular design. Computational chemistry databases and cheminformatics. Molecular descriptors and QSAR studies. Use of AI tools in scientific writing, literature review, data interpretation, visualization, language improvement and formatting.	12
V	**Scientific Writing, Research Methodology and Publication Ethics:** Structure of scientific documents – title, abstract, introduction, literature review, objectives, methodology, results, discussion, conclusions and recommendations. Preparation of figures, tables, graphs and schemes. Referencing styles (ACS, APA and Vancouver styles). Reference management software (Mendeley, Zotero and EndNote). Research ethics and publication ethics – plagiarism, fabrication, falsification, predatory journals, authorship and intellectual property rights. Scientific publishing process – manuscript preparation, peer review, journal selection, responding to reviewers and publication workflow. Patent basics and technology transfer. Grant proposal writing and project formulation.	12

Text Books:

1. R. Gopalan, P. S. Subramanian and K. Rangarajan, Elements of Analytical chemistry, 5rd Revised Edition, Sultan Chand and Sons, 2022.
2. S.M. Khopkar, Basic concepts of Analytical chemistry, 4rd Edition, New age International Publishers, 2020.
3. B. K. Sharma, Instrumental Methods of Chemical Analysis, 34rd Edition, Goel Publishing House, 2024.
4. A. K. SriVastava, and P. C. Jain, Instrumental Approach to Chemical Analysis, 6th Edition, S Chand & Company Publishers, 2022.
5. C. R. Kothari and G. Garg, Research Methodology – Methods and Techniques, 5th Edition, New Age International Publishers, 2023.

Reference Books:

1. F.A.Settle,Handbookof Instrumental Techniques for Analytical Chemistry, Prentice Hall Publisher, 7th Edition, Cengage, 2018.
2. D. A. Skoog, D. M. West, F. J. Holler and S. R. Crouch, Fundamentals of Analytical Chemistry, 11th Edition, Cengage Learning India Pvt. Ltd., 2024.
3. Galen W. Ewing, Instrumental methods of chemical analysis, 7th Revised Edition McGraw – Hill, 2018.
4. J. Gibaldi,MLA Handbookforwriters ofresearch papers, 9th Edition, Modern Language Assn of Amer,2021.

Course Outcomes (COs)

CO1: Apply statistical methods, error analysis, sampling techniques, and chemometric tools for the interpretation and validation of chemical data.

CO2: Explain the principles, instrumentation, and applications of modern instrumental analytical techniques such as XRF, ICP-AES, ICP-MS, AAS, GC, HPLC, and hyphenated techniques.

CO3: Interpret and analyze surface and electron spectroscopic data using XPS, AES, UPS, SIMS, and related techniques for chemical and materials characterization.

CO4: Utilize Artificial Intelligence (AI), Machine Learning (ML), cheminformatics, QSAR, and computational tools for chemical data analysis, molecular design, and materials discovery.

CO5: Demonstrate scientific writing skills, research methodology, publication ethics, reference management, and research dissemination practices in chemistry.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	M	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	M	S	M	S	S	M	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

ELECTIVE-II

MEDICINAL CHEMISTRY

Unit	Content	No. of Hours
I	**Basic Concepts of Drugs:** Drug design- analogues and pro- analogues, factors governing drug design, rational approach, method of variation and tailoring of drugs. Classification of drugs, mechanism of action of drugs, metabolism of drugs, absorption of drugs, factors affecting adsorption of drugs and SAR relationships	12
II	**Drugs Acting on CNS :** Anaesthetics - Classification, synthesis and mode of action of Halothane, Thiopental sodium, Methohexitone, Procaine hydrochloride and Lignocaine hydrochloride. Analgesics - Classification, mode of action and SAR of Morphine. Synthesis and mode of action of Pethidine and Fentanyl citrate. Sedatives and Hypnotics- Classification, synthesis and mode of action of Barbiturates and Diazepam. Antipsychotics drugs-Classification, synthesis and mode of action of Chlorpromazine hydrochloride and Thioridazine.	12
III	**Drugs Affecting the Cardiovascular System:** Antiarrhythmic drugs - Classification, synthesis and mode of action of Quinidine sulphate and Procainamide hydrochloride. Vasodilator- Classification, synthesis and mode of action of Hydralazine hydrochloride and sodium nitroprusside. Coagulants- Mode of action of Vitamin K and Protamine. Anticoagulants-Mode of action of Thromboplastin and Prothrombin. Antihypertensive agents- Classification, synthesis and mode of action of Methyl dopate hydrochloride and Clonidine. Diuretics- Classification, synthesis and mode of action of Acetazolamide and Chlorthiazide.	12
IV	**Drugs Affecting the Harmonal System and Immune System:** Drugs affecting hormonal systems - Hypoglycemic drugs - Causes of diabetes, classification, synthesis and mode of action of Insulin, Tolbutamide and Glipizide. Thyroid drugs- Mode of action of thyroid hormones, Synthesis and uses of Thyroxine and Propyl thiouracil. Drugs affecting the immune systems. Non - steroidal anti-inflammatory drugs - Classification, synthesis and mode of action of Flurbiprofen and Indomethacin. Antihistamics (Antiallergic agents). Histamine, Classification, SAR amongst H1-receptor blockers, prevention of histamine release, synthesis and mode of action of Diphenhydramine hydrochloride and Promethazine hydrochloride. Antiulcers- Histamine H2 Receptor Antagonists, SAR, synthesis and Characteristic features of Cimetidine and Ranitidine.	12
V	**Chemotherapeutic Agents :** Antibiotics- Classification, synthesis and mode of action of Penicillins, Chloramphenicol and Azithromycin. Sulpha drugs- Classification, SAR and mode of action of sulphonamides. Synthesis and uses of Sulfacetamide and sulpha guanidine. Antiviral drugs- Classification, synthesis and mode of action of Acyclovir and Methiazone. Antimyco bacterial drugs- Classification, synthesis and mode of action of Pyrazinamide and Ciprofloxacin hydrochloride. Anthelmintics- Types of warm parasites, classification, synthesis and mode of action of Albendazole and Mebendazole. Antineoplastic drugs- Causes of cancer, classification, synthesis and mode of action of Melphalan andMethotrexate.	12

TEXT BOOKS

1. Jayashree Ghosh**,** *A Textbook of Pharmaceutical Chemistry*, Latest Revised Edition (7th Edition)**,** S. Chand Publishing, 2022

2. Ashutar Kar, Medicinal Chemistry, 7th Edition, 2021.

3. K. Elango, P. Valentina, Textbook of Medicinal Chemistry, 2ndEdition. 2021.

4. Surendra Nath Pandey, Sanjay Pandey, Textbook of Medicinal Chemistry. 2023.

5. Ashutosh Kar, Medicinal Chemistry, 7thEdition, 2021.

6. D. Sriram, P.Yogeshwari, Medicinal Chemistry, 2ndEdition. 2023.

7. Gurdeep R. Chatwal, *Medicinal Chemistry*, Latest reprint edition, Himalaya Publishing House.

REFERENCE BOOKS

1. Willing Foyes, Principles of Medicinal Chemistry, 3rdEdition. 2022

2. Wilson and Gisvold, Textbook of Organic Medicinal and Pharmaceutical Chemistry, 11th Edition. 2019.

Course Outcomes (COs)

CO1: Explain the fundamental concepts of drug design, drug metabolism, absorption, mechanism of action, classification of drugs, and structure–activity relationships (SAR).

CO2: Analyse the chemistry, synthesis, pharmacological action, and therapeutic applications of drugs acting on the central nervous system (CNS), including anesthetics, analgesics, sedatives, hypnotics, antipsychotics, and anticonvulsants.

CO3: Interpret the synthesis, mechanism of action, and therapeutic significance of drugs affecting the cardiovascular, hormonal, and immune systems.

CO4: Evaluate the chemistry, SAR, synthesis, and biological activities of chemotherapeutic agents including antibiotics, sulfonamides, antiviral, antimycobacterial, anthelmintic, and anticancer drugs.

CO5: Apply medicinal chemistry principles to correlate chemical structure with biological activity, drug efficacy, safety, and rational drug development.

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	S	S	S	M	S	S	S	S	S	M
CO 2	S	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	M	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	S
CO 5	S	S	M	S	S	M	S	M	S	S

Level of Correlation between PSO's and CO's

CO /PO	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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

SKILL ENHANCEMENT COURSE-II

PROFESSIONAL COMPETENCY SKILL ENHANCEMENT COURSE

For a **Professional Competency Skill Enhancement Course (PCSEC)** intended to prepare M.Sc. Chemistry students for **UGC-CSIR NET, SET, TRB, UPSC, TNPSC and other competitive examinations**, the syllabus alone is insufficient. The curriculum should explicitly specify:

1. **Teaching Methodology**
2. **Training Components**
3. **Assessment Pattern**
4. **Question Paper Pattern**
5. **Evaluation Scheme**
6. **Learning Outcomes**
7. **Skill Components**
8. **Mock Tests and Performance Analysis**

The following format can be directly incorporated into the syllabus document.

SEMESTER -IV

CORE-XIII

ORGANIC CHEMISTRY –IV

Unit	Content	No. of Hours
I	**Organic Photochemistry–I** Photochemical excitation – experimental techniques, electronic transitions, singlet and triplet excited states, Jablonski diagrams. Photochemistry of carbonyl compounds – electronically excited ketones, n→π* and π→π* excited states. Norrish Type-I and Type-II reactions, photoreduction reactions and Paternò-Büchi reactions. Quantum yield and photochemical efficiency. Excimers and exciplexes. Photochemical reaction mechanisms and kinetics.	15
II	**Organic Photochemistry – II** Photochemistry of α,β-unsaturated ketones. Cis-trans photoisomerization. Energy transfer reactions and photochemical cycloadditions. Photochemistry of aromatic compounds and photochemical rearrangements. Photostationary state. Di-π-methane rearrangement. Rearrangement of conjugated cyclohexadienones to substituted phenols. Barton reaction. Photo-Fries rearrangement. Photo-Claisen rearrangement. Singlet oxygen reactions and photooxygenation. Photoredox catalysis and visible-light mediated synthesis. Applications in modern organic synthesis.	15
III	**Natural plant pigments and co-pigments:** Structure of Anthocyanins, structure elucidation of cyanin chloride. Synthesis of pelargonidin chloride, cyanidin chloride, delphinidin chloride and peonidin chloride. Structural elucidation of flavones and isoflavones. Baker Venkataraman synthesis and Kostanecki Synthesis. Flavonol - Structure and synthesis.	15
IV	**Retrosynthetic Analysis and Synthetic Strategy** Principles of retrosynthetic analysis. Functional group interconversion (FGI). Disconnection approach and synthetic planning. Importance of order of events in multistep organic synthesis. Chemoselectivity, regioselectivity and stereoselectivity. One-group C–X and C–C disconnections. Disconnections involving alcohols and carbonyl compounds. Protection and deprotection strategies. Synthons and synthetic equivalents. Umpolung reactivity. Two-group disconnections and strategic bond disconnections.	15
V	**Green Chemistry and Modern Synthetic Methods** Principles of Green Chemistry. Design of green syntheses – selection of starting materials, reagents, catalysts (biocatalysts and polymer-supported catalysts) and solvents. Green synthesis of adipic acid, methyl methacrylate, paracetamol, aspirin and ibuprofen. Atom economy, E-factor and process mass intensity (PMI). Renewable feed stocks and sustainable synthesis. Ionic liquids and deep eutectic solvents. **Microwave-assisted synthesis** – reactions on solid supports, phase-transfer catalysis, solvent-free reactions and microwave-assisted reactions in water. Oxidation of toluene to benzoic acid. Ultrasound-assisted synthesis (sonochemistry). Flow chemistry and continuous synthesis. Green catalytic methods and industrial applications.	15

TEXT BOOKS

1. Jerry March, Advanced Organic Chemistry-Reactions, Mechanisms and Structure, 7th Edition, John Wiley & Sons(2013)
2. Francis A. Carey, Organic Chemistry, 10th Edition, The McGraw-Hill Companies, 2022.
3. P.S. Kalsi, Organic Reactions and Mechanisms, 4th Edition, New Age International Publishers, 2018.
4. Charles H.Depuy, molecular reactions and photochemistry, Orville L.Chapman.Prentice Hall of India Pvt Ltd. New Delhi, 2010.
5. I.L. Finar, Organic Chemistry, Volume II, 7th Edition, First Indian reprint, Pearson Education Asia Pte. Ltd.,(2012)
6. G. Chatwal, Organic Chemistry of Natural Products, Vol I & II, Himalaya Publishing House, 2023.
7. Mary Fieser and Louis Fieser, Reagents in Organic Synthesis, Wiley Interscience, Volume 26, 2011.
8. Gill and Wills, Pericyclic Reactions, Chapman Hall, London, 1974.
9. J.A. Joule, G.F. Smith, Heterocyclic Chemistry, Garden City Press, Great Britain, 2010.

REFERENCE BOOKS

1. S. H. Pine, J.B. Hendrickson, D.J. Cram and G.S. Hammond, Organic Chemistry, IV Edn., McGraw Hill Company,2012.
2. R.O.C. Norman, Principles of Organic Synthesis, Second Edition, Chapman and Hall, 1993.
3. L.F.Fieser and M.Fieser, Organic Chemistry, Asia Publishing House, Bombay, 2012.
4. Fisher and Fisher, Steroids, Reinhold, 2012.
5. O.P. Agarwal, Chemistry of Organic Natural Products, Vol I & II, Goel Publishing House, 2022.
6. H. O. House. Modern Synthetic reactions, W.A. Benjamin Inc, 2008.
7. Jagdamba Singh and Jaya Singh, Photochemistry and Pericyclic Reactions, New Age International Publishers, New Delhi, 2012.

Course Outcomes (COs)

CO1: Explain the principles of photochemical excitation, electronic transitions, singlet and triplet excited states, Jablonski diagrams, and analyze the mechanisms and kinetics of photochemical reactions including Norrish Type-I, Type-II, Paternò–Büchi, photoreduction, excimer and exciplex formation.

CO2: Interpret the photochemical behavior of α,β-unsaturated ketones, aromatic compounds, photoisomerization, energy-transfer processes, photochemical rearrangements, singlet oxygen reactions, photoredox catalysis, and evaluate their applications in modern organic synthesis.

CO3: Describe the structure, synthesis, biosynthesis, biological significance, and spectroscopic characterization of flavonoids, anthocyanins, polyphenols, and vitamins A_1, B_2, and C, and relate their functions to biological systems.

CO4: Apply retrosynthetic analysis, disconnection approaches, synthons, synthetic equivalents, protection–deprotection strategies, and selectivity principles to design efficient multistep organic syntheses.

CO5: Evaluate green chemistry principles and modern synthetic methodologies including microwave-assisted synthesis, sonochemistry, flow chemistry, ionic liquids, deep eutectic solvents, and sustainable industrial processes using green metrics such as atom economy, E-factor, and PMI.

CO-PO Mapping (Course Articulation Matrix)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	S	S	S	M	S	S	M	S	S	M
CO 2	S	S	S	S	S	M	S	S	S	S
CO 3	S	S	M	S	M	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	M
CO 5	S	S	M	S	S	M	S	M	M	S

Level of Correlation between PSO's and CO's

CO /PO	**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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

CORE-XIV

ELECTROCHEMISTRY

Unit	Content	No. of Hours
I	**Ionic Equilibria and Ionic Conductance:** Ionic conductance – Debye-Hückel theory. Electrode reactions in strong electrolytes. Debye-Hückel-Onsager equation and its verification. Debye-Hückel limiting law. Kohlrausch's law and applications. Wien effect and Debye-Falkenhagen effect. Ionic strength, activity and activity coefficients. Determination of activity coefficients and behavior at higher concentrations. Debye-Hückel limiting law and extended Debye-Hückel equation. Ion association and ion pairing. Transport numbers and methods of determination. Conductometric titrations and applications.	12
II	**Electrode Kinetics and Interfacial Electrochemistry:** Electrode-electrolyte interface. Outer Helmholtz Plane (OHP) and Inner Helmholtz Plane (IHP). Electrical double layer. Electro capillary thermodynamics and Lippmann equation. Double-layer capacitance measurements. Helmholtz, Gouy-Chapman and Stern models. Butler-Volmer equation, transfer coefficient, Tafel equation and charge-transfer resistance. Hydrogen overvoltage, theories of overvoltage, factors affecting overvoltage and applications. Marcus theory of electron transfer. Exchange current density and polarization.	12
III	**Electrochemical Cells and Energy Storage Systems:** Electrode-electrolyte equilibrium. Classification of electrodes. EMF concept and electrochemical cell conventions. Concentration cells with and without liquid junction. Liquid junction potential. Determination of activity coefficients using concentration cells. Primary and secondary batteries – Lead-acid, Ni-Cd and Lithium-ion batteries. H_2–O_2 fuel cells. Sodium-ion batteries. Lithium-sulfur batteries. Solid-state batteries. Super capacitors and hybrid capacitors. Corrosion and corrosion protection methods. Electrochemical sensors and biosensors.	12
IV	**Fundamentals of Photochemistry and Photoelectrochemistry:** Absorption and emission of radiation. Franck-Condon principle. Decay of electronically excited states. Jablonski diagram. Radiative and non-radiative processes. Fluorescence and phosphorescence. Internal conversion and intersystem crossing. Einstein coefficients. Energy transfer processes. Excimers and exciplexes. Static and dynamic quenching. Stern-Volmer analysis. Semiconductor photochemistry. Band-gap concepts and semiconductor-electrolyte interfaces. Photophysical pathways in materials chemistry.	12
V	**Electroanalytical Techniques and Photochemical Reactions:** Quantum yield and lifetime measurements. Flash photolysis and applications. Actinometry. Photophysical processes and kinetics of photochemical reactions. Radiolysis of biologically important molecules (carbohydrates, amino acids, peptides and nucleic acids). Photoredox reactions and photosubstitution reactions in coordination chemistry. Photoreduction and photocycloreduction in organic chemistry. Photovoltaic and photogalvanic cells. Photoelectrochemistry and solar energy conversion. Photosensitization and chemiluminescence. Cyclic Voltammetry (CV) – principles, Randles-Sevcik equation and applications. Linear sweep and differential pulse voltammetry.	12

TEXT BOOKS

1. D. A.Skoog and D.M.West, Fundamentals of Analytical Chemistry, Holt Rinehart and Winston Publications, 11th Edn, 2024.
2. Willard, Merit, Dean and Settle, Instrumental Methods of Analysis, CBS Publishers and Distributors, VII Edn.2010.
3. Samuel Glasstone, Introduction to electrochemistry, East West Press Pvt. Ltd., 2011.
4. B. K.Sharma, Instrumental methods of chemical analysis, Krishna Prakashan Media Publications, 2024.
5. Jain P.C and Monika Jain, Engineering Chemistry, 19th Edition, Dhanpat Rai Publishing Co., 2024.

REFERENCE BOOKS

1. B. H. Vassos and G.W. Ewing, Electroanalytical Chemistry, John Wiley and Sons, NY, 2001.
2. A. J. Bard and L.R. Faulkner, Electrochemical methods; Fundamentals and applications, J. Wiley and Sons, NY, 2001,
3. J. Wang, Stripping Analysis, VCH Publications, 2006.
4. P. W. Atkin‟s, J.De.Paula, Physical Chemistry, 12thEdition, Oxford University Press, 2023.
5. P. H.Rieger, Electrochemistry, 2nd Edition, Springer Publications, 2012.
6. M. S. Yadav, Instrumental methods of chemical analysis, 1st Edition, Campus Book, 2006.
7. John. O. M. Bockris & A. K. N. Reddy, Modern Electrochemistry (Vol I & II), 7nd Edition, Springer Publications, 2018.
8. A.M. Bond, Modern Polarographic methods in analytical chemistry, Macel Decker Inc., 2001.

Course Outcomes (COs)

CO1: Explain the fundamental concepts of ionic equilibria, ionic conductance, activity coefficients, transport numbers, and conductometric methods, and apply the relevant theories such as Debye–Hückel and Kohlrausch laws to solve electrochemical problems.

CO2: Analyze electrode kinetics and interfacial electrochemical phenomena using electrical double-layer models, Butler–Volmer kinetics, Tafel relationships, overvoltage theories, Marcus electron-transfer theory, and Electrochemical Impedance Spectroscopy (EIS).

CO3: Evaluate electrochemical cells, concentration cells, batteries, fuel cells, supercapacitors, corrosion processes, and electrochemical sensors for energy storage and conversion applications.

CO4: Interpret photochemical and photoelectrochemical processes including excited-state dynamics, fluorescence, phosphorescence, energy transfer mechanisms, semiconductor photochemistry, and time-resolved spectroscopic techniques.

CO5: Apply electroanalytical and photochemical techniques such as cyclic voltammetry, chronoamperometry, flash photolysis, actinometry, photoredox reactions,

photocatalysis, dye-sensitized solar cells, and water-splitting systems for research and technological applications.

CO-PO Mapping (Course Articulation Matrix)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	S	S	M	S	S	S	S	S	M	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	M	S	S	S	M
CO 5	S	S	S	S	S	M	S	S	M	S

Level of Correlation between PSO's and CO's

CO /PO	**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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

CORE-XVI

ORGANIC CHEMISTRY PRACTICAL – II

OBJECTIVES

To develop analytical skill in Estimation of organic compounds, Preparation of organic compounds involving two stages, Extraction of natural products and Separation of mixture of organic compounds using Chromatographic technique.

I. Organic Estimation

1. Phenol
2. Aniline
3. Methyl Ketone
4. Glucose
5. Iodine value of an oil
6. Saponification value of an oil.

II. Organic Preparation involving two stages

1. Sym-tribromobenzene from aniline.
2. m- Nitrobenzoic acid from methylbenzoate.
3. para – Nitroaniline from acetanilide.
4. Benzanilide from benzophenone.
5. Aspirin from methyl salicylate
6. Anthraquinone from phthalicanhydride.

III. Extraction of Natural Products:

1. Caffeine from tea leaves.
2. Citric acid from lemon.

REFERENCE BOOKS

1. B.S. Furniss, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell, Vogel's Practical Organic Chemistry. 6th edn. ELBS.2008.
2. Raj K. Bansal, Laboratory manual of Organic Chemistry, V Edn., New Age International (P) Ltd.2018.
3. Gnanpragasam, Ramamurthy, Organic lab Manual, Viswanathan, S., Printers & Publishers Pvt Ltd, 2009.

Course Outcomes (COs)

CO1: Perform quantitative estimations of important organic compounds such as phenol, aniline, methyl ketone, glucose, and determine iodine and saponification values of oils using standard analytical methods.

CO2: Apply principles of organic chemistry and stoichiometry in the quantitative analysis of organic substances and interpret experimental results accurately.

CO3: Carry out multistep organic syntheses involving nitration, bromination, oxidation, reduction, acetylation, and condensation reactions for the preparation of organic compounds.

CO4: Purify synthesized compounds using appropriate laboratory techniques, evaluate their purity through physical characterization methods such as melting point determination, and yield calculations.

CO5: Demonstrate laboratory skills, safe handling of chemicals, proper documentation, and scientific reporting of experimental observations and results.

CO-PO Mapping (Course Articulation Matrix)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	S	S	S	S	S	S	S	S	M	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	S	S	S	S	M
CO 5	S	M	S	S	S	M	S	S	S	S

Level of Correlation between PSO's and CO's

CO /PO	**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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

CORE- XVII

INORGANIC CHEMISTRY PRACTICAL – II

OBJECTIVES

To develop analytical skill in Quantitative analysis of complex materials, Analysis of Ores and Alloys and Preparation of complexes

Part I Quantitative analysis of complex materials

1. Iron and magnesium
2. Iron and nickel
3. Copper and nickel
4. Copper and Zinc

B) Analysis of Alloys

1. Determination of tin and lead in solder
2. Determination of copper and zinc in brass.
3. Determination of Chromium and nickel in stainless steel.

Part II Preparation of the following

1. Sodium hexanitrocobaltate (III)
2. Sodium Trisoxalatoferrate(III)
3. Prussian blue Fe4[Fe(CN)6]3
4. Bis (Actylacetanato) Copper(II)
5. Hexamminecobalt (III)chloride
6. Hexamminenickel (II)chloride

REFERENCE BOOKS

1. G.Svehla, Vogel's qualitative Inorganic analysis, VI Edition, Orient Longman, 1987.International (P) Ltd.1996.
2. V.V. Ramanujam, Inorganic Semimicro Qualitative analysis. National Publishing Co., Chennai.1971.
3. J. Basset, R.C. Denney, G.H. Jeffery and J.Mendham Vogel's Text book of quantitative inorganic analysis, VI Edition, ELBS, 2009.
4. W.G. Palmer, Experimental Inorganic Chemistry, Van Nostrand Reinhold Co., London,1972.
5. D.N. Grindley, An advanced course in practical Inorganic Chemistry, Butterworths,1964.

Course Outcomes (COs)

CO1: Perform quantitative analysis of binary metal mixtures and accurately determine the composition of complex materials containing transition and main-group metal ions.

CO2: Analyze industrially important alloys such as solder, brass, and stainless steel using classical analytical methods and interpret the results in terms of alloy composition and applications.

CO3: Apply principles of inorganic and analytical chemistry in the separation, identification, and estimation of metal ions present in mixtures and alloys.

CO4: Synthesize coordination compounds and inorganic complexes using appropriate laboratory techniques and reaction conditions.

CO5: Characterize synthesized inorganic compounds through yield determination, observation of physical properties, and chemical verification tests, while maintaining proper laboratory records.

CO-PO Mapping (Course Articulation Matrix)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	S	S	S	S	S	S	S	S	M	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	S	S	S	S	M
CO 5	S	M	S	S	S	M	S	S	S	S

Level of Correlation between PSO's and CO's

CO /PO	**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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

CORE-XVII

PHYSICAL CHEMISTRY PRACTICAL-II

OBJECTIVE

1) To perform experiments in viscosity, surface tension, potentiometry and chemical kinetics.

1. Potentiometric experiments

i) Acid –Base Titration (Strong acid Vs. Strong base).

ii) Acid –Base Titration (Weak acid Vs. Strong base).

iii) Acid–Base Titration (Mixture of acids Vs. Strong base).

iv) Redox Titration (KMnO4Vs.FeSO4).

v) Redox Titration (K2Cr2O7Vs.FAS).

vi) Determination of pH of a Buffer solution using quinhydrone.

vii) Determination of dissociation constant pKa of weak acid.

2. Phase rule: Construction of phase diagram for a simple binary system - Simple eutectic formation - Naphthalene-Biphenyl and Benzophenone- diphenyl amine

3. Adsorption studies: Adsorption of oxalic acid on charcoal & determination of surface area (Freundlich isotherm only).

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

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

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

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

8. Polarimetry: Study the inversion of cane sugar in presence of acid using polarimeter

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

Text Books:

1. V. Venkateswaran, R. Veeraswamy & A.R. Kulandaivelu, *Basic Principles of Practical Chemistry*, 2nd Edition, Sultan Chand & Sons Publishers, 2012.

2. B.Viswanathan & P. S. Raghavan, *Practical Physical Chemistry*, 3rd Edition, Viva Books Publishers, 2009.

3. J. B.Yadav, *Advanced Practical Physical Chemistry*, Krishna Prakashan Media, 2016.

Reference Books:

1. S.R. Palit and S.K. De, *Practical Physical Chemistry*, Science Book Agency, Calcutta, 2003.

2. G. Palmer, *Experimental Physical Chemistry*, 1st Edition, Cambridge University Press, 1964.

3. CarlW. Garland, Joseph W. Nibler & David P. Shoemaker, *Experiments in Physical Chemistry*, 8th Edition, McGraw-Hill Education, 2008.

Course Outcomes (COs)

CO1: Perform potentiometric titrations involving acid–base and redox systems and interpret titration curves to determine equivalence points and related electrochemical parameters.

CO2: Determine important physicochemical parameters such as pH, buffer characteristics, and dissociation constants (pKa) using potentiometric methods and electrochemical principles.

CO3: Apply the principles of chemical kinetics, phase equilibria, and surface chemistry to investigate reaction behavior, eutectic formation, and adsorption phenomena.

CO4: Evaluate experimental data using physicochemical models such as the Freundlich adsorption isotherm and phase rule concepts to explain the properties of chemical systems.

CO5: Determine molecular weight and study reaction kinetics using instrumental techniques such as Rast's method and polarimetry, and interpret the results quantitatively.

CO-PO Mapping (Course Articulation Matrix)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO 1	S	S	S	S	M	S	S	S	S	M
CO 2	S	S	S	S	S	S	S	S	M	S
CO 3	S	S	M	S	S	S	S	M	S	S
CO 4	M	S	S	S	S	S	S	S	S	M
CO 5	S	M	S	S	S	M	S	S	S	S

Level of Correlation between PSO's and CO's

CO /PO	**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
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Strong – 3, Medium-2, Low-1

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