



UNIVERSITY OF JAMMU

(NAAC ACCREDITED 'A' GRADE UNIVERSITY)
(Baba Sahib Ambedkar Road, Jammu-180006 (J&K))

Academic Section

Email: academicsectionju14@gmail.com

NOTIFICATION

(23/Sept/Adp/84)

It is hereby notified for the information of all concerned that the Vice-Chancellor, in anticipation of the approval of the Academic Council, is pleased to authorize the adoption of the revised Syllabi and Courses of Study in the subject of **Master Degree Programme of Chemistry** for semesters Ist to IVth under the **Choice Based Credit System (as given in the Annexure)** for the examinations to be held in the years indicated against each semester as under:-

Subject	Semester	Course Code	For the examinations to be held in the year	% of Change
M.Sc. (Chemistry)	Semester-I	PSCHTC-121	Dec.2023, 2024 and 2025	20%
		PSCHTC-122	Dec.2023, 2024 and 2025	20%
		PSCHTC-123	Dec.2023, 2024 and 2025	20%
		PSCHTC-124	Dec.2023,2024 and 2025	20%
		PSCHTC-125	Dec.2023, 2024 and 2025	100%
	Semester-II	PSCHTC-221	May 2024, 2025 and 2026	20%
		PSCHTC-222	May 2024, 2025 and 2026	20%
		PSCHTC-223	May 2024, 2025 and 2026	20%
		PSCHTC-224	May 2024, 2025 and 2026	20%
		PSCHLC-225	May2024,2025 and 2026	100%
	Semester-III	PSCHTC-321	Dec 2024, 2025and 2026	100%
		PSCHTE-322	Dec 2024, 2025 and 2026	100%
		PSCHTE-323	Dec 2024, 2025and 2026	20%
		PSCHTE-324	Dec 2024, 2025 and 2026	100%
		PSCHTE-325	Dec 2024, 2025 and 2026	40%
		PSCHTE-326	Dec 2024, 2025 and 2026	20%
		PSCHTE-327	Dec 2024, 2025 and 2026	100%
		PSCHTE-351*	Dec 2024, 2025 and 2026	-
		PSCHLE-328	Dec 2024, 2025 and 2026	100%
		PSCHLE-329	Dec 2024, 2025 and 2026	100%
PSCHLE-330	Dec 2024, 2025 and 2026	100%		



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Semester-IV	Course Code	Exam Dates	Percentage
	PSCHTE-421	May 2025, 2026 and 2027	100%
	PSCHTE-422	May 2025, 2026 and 2027	20%
	PSCHTE-423	May 2025, 2026 and 2027	10%
	PSCHTE-424	May 2025, 2026 and 2027	70%
	PSCHTE-425	May 2025, 2026 and 2027	100%
	PSCHTE-426	May 2025, 2026 and 2027	50%
	PSCHTE-427	May 2025, 2026 and 2027	20%
	PSCHTE-428	May 2025, 2026 and 2027	30%
	PSCHTE-429	May 2025, 2026 and 2027	40%
	PSCHTO-430#	May 2025, 2026 and 2027	No Change
	PSCHDE-431	May 2025, 2026 and 2027	100%
	PSCHDE-432	May 2025, 2026 and 2027	100%
	PSCHDE-433	May 2025, 2026 and 2027	100%

The Syllabi of the courses is also available on the University website: www.jammuuniversity.ac.in

Anju Basu
DEAN, ACADEMIC AFFAIRS

No. F.Acd/II/23/9868-9907
Dated: 12-9-2023

Sumit
29/9/23
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Copy for information and necessary action to:

1. Dean, Faculty of Science
2. Convener, Board of Studies in Chemistry
3. All members of the Board of Studies
4. I/C Director, Computer Centre, University of Jammu
- ✓ 5. Incharge, University Website for Uploading of the notification.

CHOICE BASED CREDIT SYSTEM

M. Sc. CHEMISTRY

PROGRAMME SPECIFIC OUT COMES (PSO)

The courses are designed in such a manner that the student feels an essence of studying the specialized courses of Chemistry in various semesters with a keen interest. The curriculum of Choice Based Credit System of M.Sc. program in Chemistry is designed to motivate Post Graduate students to achieve the following program specific outcomes:

1. To enable the students to modulate, simulate and validate the advanced concepts related to different branches of Chemistry.
2. To practice and solve numerical problems and also to understand the mechanism of advanced organic/inorganic reactions and various theories associated with the latest developments.
3. To develop communication and other skills for use in a wide range of industrial areas.
4. To give a practical training with the sophisticated instruments/equipments.
5. To create an awareness and the impact of chemistry on the environment, society and development outside the scientific community.
6. To inculcate the scientific temperament in the students and outside the scientific community.
7. To understand good laboratory practices and safety measures and to develop research oriented skills.

Dr. S. K. Singh

S. K. Singh

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POST GRADUATE DEPARTMENT OF CHEMISTRY, UNIVERSITY OF JAMMU

Semester	Course Code	Title	Credits	Nature of course
I	PSCHTC121	Inorganic Chemistry-I	4	Core
	PSCHTC122	Quantum Chemistry	4	Core
	PSCHTC123	Organic Chemistry-I	4	Core
	PSCHTC124	Principles of Spectroscopy	4	Core
	PSCHLC125	Laboratory Course in Inorganic, Organic & Physical Chemistry-I	8	Core
II	PSCHTC221	Inorganic Chemistry-II	4	Core
	PSCHTC222	Chemical Dynamics, Surface and Electro Chemistry	4	Core
	PSCHTC223	Organic Chemistry-II	4	Core
	PSCHTC224	Applications of Spectroscopy in Organic Chemistry	4	Core
	PSCHLC225	Laboratory Course in Inorganic, Organic & Physical Chemistry-II	8	Core
III	PSCHTC321	Environmental Chemistry	4	Core
	PSCHTE322	Analytical Chemistry-I	4	Elective
	PSCHTE323	Spectroscopy and Photochemistry in Inorganic Chemistry	4	Elective
	PSCHTE324	Heuristic Approach to Organic Synthesis	4	Elective
	PSCHTE325	Bioorganic and Medicinal Chemistry	4	Elective
	PSCHTE326	Thermodynamics and Statistical Mechanics	4	Elective
	PSCHTE327	Nano-Chemistry	4	Elective
	PSCHTE351*	Title of the MOOC/SWAYAM course opted by students	4	Elective MOOC
	PSCHLE328	Laboratory Course in Inorganic Chemistry	8	Elective
	PSCHLE329	Laboratory Course in Organic Chemistry	8	Elective
	PSCHLE330	Laboratory Course in Physical Chemistry	8	Elective
IV	PSCHTE421	Analytical Chemistry-II	4	Elective
	PSCHTE422	Organotransition Metal Chemistry	4	Elective
	PSCHTE423	Bioinorganic and Supramolecular Chemistry	4	Elective
	PSCHTE424	Chemistry of Heterocyclic Compounds	4	Elective
	PSCHTE425	Catalysis in Organic Synthesis	4	Elective
	PSCHTE426	Chemistry of Natural Products	4	Elective
	PSCHTE427	Solid State Chemistry	4	Elective
	PSCHTE428	Polymer Chemistry	4	Elective
	PSCHTE429	Chemistry of Materials and Liquids	4	Elective
	PSCHTO430#	Chemistry in Daily life	4	Open
	PSCHDE431	Project in Inorganic Chemistry	8	Elective
	PSCHDE432	Project in Organic Chemistry	8	Elective
	PSCHDE433	Project in Physical Chemistry	8	Elective

NOTE: The students of Chemistry Department in M.Sc. Semester-IV have to register for 4-credits of course from other departments.

* All the students must complete one MOOC course of four credits from SWAYAM UGC Portal as per the existing guidelines and requirements of University of Jammu regarding SWAYAM course.

#Open Course, available only for students enrolled in programmes other than Chemistry.

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PATTERN OF EXAMINATION

THEORY

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
Minor Test – I (after 30 days)	Upto 20%	1½ hour	20
Minor Test – II (after 60 days)	Upto 40%	1½ hour	20
Major Test (after 90 days)	Upto 100%	3 hours	60

The **Minor Test** would consist of two **Sections (A & B)**.

Section A would consist of two short answer type questions of 05 marks each and students are required to answer both questions.

Section B would consist of two long answer type questions of 10 marks each. Students are required to answer one question from **Section B**.

The **Major Test** will have seven questions (each of twelve marks). The students have to attempt five questions in all. Question no. 1 (short answer type) will be compulsory and will be set out from 40% of syllabus covered in Minor I & II. The remaining six questions will be from across the syllabus of 41% to 100% i.e. beyond Minor I & II. The student has to attempt any four questions out of six questions.

In addition, there shall be a MOOC course through SWAYAM Portal which the students have to study in Semester III.

NOTE: Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.

PRACTICAL

(Semesters-I to III)

The daily evaluation of practical records, assignments, viva-voce and attendance shall have marks weightage of 50% of the total marks. The final practical performance test along with viva-voce examination will be held at the end of semester covering 100% of the syllabus and having marks weightage of 50% of the total marks.

Semester- IV

During this semester, the students will be assigned mentor under whose guidance they have to complete a project based on the research work. In the end of the semester, the students have to submit a project report in the form of dissertation.

Evaluation Scheme: Project examination consists of two parts – Internal and External. Internal part is 50% of the total marks and external is 50% of the total marks.

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Semester - I

Syllabus for the examinations to be held in Dec. 2023, Dec. 2024 & Dec. 2025

Course Code: PSCHTC121
Title: Inorganic Chemistry-I
Credits: 04
No. of hours: 60

Nature of Course: Core

Maximum Marks: 100

Course Outcome: This course will enable the students to learn the concept of group theory and its applications, stereochemistry and bonding, theories of bonding, metal-ligand equilibria as well as electronic spectra of transition metal complexes.

After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

Unit-I Concept of Group theory in Chemistry and its Applications (12 hours)

Symmetry elements and symmetry operations, Definitions of group, Subgroup, Point symmetry groups, Schoenflies symbols, Symmetry operations as group elements, Multiplication table, Conjugacy relation and classes, Representation of symmetry operations by matrices, Character of a representation, Reducible & irreducible representation, Derivation of Character tables for C_{2v} , C_{3v} , C_{2h} , Simple applications of Character Table

Unit-II Stereochemistry and Bonding in Main Group Compounds (12 hours)

VSEPR, Walsh diagram (tri- and penta atomic molecules), Bent rule and energetics of hybridization, $d\pi$ - $p\pi$ bonds, Chemistry of inorganic rings and cages, Borazines, Phosphazenes, Polyhedral boranes, Carboranes, Metalloboranes and Metallocarboranes.

Unit-III Theories of Bonding in Transition Metal Complexes (12 hours)

Shortcomings in Valence Bond Theory, Crystal field splitting in Octahedral, Tetrahedral, Square planar, Square Pyramidal and Trigonal Bipyramidal complexes, Structural effects of crystal field splitting, Variation of ionic ratio, Lattice energy, Molecular orbital theory, MO energy level diagrams for octahedral, tetrahedral and square planar complexes, π bonding and M.O theory, Variation of Δ_o with the π acceptor and σ donor ligand.

Unit-IV Metal-Ligand Equilibria in Solution (12 hours)

Stepwise and overall formation constants and their interaction, Trends in stepwise constants, Factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, Chelate effect and its thermodynamic origin, Determination of binary formation constants by pH-metry, Formation of colored complexes in solution in different metal to ligand ratios, Calculation of stability constant of a complex formed in 1:1 metal to ligand ratio by spectrophotometric method, Determination of ϵ .

Unit-V Electronic Spectra of Transition Metal Complexes (12 hours)

Spectroscopic ground states, Term symbol, Splitting of terms by ligands, Rules for electronic transitions, Correlation diagrams, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1 - d^9), Calculation of Dq , B and β Parameters, Nephelauxetic effect and Jahn-Teller Effect, Charge transfer spectra

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Semester - 2

Syllabus for the examinations to be held in Dec. 2023, Dec. 2024 & Dec. 2025

BOOKS RECOMMENDED:

1. Analytical applications of complex equilibria, J. Inczedy, Halsted Press: New York, NY (1976).
2. Solution Equilibria, F. R. Hartley, C. Burgess & R. M. Alcock, Prentice-Hall: Europe (1980).
3. Complexation in Analytical Chemistry, A. Ringbom, Wiley: New York (1963).
4. Chemical Applications of Group Theory, F.A. Cotton.
5. Group Theory and Symmetry in Chemistry Lowell H. Hall.
6. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
7. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
8. Advanced Inorganic Chemistry, F.A. Cotton and G. Wilkinson, John Wiley.
9. Advanced Inorganic Chemistry, J. D. Lee.
10. Comprehensive Coordination Chemistry, G. Wilkinson, R.D. Gillars and J.A. McCleverty, Pergamon.
11. Group Theory and Chemistry, D. M. Bishop, Clarendon Press: Oxford, U.K. (1973).
12. Symmetry in Chemistry, H. H. Jaffe & M. Orchin, Dover Publications (2002).
13. Electronic Spectra of Transition Metal Complexes, D. Sutton, McGraw-Hill: New York (1968).
14. Ligand Field Theory and its Applications, Brian N. Figgis and Michael A. Hitchman, Wiley-VCH.
15. Inorganic Solids: An Introduction to Concepts in Solid-State Structural Chemistry, D. M. Adams, John Wiley & Sons, London (1974).
16. Inorganic Chemistry by Catherine Housecroft and A G Sharpe Prentice Hall; 2nd edition (2004-11-18).
17. Inorganic Chemistry, Gary L. Miessler, Donald A. Tarr, Prentice Hall (4th Edition), 2010.
18. Concepts and Models of Inorganic Chemistry, Bodie Douglas, DarlMcDaniel, John Alexander, Wiley; 3 rd edition (2006).
19. Inorganic Chemistry, A.G. Sharpe, Pearson, India, 3rd edition, (2002).

PATTERN OF EXAMINATION

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Semester-I

Syllabus for the examinations to be held in Dec. 2023, Dec. 2024 & Dec. 2025

Course Code: PSCHTC122

Title: Quantum Chemistry

Credits: 04

No. of hours: 60

Nature of Course: Core

Maximum Marks: 100

Course Outcome: This course will help to understand the various aspects of quantum mechanics. In addition, the students will gather knowledge about angular momentum, approximation methods, chemical bonding, HMO methods and its applications. This course also offers employability in the research institutes and academics.

UNIT-I : Exact quantum mechanical results (15 hours)

Schrodinger equation and the postulates of quantum mechanics, Operator concept, Some properties of quantum mechanical operators, Linear, Hermitian and Unitary operators, Commutator and their properties, Operators for different observables, Schrodinger wave equation for Hydrogen like atoms in spherical polar coordinates, Separation into three equations, Quantum numbers and their importance, Radial and Angular wave functions (Spherical Harmonics).

Complete solution of Schrodinger equation for the following model systems: Particle in a box (1 and 3 dimensional), Concept of degeneracy, One dimensional Simple Harmonic Oscillator & the Rigid Rotator, Calculation of various average values for the above systems, Concept of Tunneling, Numericals.

UNIT-II: Angular momentum and Electronic structure of atom (12 hours)

General theory of angular momentum, Eigen functions and Eigen values of angular momentum operators, Ladder operators, Commutation relations, Spin angular momentum, Anti-symmetry and Pauli's principle.

Electronic configuration, Russell-Saunders and jj-coupling schemes, Slater determinant, Vector model of the atom, Atomic term symbols, Term separation of p^n configurations, Spin-orbit coupling, Zeeman splitting, Virial theorem, Numericals.

UNIT-III: Approximation methods (10 hours)

Approximation methods, The Variation method, Linear variation principle, Perturbation method—postulates and calculation of first order perturbation (non-degenerate), Application of variation method and perturbation method to Helium atom (Ground state energy), Numericals.

UNIT-IV: Chemical Bonding (13 hours)

Molecular orbital theory (Homonuclear and Heteronuclear diatomics), LCAO-MO approximation, Molecular orbital treatment of H_2^+ molecular ion and H_2 molecule, Calculation of energy levels from wave functions, Comparison of experimental and theoretical results, Physical picture of bonding and anti-bonding wave function, Brief introduction to H_2 . Valence bond treatment of H_2 molecule, Comparison of MO and VB methods, Numericals.

UNIT-V: HMO method and its applications (10 hours)

Huckel's MO theory of conjugated systems; Application to Ethylene, Butadiene, Cyclobutadiene, Allyl systems (Allyl cation, Allyl radical and Allyl anion), Cyclopropenyl systems (Cyclopropenylcation, Cyclopropenylradical and Cyclopropenylcarbanion). Calculation of properties- Delocalization energy, Electron density and Bond order, Numericals.

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Semester - I

Syllabus for the examinations to be held in Dec. 2023, Dec. 2024 & Dec. 2025

BOOKS RECOMMENDED

1. Physical Chemistry, P. W. Atkins, J. de Paula, Oxford, Tenth Edition, 2014.
2. Introduction to Quantum Chemistry, A. K. Chandra, McGraw Hill, Fourth Edition, 2001.
3. Quantum Chemistry, Ira. N. Levine, Pearson, Seventh Edition, 2016.
4. Molecular Quantum Mechanics, P. W. Atkins and R. S. Friedmann, Oxford, Fifth Edition, 2012.
5. Quantum Chemistry and Spectroscopy by T. Engel and P. Reid, Pearson, Third Edition, 2018.
6. Quantum Chemistry, J. P. Lowe and K. A. Peterson, Academic Press, Third Edition, 2005.
7. Physical Chemistry by R. J. Silby, R. A. Alberty and M. G. Bawendi, Wiley, Fourth Edition, 2004.
8. Quantum Chemistry by D. A. McQuarrie, Viva Books Pvt. Ltd, New Delhi, 2011.
9. Mathematics for Physical Chemistry, R. G. Mortimer, Third Edition, Elsevier, 2005.
10. Elementary Quantum Chemistry, F. L. Pilar, Second Edition, Dover Publication Inc., New York, 2001.
11. Physical Chemistry: A Molecular Approach, D. A McQuarrie and J. D. Simon, Univ. Science Books, Third Edition 2001.

PATTERN OF EXAMINATION

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Semester - I

Syllabus for the examinations to be held in Dec. 2023, Dec. 2024 & Dec. 2025

Course Code: PSCHTC123

Title: Organic Chemistry-I

Credits: 04

No. of hours: 60

Nature of Course: Core

Maximum Marks: 60

Course Outcome: This course is focussed on nature of bonding in organic molecules, stereochemistry, reaction mechanism, aliphatic nucleophilic substitution and free radical reactions.

After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

UNIT-I: Nature of bonding in organic molecules (12 hours)

Delocalized chemical bonding-conjugation, Crossconjugation, Resonance, Hyperconjugation, Tautomerism, Aromaticity in benzenoid and non-benzenoid compounds, Alternant and non-alternant hydrocarbons, Huckel's rule, Energy level of molecular orbitals, Annulenes, Antiaromaticity, Homo-aromaticity, Crown ether complexes and cryptands, Inclusion compounds, Cyclodextrins.

UNIT -II: Stereochemistry (12 hours)

Elements of symmetry, Molecular Chirality, Absolute configuration, Molecules with more than one chiral center, Threo- and erythro- isomers, Properties of enantiomers (Carvone & Limonene) & birth of chiral drugs (examples Nicotine, Thyroxine and Thalodimide). Methods of resolution, Optical purity, Enantiotopic and diastereotopic atoms, Groups and faces, Chirality in Biphenyls, Allenes and Spiranes. Conformational analysis of cyclohexanes, Decalins, Effect of conformation on reactivity.

UNIT -III: Reaction Mechanism: Structure and Reactivity (12 hours)

Types of mechanisms, Kinetic and thermodynamic control, Curtin-Hammett principle, Potential energy diagrams, Transition states and intermediates, Methods of determining mechanisms, Isotope effects, Structure, stability and reactions of carbenes and nitrenes, Effect of structure on reactivity-Resonance and field effects, Steric effect, Qualitative treatment, The Hammett equation and linear free energy relationship, Substituent and reaction constants.

UNIT -IV: Nucleophilic Substitutions (12 hours)

The S_N2 , S_N1 , Mixed S_N1 and S_N2 and SET mechanisms, The neighbouring group mechanism, Neighbouring group participation by σ and π bonds, Classical and non-classical carbocations, Phenonium ions, Norbornyl system, The S_{Ni} mechanism. Nucleophilic substitutions at an allylic, aliphatic trigonal and a vinylic carbon, Reactivity effects of substrate structure, Attacking nucleophile, Leaving group and reaction medium, Phase transfer catalysis and ultrasound, Ambident nucleophile and regioselectivity.

UNIT -V: Free Radical Reactions (12 hours)

Mechanism of free-radical reactions, Neighbouring group assistance, The effect of solvent and attacking radicals on reactivity, Allylic halogenations (NBS), Oxidation of aldehydes to carboxylic acids, Auto-oxidation, Coupling of alkynes [Cadiot-Chodkiewicz coupling] and arylation of aromatic compounds by diazonium salts, Sandmeyer, Barton and Hunsdiecker reactions. Alkylation and acylation of N-heterocycles.

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Semester - I

Syllabus for the examinations to be held in Dec. 2023, Dec. 2024 & Dec. 2025

BOOKS RECOMMENDED

1. Advanced Organic Chemistry, Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Organic Chemistry, Jonathan Clayden, Nick Greeves, Stuart Warren, Peter Wothers, Oxford (2000).
3. Advance Organic Chemistry, Part-A: Structure & Mechanism (Fifth Edition), F.A. Carey & R.J. Sundberg, Published by Springer Science (2007).
4. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
5. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Corell University Press.
6. Organic Chemistry, R.T. Morrison & R.N. Boyd, Prentice Hall.
7. Stereochemistry of Organic Compounds, D. Nasipuri (3rd Edition), New Age International (P) Limited, New Delhi (2014).
8. Organic Synthesis, Michael B. Smith, McGraw Hill Education.
9. Steric and Stereoelectronic Effect in Organic Chemistry, V. K. Yadav, Springer Singapore (2016).
10. Modern Methods of Organic Chemistry, William Carruthers and Liancoldham, Cambridge University Press (4th edition, 2015).
11. Organic Chemistry, Stanley H. Pine, Tata McGraw Hill (5th Edition, 2007).

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Semester - I

Syllabus for the examinations to be held in Dec. 2023, Dec. 2024 & Dec. 2025

Course Code: PSCHTC124

Nature of Course: Core

Title: Principles of Spectroscopy

Maximum Marks: 100

Credits: 04

No. of hours: 60

Course Outcome: By studying this course, the students are able to concentrate on physical aspects of various techniques of spectroscopy, namely, microwave, vibrational, Raman, NMR. Information about X-ray and neutron diffraction techniques will also be dealt. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

UNIT-I: Unifying Principles

(10 hours)

Electromagnetic Radiation, Characterization, Quantization of energy, Regions of emr, Interaction of emr with matter, Phenomenon related to radiation-Transmission, reflection, refraction, dispersion, polarization, Width and intensity of spectral lines, Factors contributing to this effect: Collision broadening, Doppler broadening, Heisenberg's uncertainty principle, Transition probability, Population of states and Path length of sample, Results of time dependent Perturbation theory: Stimulated (Induced) absorption, Stimulated and spontaneous emission, Einstein coefficients, Numericals

UNIT -II: Microwave Spectroscopy

(10 hours)

The classification of molecules on the basis of moment of inertia, Interaction of radiation with rotating molecule, Rotational spectra of diatomic molecules: the rigid diatomic molecule, the intensities of spectral lines, the effect of isotopic substitution, determination of bond length and/or atomic masses from microwave data, the non-rigid rotator, the spectrum of non-rigid rotator, Energy levels and spectra of linear polyatomic molecules, Chemical analysis by microwave spectroscopy, Numericals

UNIT -III: Vibrational Spectroscopy

(12 hours)

Vibrating diatomic molecule: the energy of a diatomic molecule, the simple Harmonic oscillator, the Anharmonic oscillator, Selection rules, overtones and combination bands, dissociation energies from vibrational spectra, Vibrational-rotational spectra, P, Q and R branches, Breakdown of Born-Oppenheimer approximation, Vibrations of polyatomic molecules: Fundamental vibrations and their symmetry, Influence of rotation on the spectra of polyatomic molecules: linear molecules, the influence of nuclear spin, Numericals

UNIT -IV: Raman Spectroscopy and Nuclear Magnetic Resonance Spectroscopy

(14hours)

Raman Spectroscopy: Quantum theory of Raman effect, Classical theory of Raman effect, Pure rotational Raman spectra of linear molecules, Vibrational Raman spectra: Raman activity of vibrations, Rule of Mutual exclusion, Vibrational Raman spectra, Selection rules, Numericals.

Nuclear Magnetic Resonance Spectroscopy: Nuclear spin, Nuclear Magnetic resonance, Saturation, Chemical shift and its measurements, Factors affecting chemical shift, Deshielding, Spin-spin interactions, Factors affecting coupling constant, Basic idea about NMR instrument, FT NMR, Advantages of FT NMR

UNIT -V: Diffraction Techniques

(14 hours)

X-ray diffraction: X-rays and their generation, Diffraction of X-rays, Crystal systems and Bravais lattice, Lattice planes, Miller indices and directions, d-spacing formulae, index

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Semester - I

Syllabus for the examinations to be held in Dec. 2023, Dec. 2024 & Dec. 2025

reflections, Identifications of unit cells from systematic absences in diffraction pattern, Debye-Scherrer method of X-ray structural analysis of crystals, Intensities of X-ray reflections: Scattering of X-rays by an atom and by a crystal, Structure factor and its relation to intensity and electron density, Uses of Powder X-ray diffraction, Numericals
Neutron diffraction: General introduction, Magnetic structure analysis, Uses of Neutron diffraction

BOOKS RECOMMENDED

1. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
2. Basic Principles of Spectroscopy, R. Chang, McGraw Hill.
3. Fundamentals of molecular spectroscopy, C.N. Banwell and E.M. McCash, Tata McGraw Hill.
4. Solid State Chemistry and its applications, A.R. West, John Wiley & Sons.
5. Solid State Chemistry: An Introduction, L. Smart and E. Moore, Nelson Thrones Ltd., UK.
6. Atomic and molecular spectroscopy- Basic concepts and applications. Rita Kakkar, Cambridge Press, 2017.

PATTERN OF EXAMINATION

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
Minor Test - I (after 30 days)	Upto 20%	1½ hour	20
Minor Test - II (after 60 days)	Upto 40%	1½ hour	20
Major Test (after 90 days)	Upto 100%	3 hours	60

The **Minor Test** would consist of two **Sections (A & B)**.

Section A would consist of two short answer type questions of 05 marks each and students are required to answer both questions.

Section B would consist of two long answer type questions of 10 marks each. Students are required to answer one question from **Section B**.

The **Major Test** will have seven questions (each of twelve marks). The students have to attempt five questions in all. Question no. 1 (short answer type) will be compulsory and will be set out from 40% of syllabus covered in Minor I & II. The remaining six questions will be from across the syllabus of 41% to 100% i.e. beyond Minor I & II. The student has to attempt any four questions out of six questions.

NOTE: Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.

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Course Code: PSCHLC125

Nature of Course: Core

Title: Laboratory Course in Inorganic, Organic and Physical Chemistry-I

Credits: 08

Maximum Marks: 200

No. of hours: 240

Course Outcome: This course will help the students to learn how the rare analysis of metals is analyzed and simultaneously to prepare and characterize coordination complexes. After completing this course, students will be employable in R&D divisions of Industries Research and Academic Institutes.

INORGANIC CHEMISTRY

1. Qualitative analysis of less common (rare) metals
Analysis of mixture containing less common metal ions: Tl, W, Mo, Se, Te, Zr, Ti, Ce, Th, V, U, Li (four metal ions in cationic/anionic forms)
 2. Prepare $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2$ and carry out its ligand exchange reactions with bidentate ligands like Oxalate (ox), Glycine(gly), acetylacetonone (acac) and dimethyl glyoxime(dmg) by substitution method.
 3. Prepare $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2 \cdot 2\text{H}_2\text{O}$ and $[\text{Ni}(\text{en})_2]\text{Cl}_2 \cdot 2\text{H}_2\text{O}$. Record electronic spectra of nickel(II) chloride hexahydrate and these complexes and determine energies of transition and spectrochemical order of ligands H_2O , NH_3 and en.
 4. Prepare two copper oxalate hydrate complexes; $\text{K}_2[\text{Cu}(\text{C}_2\text{O}_4)_2] \cdot 4\text{H}_2\text{O}$ and $\text{K}_2[\text{Cu}(\text{C}_2\text{O}_4)_2] \cdot 2\text{H}_2\text{O}$ by controlling experimental conditions: Kinetic vs Thermodynamic factors
 5. Prepare *cis* and *trans*- $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$ complexes.
 6. Prepare *cis*, *trans*- $\text{K}[\text{Cr}(\text{C}_2\text{O}_4)_2(\text{H}_2\text{O})_2] \cdot 2\text{H}_2\text{O}$ and $\text{K}_3[\text{Cr}(\text{C}_2\text{O}_4)_3] \cdot 3\text{H}_2\text{O}$ complexes.
 7. Prepare $\text{Cu}(\text{acac})_2$, $\text{Mn}(\text{acac})_3$, $\text{Fe}(\text{acac})_3$ and $\text{VO}(\text{acac})_2$ Complexes
 8. Prepare Bis(ethylenediammine)dioxalatocobalt(III) chloride dihydrate
 9. Determine wavelength of maximum absorption (λ_{max}) of the complex formed between Fe^{2+} and 1,10-phenanthroline and determine concentration of ferrous ion in a sample from calibration curve.
 10. Determine composition of Fe^{3+} - salicylic acid complex in solution by Job's Method.
 11. Determine composition of Fe^{3+} - NCS^- complex in solution by Job's Method.
 12. Estimation of 10Dq for $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ by spectrophotometric method
- Any other experiment introduced by the concerned teacher.**

Books Suggested:

1. Vogel's Qualitative Inorganic Analysis, 7thEdn., Pearson Education Ltd
2. Synthesis and Characterization of Inorganic Compounds, William L. Jolly, Prentice Hall.
3. Experimental Inorganic Chemistry by W.G. Palmer, Cambridge
4. Inorganic Synthesis, MC Graw Hill.
5. Handbook of Preparative Inorganic chemistry Vol. I and II, Academic press.
6. Standard methods of chemical analysis by W.W. Scaff, Technical Pres

Semester - I

Syllabus for the examinations to be held in Dec. 2023, Dec. 2024 & Dec. 2025

ORGANIC CHEMISTRY

Course Outcome: The organic synthesis of various compounds with characteristic functional groups will be carried out. IR spectra will be used to identify various functional groups.

Quantitative Analysis

Separation, purification and identification of compounds of binary mixture (two solids) using TLC, chemical tests, IR spectra to be used for functional group identification.

Organic Synthesis

Acetylation: Acetylation of $-NH_2$ and $-OH$ groups.

Synthesis of oximes of carbonyl compounds.

Aldol condensation: Dibenzal acetone and benzylidene acetone from benzaldehyde.

Cannizzaro reaction: Benzyl alcohol and benzoic acid from benzaldehyde.

Any other experiment introduced by the concerned teacher.

BOOKS RECOMMENDED

1. Experiments and techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall.
2. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Heath.
3. Systematic Qualitative Organic Analysis, H. Muddleton, Edward Arnold.
4. Handbook of Organic Analysis- Qualitative and Quantitative, H. Clark, Edward Arnold.
5. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
6. Monograph on Green Chemistry by Green Chemistry Task Force Committee, DST.

PHYSICAL CHEMISTRY

Course Outcome: Error analysis and statistical analysis data will be analyzed by the students before proceeding to the actual performance of various experiments as mentioned in the following details.

Number of hours for each experiment: 3-4 hours

A list of experiments under different headings is given below. Typical experiments are to be selected from each type. Students are required to perform at least 25 experiments.

Error Analysis and Statistical Data Analysis

Errors, types of errors, minimization of errors, error distribution curves, precision, accuracy and combination; statistical treatment for error analysis, student 't' test, null hypothesis, rejection criteria, F&Q test; linear regression analysis, curve fitting, calibration of volumetric apparatus, burette, pipette and standard flask.

Phase Equilibria

To construct the phase diagram for three component system (e.g. Chloroform-acetic acid-water, ethanol-benzene-water, ethanol-ethyl acetate-water, acetic acid-benzene-water).

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Semester - I

Syllabus for the examinations to be held in Dec. 2023, Dec. 2024 & Dec. 2025

Chemical Kinetics

- i) Determination of the effect of (a) change of temperature (b) change of concentration of reactants and catalyst and (c) ionic strength of media on the velocity constant of hydrolysis of an ester/ionic reaction in micellar media.
- ii) Determination of velocity constant of hydrolysis of an ester/ionic reaction in micellar media.
- iii) Determination of the rate constant for the oxidation of iodine ions by hydrogen peroxide studying the kinetics as an iodine clock reaction.
- iv) Flowing clock reactions.
- v) Determination of the primary salt effect on the kinetics of ionic reactions and testing of the Bronsted relationship (iodide ion is oxidized by persulphate ion).

Solutions

- i) Determination of molecular weight of non-volatile and non-electrolyte/electrolyte by cryoscopic method and to determine the activity coefficient of an electrolyte.
- ii) Determination of the degree of disassociation of weak electrolyte and to study the deviation from ideal behaviour that occurs with a strong electrolyte.

Viscosity

- i) Determination of molecular weight of high polymer (polystyrene) from viscosity measurements.

Surface-Tension

Study of variation of surface tension of solution with concentration and determination of surface excess, Study of interfacial tension between two immiscible liquids, CMC from surface-tension measurements

Any other practical introduced by the teacher

BOOKS RECOMMENDED

1. Practical Physical Chemistry, A. M. James and F. E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B. P. Levitt, Longman.
3. Experimental Physical Chemistry, R. C. Das and B. Behera, Tata McGraw Hill.
4. Experiments in Physical Chemistry by Shoemaker.
5. Practical Physical Chemistry, Viswanathan and Raghavan.
6. Advanced Physical Chemistry, J.B. Yadav, Goel Publishing House.

PATTERN OF EXAMINATION

The daily evaluation of practical records, assignments, viva-voce and attendance shall have marks weightage of 50% of the total marks. The final practical performance test along with viva-voce examination will be held at the end of semester covering 100% of the syllabus and having marks weightage of 50% of the total marks.

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Semester-II

Syllabus for the examinations to be held in May 2024, May 2025 & May 2026

Course Code: PSCHTC221
Title: Inorganic Chemistry-II
Credits: 04
No. of hours: 60

Nature of Course: Core
Maximum Marks: 100

Course Outcome: By studying this course, the students will come to know the mechanism of reactions in inorganic complexes, magnetic properties of complexes and metal clusters framework of complexes.

After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

UNIT-I: Mechanism of Substitution Reactions in Octahedral Transition Metal complexes (12 hours)

Energy profile of a substitution reaction, Inert and labile complexes, Factors affecting the inert and labile nature, Calculation of CFAE (Crystal field activation energy), Intimate and Stoichiometric Mechanism, Rate Laws for Different Stoichiometric Mechanisms, Different factors reaction rate and reaction mechanisms, Acid hydrolysis of octahedral Co(III)-ammine complexes, Base hydrolysis of octahedral Co(III)-ammine complexes, Evidence of SN1 CB mechanism, Anation reaction, Substitution reaction without breakage of metal to ligand bond.

UNIT -II: Mechanism of Substitution Reactions in Square Planar Complexes and Electron Transfer (or Oxidation-Reduction) Reaction (12 hours)

Mechanism of substitution reactions in Pt(II) complexes, Factors effecting the reactivity of square planar complexes, Trans-effect, Theories of trans-effect-Grinberg's electrostatic polarization theory and Chatt and Orgel pi-bonding theory, Application of trans-effect to synthesis of complexes, Reductions -oxidation reaction, One electron transfer reaction, Outer sphere, Marcus equation for outer-sphere cross reactions, Inner sphere redox reaction, steps of inner sphere redox reaction, Types of inner sphere electron transfer reactions.

UNIT -III: Magnetic Properties of Transition Metal Complexes (12 hours)

Elements of magnetic properties and Terminology, Spin-orbit coupling constants and splitting of energy levels, Lande splitting rule, Paramagnetism and thermal energy, multiplet width, Curie equation and Van-Vleck equation, Quenching of orbital contribution to magnetic moment by crystal field, orbital contribution from excited state through spin-orbit coupling, magnetic properties of complexes of first transition metal ions, magnetic properties of lanthanides, magnetic moments of metal complexes with crystal field terms of A, E and T symmetry, T.I.P, anomalous magnetic moments, high and low spin equilibrium, Intramolecular effects, Antiferromagnetism and ferromagnetism of metal complexes, Magnetic exchange coupling.

UNIT -IV: Metal Carbonyls, Nitrosyls, Dinitroge and Oxygen Complexes (12 hours)

Metal carbonyls, Structure and bonding, Vibrational spectra of metal carbonyls for bonding and structural elucidation, Important reactions of metal carbonyls, Preparation, Bonding, Structure and important reactions of transition metal nitrosyls, Dinitrogen and oxygen complexes, Tertiary phosphine as ligand.

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Semester - II

Syllabus for the examinations to be held in May 2024, May 2025 & May 2026

Syllabus for the examinations to be held in May 2024, May 2025 & May 2026

UNIT-V: Metal Clusters

(12 hours)

Introduction, dinuclear clusters, multiple metal-metal bonds, multinuclear clusters, low nuclearity carbonyl clusters, high nuclearity carbonyl clusters, electron counting schemes for high nuclearity carbonyl clusters, capping rule, limitations & exceptions, polyhedral skeletal electron pair approach or Mingos's rules, isolobal analogy, Isolobal main-group and transition-metal fragments, examples of applications of analogy, clusters having interstitial main group elements, carbide clusters.

BOOKS RECOMMENDED:

1. Inorganic Reaction Mechanism, F. Basolo & G. Pearson.
2. Inorganic Reaction Mechanism, J. O. Edwards.
3. Selected Topics in Inorganic Chemistry, Malik, Madan & Tuli.
4. Mechanism of Inorganic Reactions, D. Katakis & G. Gordon, John Wiley & Sons: N.Y. (1987).
5. Ligand Substitution Processes, H. Langford & H.B. Gray, W.A. Benjamin, Inc. New York.
6. Magnetochemistry by R.L. Carlin, Springer Verlag.
7. Magnetism and Transition Metal Complexes, F. E. Mabbs & D. J. Machin, Chapman and Hall: U.K. (1973).
8. Advanced Inorganic Chemistry, F.A. Cotton and G. Wilkinson, John Wiley.
9. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
10. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
11. Comprehensive Coordination Chemistry eds., G. Wilkinson, R.D. Gillars and J. A. Mc Cleverty, Pergamon.
12. Inorganic Chemistry – Principles of Structure & Reactivity, J E Huheey, Ellen A Keiter & Richard L Keiter, IV Edition (2005).
13. Introduction to metal pi-complex chemistry, M. Tsutsui, M. N. Levy, A. Nakamura, Springer
14. Inorganic Chemistry, Gary L. Miessler, Donald A. Tarr, Prentice Hall (4th Edition), 2010.
15. Concepts and Models of Inorganic Chemistry, Bodie Douglas, Darl McDaniel, John Alexander, Wiley; Third edition (2006).
16. Inorganic Chemistry by A. G. Sharpe, Pearson India; 3rd Edition (2002).
17. Basic Organometallic Chemistry: Concepts, Syntheses and Applications 2nd Edition, B. D. Gupta and A. J. Elias, 2nd Edition, Universities Press.

PATTERN OF EXAMINATION

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
Minor Test – I (after 30 days)	Upto 20%	1½ hour	20
Minor Test – II (after 60 days)	Upto 40%	1½ hour	20
Major Test (after 90 days)	Upto 100%	3 hours	60

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Semester-II

Syllabus for the examinations to be held in May 2024, May 2025 & May 2026

The **Minor Test** would consist of two **Sections (A & B)**.

Section A would consist of two short answer type questions of 05 marks each and students are required to answer both questions.

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semester - IInd

Syllabus for the examinations to be held in May 2024, May 2025 & May 2026

Course Code: PSCHTC222

Nature of Course: Core

Title: Chemical Dynamics, Surface and Electro Chemistry

Credits: 04

Maximum Marks: 100

No. of hours: 60

Course Outcome: This course will help to understand chemical kinetics using various theories of bimolecular and unimolecular reactions. Polymer Chemistry, Micelles and Advanced Electrochemistry details will be imparted to the students. A brief idea of nano materials is also introduced.

This course also offers employability in the Research and Development sector, research institutes and academics.

UNIT-I: Chemical Dynamics – I (12 hours)

Collision theory of reaction rates, Steric factor, Activated complex theory, Arrhenius equation and the activated complex theory; Ionic reactions, Kinetic salt effects, Kinetic and thermodynamic control of reactions, Steady state kinetics, Photochemical and thermal reaction between hydrogen and bromine, Photochemical reaction between hydrogen and chlorine, Pyrolysis of acetaldehyde, Decomposition of ethane, Decomposition of nitrogen pentoxide, Formation and decomposition of phosgene, Oscillatory reactions (Belousov-Zhabotinsky reaction), Homogeneous catalysis, Kinetics of enzyme reactions, Numericals.

UNIT-II: Chemical Dynamics – II (12 hours)

General features of fast reactions, Study and kinetics of fast reactions by flow method, Relaxation method (Kinetics of first order reaction reversed by a first order, second order reaction reversed by first order and first order reaction reversed by a second order reaction) and Flash Photolysis method, Theories of unimolecular reactions: Lindemann-Christiansen, Hinshelwood and Rice-Ramsperger-Kassel (RRK) theories, Kinetics of complex reactions: Opposing/Reversible reactions and Consecutive reactions, Combination and Disproportionation Reactions, Numericals.

UNIT-III: Surface Chemistry (12 hours)

Surface tension and surface free energy, Capillary action, Pressure difference across curved surface (Laplace equation), Vapour pressure of droplets (Kelvin equation), Nature and thermodynamics of liquid interfaces: Surface thermodynamic quantities for a pure substance, The total surface energy, Adsorption and its types, Adsorption isotherms, Freundlich and Langmuir adsorption isotherms, BET equation, Determination of surface area, Gibbs adsorption equation, Surface films on liquids, Catalytic activity at surfaces, Numericals.

UNIT-IV: Electrochemistry-I (12 hours)

Debye-Huckel limiting law, Debye-Huckel-Onsager treatment and its extension, Debye-Huckel-Bjerrum equation, Thermodynamics of electrified interfaces, Lippman equation, Method of determination of surface excess, Structure of electrified interfaces: Helmholtz-Perrin, Guoy-Chapman and Stern models, Over potential, Exchange current density, Butler-Volmer equation, Tafel plot, Electrocatalysis, Numericals.

UNIT-V: Electrochemistry-II and Micelles (12 hours)

Analogies between semiconductor and electrolyte, Structure of semiconductor-electrolyte interface, The diffuse charge region inside an intrinsic semiconductor (The Garrett-Brattain Space), Differential capacity due to space charge.

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Semester-IInd

Syllabus for the examinations to be held in May 2024, May 2025 & May 2026

Polarography: Theory and working of polarography, Ilkovic equation, Half wave potential and its significance, Overvoltage.

Micelles

Surface active agents, Classification of surface active agents, Micellization, Hydrophobic interaction, Critical micellar concentration (CMC), Factors affecting the CMC of surfactants, Counter ion binding of micelles, Thermodynamics of micellization-phase separation and mass action models, Solubilisation, Micro emulsion, Reverse micelles.

BOOKS RECOMMENDED

1. Physical Chemistry, P.W. Atkins, ELBS.
2. Chemical Kinetics, K.J. Laidler, Pearson, 3rd Edition.
3. Physical Chemistry of Surfaces, A.W. Adamson, John Wiley and sons, 5th Edition.
4. Micelles, Theoretical and Applied Aspects, V.Moroi, Plenum.
5. Modern Electrochemistry Vol. 1, Vol. 2A and Vol. 2B, J.O.M. Bockris and A.K.N. Reddy, Plenum.
6. Nanomaterials, B. Viswanathan, Narosa Publishing House.

PATTERN OF EXAMINATION

THEORY

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
Minor Test – I (after 30 days)	Upto 20%	1½ hour	20
Minor Test – II (after 60 days)	Upto 40%	1½ hour	20
Major Test (after 90 days)	Upto 100%	3 hours	60

The **Minor Test** would consist of two **Sections (A & B)**.

Section A would consist of two short answer type questions of 05 marks each and students are required to answer both questions.

Section B would consist of two long answer type questions of 10 marks each. Students are required to answer one question from **Section B**.

The **Major Test** will have seven questions (each of twelve marks). The students have to attempt five questions in all. Question no. 1 (short answer type) will be compulsory and will be set out from 40% of syllabus covered in Minor I & II. The remaining six questions will be from across the syllabus of 41% to 100% i.e. beyond Minor I & II. The student has to attempt any four questions out of six questions.

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Semester - II

Syllabus for the examinations to be held in May 2024, May 2025 & May 2026

Course Code: PSCHTC223
Title: Organic Chemistry- II
Credits: 04
No. of hours: 60

Nature of Course: Core
Maximum Marks: 100

Course Outcome: The contents of this course are focussed on electrophilic, nucleophilic substitution, addition, elimination reactions from their mechanistic point of view. Rearrangement and pericyclic reactions will also be dealt in this course.

After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

UNIT-I: Aromatic Electrophilic & Nucleophilic Substitutions (12 hours)

The arenium ion mechanism, orientation and reactivity in substituted benzenes, energy profile diagrams, The ortho/para ratio, ipso attack, Orientation in other ring systems (hydrocarbons and heterocyclic compounds), Friedel-Crafts reaction of alkenes and alcohol substrates, Vilsmier reaction.

The S_NAr , S_N1 , benzyne and $S_{RN}1$ mechanisms, Reactivity effect of substrate structure, leaving group and attacking nucleophiles, The Smiles and Sommelet-Hauser rearrangements.

UNIT -II : Addition of Carbon-Carbon Multiple Bonds (12 hours)

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, Regio- and chemoselectivity, Orientation and reactivity, Addition to cyclopropane ring, Regioselective hydroboration of asymmetric olefins, Michael reaction, Sharpless asymmetric epoxidation.

Elimination Reactions

The E2, E1 and E1cB mechanisms, Regioselectivity of E1 and E2 eliminations, Base and stereoelectronic effect on E2/ S_N2 competition; Orientation of the double bond, Reactivity: Effects of substrate structures, Attacking base, the leaving group and the reaction medium, Mechanism and orientation in pyrolytic eliminations, Peterson olefination.

UNIT -III : Addition to Carbon-Hetero Multiple Bonds (12 hours)

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles [LAH, $NaBH_4$, BH_3 , DIBAL-H], Addition of Grignard, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds, The Wittig reaction, Mechanism of condensation reactions involving enolates – Aldol, Knoevenagel and Claisen Condensations, Hydrolysis of esters and amides.

UNIT -IV: Pericyclic Reactions (12 hours)

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene and 1,3,5-hexatriene system, Classification of pericyclic reactions, Woodward-Hoffmann correlation diagrams, FMO and PMO approach, Electrocyclic reactions-conrotatory and disrotatory motions, $4n$ and $4n+2$ systems, Cycloadditions: Antrafacial and suprafacial additions, $4n$ and $4n+2$ systems, 1,3-dipolar cycloadditions, Sigmatropic rearrangements-suprafacial and antrafacial shifts of H, Sigmatropic shifts involving carbon moieties, Claisen, Cope and Ene reaction.

UNIT -V: Rearrangements (12hours)

General mechanistic considerations-Nature of migration, Migratory aptitude, Memory effects.

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Semester - IInd

Syllabus for the examinations to be held in May 2024, May 2025 & May 2026

A detailed study of the following rearrangements:

Wagner-Merrwein Shifts, Pinacol-Pinacolone, Tiffeneau-Demjanov, Favorskii, Stevens, Arndt-Eistert synthesis, Neber, Hofman, Curtius, Schmidt and Baeyer-Villiger.

BOOKS RECOMMENDED

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Organic Chemistry, Jonathan Clayden, Nick Greeves, Stuart Warren, Peter Wothers, Oxford (2000).
3. Advance Organic Chemistry, Part-A: Structure & Mechanism (Fifth Edition), F.A. Carey & R.J. Sundberg, Published by Springer Science (2007).
4. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.
5. Organic Chemistry, R.T. Morrison and R.N. Boyd, Prentic-Hall.
6. Pericyclic Reactions, S.M. Mukherji, Macmillan, India.
7. Advanced Organic Chemistry: Reaction Mechanisms, Reinhard Bruckner, Academic Press, USA.
8. Pericyclic reactions by Ian Flemmings, University Oxford Press (2015, 2nd Edition).
9. Modern Methods of Organic Chemistry, William Carruthers and Liancoldham, Cambridge University Press (4th edition, 2015).
10. Polar rearrangements, Laurence M. Harwood, Oxford Science Publications, Oxford University Press (1992).
11. Organic Chemistry, Stanley H. Pine, Tata McGraw Hill (5th Edition, 2007)

PATTERN OF EXAMINATION

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
Minor Test - I (after 30 days)	Upto 20%	1½ hour	20
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Semester-IInd

Syllabus for the examinations to be held in May 2024, May 2025 & May 2026

Course Code: PSCHTC224

Nature of Course: Core

Title: Applications of Spectroscopy in Organic Chemistry

Credits: 04

Maximum Marks: 100

No. of hours: 60

Course Outcome: The course is designed from application point of view. The different spectroscopic techniques used in organic chemistry will be considered and number of examples will be put before the students to solve making use of different spectroscopic techniques.

After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

UNIT –I: Ultraviolet and Visible Spectroscopy (12 hours)

Various electronic transitions (185-800 nm), Beer-Lambert law, Effect of solvent on electronic transitions, Ultraviolet bands for carbonyl compounds, Unsaturated carbonyl compounds, Dienes, Conjugated polyenes, Fieser-Woodward rules for conjugated dienes and carbonyl compounds, Ultraviolet spectra of aromatic compounds, Steric effect in biphenyls.

Circular Dichorism (CD): Principle of CD exciton chirality, Methods and applications.

UNIT –II: Infrared Spectroscopy (12 hours)

Basic principles, Characteristic vibrational frequencies of Alkanes, Alkenes, Alkynes, Aromatic compounds, Alcohols, Ethers, Phenols and Amines, Detailed study of vibrational frequencies of carbonyl compounds (Ketones, Aldehydes, Esters, Amides, Acids, Anhydrides, Lactones, Lactams and Conjugated carbonyl compounds), Effect of hydrogen bonding and solvent effect on vibrational frequencies, Overtones, Combination bands and Fermi resonance.

UNIT –III: Nuclear Magnetic Resonance Spectroscopy (14 hours)

General introduction and definition, Excitation & Relaxation, Pulsed Experiments, Chemical shift, Spin-spin Coupling, Shielding mechanism, Chemical shift values and correlation for protons bonded to carbon and other nuclei. Complex spin-spin interaction between two, three, four and five nuclei (first order spectra), Virtual coupling, Hindered rotation, Karplus curve-variation of coupling constant with dihedral angle, Chemical exchange, Effect of deuteration. Simplification of complex spectra: Nuclear magnetic double resonance, Contact shift reagents, Solvent effects, Fourier transform techniques, Nuclear overhauser effect (NOE).

UNIT-IV: Carbon-13 NMR Spectroscopy (10 hours)

General considerations, Factors influencing carbon shifts, Chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), DEPT, APT.

Two dimensional NMR spectroscopy

Proton-Proton Correlation through coupling [COSY], Proton-Heteronucleus Correlation [HETCOR and H, C COSY], Carbon-Carbon Correlation [2D-INADEQUATE and C,C COSY].

UNIT-V: Mass Spectrometry (12hours)

Introduction, Ion production – EI, CI, FD and FAB, Factors affecting fragmentation of organic compounds, Common functional groups, Molecular ion peak, Metastable peak, McLafferty rearrangement, Nitrogen rule, High resolution mass spectrometry, Examples of

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Syllabus for the examinations to be held in May 2024, May 2025 & May 2026

mass spectral fragmentation of organic compounds with respect to their structure determination, Introduction to modern MS techniques (MALDI, ESI).

BOOKS RECOMMENDED

1. Practical NMR Spectroscopy, M.L. Martin, J.J. Delpuch and G.J. Martin, Heyden.
2. Spectrometric Identification of Organic Compounds, R.M. Silverstein, G.C. Bassler and T.C. Morrill, John Wiley & Sons (2005).
3. Introduction to NMR Spectroscopy, R.J. Abraham, J. Fisher and P. Loftus, Wiley (1992).
4. Spectroscopic Methods in Organic Chemistry, D.H. Williams, I. Fleming, (6th Edition) Tata McGraw Hill Education (2011).
5. Organic Spectroscopy, William Kemp; Palgrave USA (2008).
6. Introduction to spectroscopy 94th edition, Donald L. Pavia, Gary M. Lampman, George S. Kriz and James R. Vyvyan, Brooks/Cole, Cengage Learning (2009).
7. Comprehensive chiroptical spectroscopy: Applications in stereochemical analysis of synthetic compounds, natural products and biomolecules, Vol. 2, John Wiley & sons (2012).
8. Application of Mass spectrometry to Organic Chemistry, R. I. Reed, Academic Press London & New York.
9. Organic Structural Spectroscopy, J.B. Lambert, H.F. Shurvell, D.A. Lightner & R.G. Cooks, Prentice-Hall International, UK (1998).

PATTERN OF EXAMINATION

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
Minor Test – I (after 30 days)	Upto 20%	1½ hour	20
Minor Test – II (after 60 days)	Upto 40%	1½ hour	20
Major Test (after 90 days)	Upto 100%	3 hours	60

The Minor Test would consist of two Sections (A & B).

Section A would consist of two short answer type questions of 05 marks each and students are required to answer both questions.

Section B would consist of two long answer type questions of 10 marks each. Students are required to answer one question from **Section B**.

The **Major Test** will have seven questions (each of twelve marks). The students have to attempt five questions in all. Question no. 1 (short answer type) will be compulsory and will be set out from 40% of syllabus covered in Minor I & II. The remaining six questions will be from across the syllabus of 41% to 100% i.e. beyond Minor I & II. The student has to attempt any four questions out of six questions.

NOTE: Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.

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Semester - II^{ud}

Syllabus for the examinations to be held in May 2024, May 2025 & May 2026

Course Code: PSCHLC225

Nature of Course: Core

Title: Laboratory Course in Inorganic, Organic and Physical Chemistry-II

Maximum Marks: 200

Credits: 08

No. of Hours: 240

Course Outcome: This course will help the students to learn how the rare analysis of metals is analyzed and simultaneously to prepare and characterize coordination complexes.

After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

INORGANIC CHEMISTRY

1. Determination of Boric acid in borax.
2. Determine total alkalinity in water sample from different sources.
3. Determination of dissolved oxygen(DO) in water sample Iodometrically.
4. Determination of chlorine in Commercial sample of bleaching powder Iodometrically.
5. Determination of total, temporary and permanent hardness of water complexometrically using Eriochrome Black-T as indicator
6. Determination of strength of Ca^{2+} ions present in a given milk sample by EDTA back titration.
7. Determination of strength of Al^{3+} ions by EDTA back titration.
8. Determination of strength of Mg^{2+} and Al^{3+} ions present in the mixture by titrating against EDTA using masking agent.
9. Determination of strength of sodium chloride solution using Mohr's Method.
10. Determination of strength of silver nitrate solution using Volhard's Method.
11. Determination of strength of sodium chloride solution using Fajan's Method.
12. Estimation of Ca^{2+} and Mg^{2+} ions content present in a sample of cement.
13. Estimation of Ag gravimetrically and Cu volumetrically in a mixture solution containing Ag^+ and Cu^{2+} ions
14. Estimation of Cu^{2+} and Ni^{2+} in a mixture solution by gravimetric method
15. Estimation of Cu^{2+} and Zn^{2+} in a mixture solution by gravimetric method
16. Estimation of Zn^{2+} and Ni^{2+} in a mixture solution by gravimetric method
17. Determination of ascorbic acid in packed juice/fresh juice/vitamin-c tablet by titration with potassium iodate
18. Determination of hydrazine by titration with potassium iodate
19. Determination of iodine content in Iodized salt.
20. Determination of phosphate content in a soft drink.

Any other experiment introduced by the concerned teacher.

Books Suggested:

1. Vogel's Qualitative Inorganic Analysis, 7th Edn., Pearson Education Ltd.
2. Vogel's Textbook of Quantitative Inorganic Analysis, 4th Edn., Longman Group Limited, London.
3. Standard methods of chemical analysis by W.W. Scaff, Technical Pres

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Semester-II^{ud}

Syllabus for the examinations to be held in May 2024, May 2025 & May 2026

ORGANIC CHEMISTRY

Course Outcome: The students will be trained in synthesising the starting materials which may be of useful in the synthesis of more compounds. They will also get training as to how the two components can be separated from each other. The quantitative analysis will also form the part of the experimental course.

- Organic Synthesis:** Sandmeyer reaction: p-Chlorotoluene from p-toluidine. Knoevenagel Condensation: Synthesis of cinnamic acid.
- Friedel Crafts Reaction: β -Benzoyl propionic acid from succinic anhydride and benzene. Aromatic electrophilic substitutions: Synthesis of 4-nitroaniline and 4-bromoaniline. Beckmann rearrangement of acetophenone and benzophenone oximes. The products may be characterized by spectral techniques.
- Separation and identification of organic compounds from two component mixture. The products may be characterized by spectral techniques.
- Quantitative Analysis:** Determination of the percentage or number of hydroxyl groups in an organic compound by acetylation method. Estimation of amines/phenols and glucose using bromated bromide solution/acetylation method. Determination of iodine and saponification values of an oil sample.

Any other experiment introduced by the concerned teacher.

BOOKS RECOMMENDED

- Experiments and techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall.
- Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Heath.
- Systematic Qualitative Organic Analysis, H. Middleton, Edward Arnold.
- Handbook of Organic Analysis-Qualitative and Quantitative, H. Clark, Edward Arnold.
- Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
- Monograph on Green Chemistry by Green Chemistry Task Force Committee, DST.

PHYSICAL CHEMISTRY

Course Outcome: The aim of this course is to develop the experimental skill to the students by taking instrumentation tools and also physical tools to evaluate the various properties of solutions.

Heat of solution:

Study the heat of solution of benzoic acid/oxalic acid by solubility method at different temperatures and the effect of electrolyte on it.

Adsorption:

Study the adsorption of oxalic acid on charcoal and hence check the validity of Langmuir adsorption isotherm and classical adsorption isotherm.

Critical solution temperature:

Determine the mutual solubility curve of phenol and water and hence find its consolute temperature and the effect of electrolyte on the system.

Abbe's refractometer:

Determine the refractive indices of given organic liquid at room temperature

pH meter and Conductivity meter:

Semester - II

Syllabus for the examinations to be held in May 2024, May 2025 & May 2026

Determine the pH of various mixtures of sodium acetate and acetic acid in aqueous solution and hence determine the dissociation constant of acid.

Determine the strength of strong and weak acid and their mixture using pH metry.

Determine the strength of strong and weak acid and their mixture using conductivity meter.

Study of kinetics of second order reaction using conductivity -meter .

Phase-Equilibria

Phase diagram of two component eutectic systems (Naphthalene-benzoic acid; acetamide-benzoic acid; naphthalene-diphenyl).

Phase diagram of two component compound forming systems (salicylic acid – benzamide, acetamide- β -naphthol).

Any other practical introduced by the teacher.

BOOKS RECOMMENDED

1. Practical Physical Chemistry, A. M. James and F. E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B. P. Levitt, Longman.
3. Experimental Physical Chemistry, R. C. Das and B. Behera, Tata McGraw Hill.
4. Experiments in Physical Chemistry by Shoemaker.
5. Practical Physical Chemistry by Viswanathan and Raghavan.
6. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publishing House.

PATTERN OF EXAMINATION

The daily evaluation of practical records, assignments, viva-voce and attendance shall have marks weightage of 50% of the total marks. The final practical performance test along with viva-voce examination will be held at the end of semester covering 100% of the syllabus and having marks weightage of 50% of the total marks.

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Course No: PSCHTE321
 Title: Environmental Chemistry
 Maximum Marks: 100

Nature of Course: Core
 Credits: 04
 No. of hours: 60

Course Outcome: This course will enable the students to learn about the chemistry atmosphere, biosphere, hydrosphere, lithosphere and will to gain knowledge on air, water, soil, marine and solid waste management as well as environmental toxicology. This course will also familiarize with the green chemistry, environmental issues and analytical techniques.

UNIT-I: Atmosphere (12 hours)

Earth's Atmosphere: Structure and chemical composition of atmosphere. Chemical and photo-chemical reactions, Formation of inorganic and organic particulate matter, Air quality standards, Air pollution—types and sources, Effects of NO_x, SO₂ and CO, depletion of stratospheric ozone, impact of chlorofluoro hydrocarbons, alternatives for CFC's, green house effect (Global warming) and acid rains. Temperature measurements and controls: Vertical temperature and stability of atmosphere. Biogeochemical cycle of Carbon, Nitrogen, Oxygen and Sulfur.

UNIT –II: Lithosphere (12 hours)

Soil formation and composition, Soil physical properties: texture, colour, pore space, particle density; Chemical composition of Soil, Inorganic and organic constituents, Soil profile and composition of its horizons; Concept and importance of soil solution; Soil quality parameters; various micro and macro nutrients present in soil; Acid-base and ion exchange reactions in soils; NPK in soil; Sources of soil pollution: Industrial, Urban waste, Agricultural practice and solid waste (plastics and metals), Measures to control soil pollution; Soil analysis: Soil pH, total nitrogen, phosphorus, sulfur, potassium and magnesium.

UNIT –III: Hydrosphere (12 hours)

Water: Structure and bonding of water molecule, properties of water, Chemical composition of water bodies – lakes, streams and rivers; Hydrological cycle; Aquatic environment, complexation in natural water and waste water; Water pollution: Classification, types and sources of water pollution, ground water pollution: Medak case and arsenic contamination, common sources of ground and surface water pollution, inorganic and organic pollutants and toxic metals, Effects of water pollutants on life and environment; Climate change impacts on water Cycle and water Demand; Water quality parameter and their analytical methods: Dissolved oxygen (DO), Biochemical oxygen demand (BOD), Chemical oxygen demands (COD), solids, contents of chloride and chlorine demand and their determination.

UNIT –IV: Industrial Pollution (12 hours)

Environmental implications and abatement of cement industry, sugar mill, distillery, textile, paper and pulp mill, thermal power plant and polymer/plastic industry; Environment without plastic and plastic recycling techniques, Solid Waste Management: landfill, incineration, resource reduction, recycling and reuse, composting and organic farming. Treatment of sewage and industrial waste water and criteria of water quality.

UNIT-V: Environmental Toxicology (12 hours)

Hazardous waste: Introduction, listed hazardous wastes, origin, transport, effects and fates of hazardous wastes; Chemical solutions to environmental toxicity, biodegradability/bioremediation, principles of decomposition.

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Semester - III

Syllabus for the examinations to be held in Dec. 2024, Dec. 2025 & Dec. 2026

Bhopal gas tragedy: MIC and its impacts, Minamata disasters: mercury and its toxicity; Nuclear Hazards: Chernobyl and Three Mile Island.

Green chemistry: Principles and goals of green chemistry, Green chemicals, green catalysts, green solvents and green synthesis.

BOOKS RECOMMENDED

1. Environmental Chemistry, S. E. Manahan, Lewis Publishers
2. Environmental Chemistry, Sharma & Kaur, Krishna Publishers
3. Environmental Chemistry, A. K. De, Wiley Eastern.
4. Environmental Pollution Analysis, S. M. Khopkar, Wiley Eastern.
5. Standard Method of Chemical Analysis, F. J. Welcher, Vol. III, Van Nostrand Reinhold Co.
6. Environmental Toxicology, Ed. J. Rose, Gordon and Breach Science Publication.
7. Elemental Analysis of Airborne Particles, Ed. S. Landsberger and M. Creatchman, Gordon and Breach Science Publication.
8. Environmental Chemistry, C. Baird and W. H. Freeman.

PATTERN OF EXAMINATION

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
Minor Test - I (after 30 days)	Upto 20%	1½ hour	20
Minor Test - II (after 60 days)	Upto 40%	1½ hour	20
Major Test (after 90 days)	Upto 100%	3 hours	60

The **Minor Test** would consist of two **Sections (A & B)**.

Section A would consist of two short answer type questions of 05 marks each and students are required to answer both questions.

Section B would consist of two long answer type questions of 10 marks each. Students are required to answer one question from **Section B**.

The **Major Test** will have seven questions (each of twelve marks). The students have to attempt five questions in all. Question no. 1 (short answer type) will be compulsory and will be set out from 40% of syllabus covered in Minor I & II. The remaining six questions will be from across the syllabus of 41% to 100% i.e. beyond Minor I & II. The student has to attempt any four questions out of six questions.

NOTE: Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.

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Course Code: PSCHTE322
Title: Analytical Chemistry-I
Maximum Marks: 100
No. of Hours: 60

Nature of Course: Elective
Credits: 04

Course Outcome: This course is aimed to have an insight of various analytical techniques in analyzing the chemicals quantitatively.

After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

UNIT-I: Evaluation of Analytical Results (12 hours)

Data reduction, accuracy versus precision, determinate errors, detection of determinate errors, indeterminate errors, confidence interval, rejection of data, propagation of determinate and indeterminate errors, estimation of precision inherent to analytical method, mean deviation, standard deviation, accuracy of method, fitting data to a straight line, least-square plots, detection limits, good laboratory practice; validation of analytical method, quality assurance,

UNIT-II: Gravimetric Analysis (12 hours)

Gravimetric analysis requirements; identify an insoluble form, separate the analyte from any constituent that may interfere, properties of precipitates. nucleation and crystal growth, factors influencing completion of precipitation, co-precipitation and post-precipitation, wash the precipitate free of impurities and co-precipitants (surface adsorption, inclusions and occlusions), convert precipitate to a reliable weighing form, organic and inorganic precipitating reagents, electrogravimetric analysis, thermogravimetric analysis, volatilization techniques.

UNIT-III: Complexometric and Precipitation Titrations (12 hours)

Complexometric Titrations:Theoretical principles, titration curve, equivalence point, titration curve calculations, specificity of edta titrations, endpoint signals, applications.

Precipitation Titrations:Theoretical principles, titration curve, endpoint signals, applications, determination of Ag in an alloy: Volhard method, determination of chloride in soluble chloride: Fajan's method

UNIT -IV: Redox and Acid-Base Titrations (12 hour)

Redox Titrations: Fundamental terms, nernst equation, half cell potentials, theoretical principles of titration curves, equivalence point, endpoint signals, redox titration feasibility, multicomponent systems, applications; adjustment of analyte's oxidation state, redox titrants: potassium permanganate, potassium dichromate, iodine, potassium iodate, potassium bromate, periodic acid

Acid-Base Titrations: Neutralisation curves, neutralisation of a strong acid and a strong base, neutralisation of a weak acid with a strong base, neutralisation of a weak base with a strong acid, neutralisation of a polyprotic acid with a strong base, neutralisation indicators, choice of indicators in neutralisation reactions, mixed indicators,

UNIT-V: Spectrochemical Methods (12 hours)

Survey of spectrochemical methods, quantitative principles of absorption; Beer's law, analytical use of Beer's law, mixtures of absorbing species, calculation of unknown from calibration curve, deviation from Beer's law, spectroscopic determination of pK value of the

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Semester - III

Syllabus for the examinations to be held in Dec. 2024, Dec. 2025 & Dec. 2026

indicator(methyl red), Simultaneous spectroscopic determination (Cr and Mn), spectroscopic titrations,
Industrial applications, Environmental applications, Clinical applications

BOOKS RECOMMENDED:

1. Vogel's Textbook of Quantitative Inorganic Analysis, 4th Edition, The English Language Book Society & Longman
2. Vigel's Textbook of Quantitative Chemical Analysis, 6th Edition, Pearson
3. Analytical Chemistry: Principles, John H. Kennedy, 2nd Edition, Saunders College Publishing.
4. Analytical Chemistry, Gary D. Christian, 6th Edition, Wiley
5. Basic Concepts of Analytical Chemistry, S. M. Khopkar, 2nd Edition, New Age International (P)Limited, Publishers

PATTERN OF EXAMINATION

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
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Minor Test - II (after 60 days)	Upto 40%	1½ hour	20
Major Test (after 90 days)	Upto 100%	3 hours	60

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Course Code: PSCHTE323

Nature of Course: Elective

Title: Spectroscopy and Photochemistry in Inorganic Chemistry

Credits: 04

Maximum Marks: 100

No. of hours: 60

Course Outcome: This course is aimed to have an insight of various spectroscopic tools in analyzing the inorganic molecules/complexes. The ligand field photochemistry is also a part of the course.

After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

UNIT-I: Vibrational Spectroscopy (12 hours)

Symmetry and shape of AB₂, AB₃, AB₄, AB₅ and AB₆ molecules, Mode of bonding of ambidentate ligands, nitro, thiocyanato, ethylenediamine and diketonato complexes, Raman Spectroscopy: Stokes and anti-stokes lines, Polarisability of ellipsoids, Rotational and vibrational Raman spectroscopy, Selection rules, Resonance Raman spectroscopy, Basic understanding and its applications particularly for study of active sites of metalloproteins.

UNIT -II: NMR of Paramagnetic Compounds and NQR Spectroscopy (12 hours)

Nuclear Magnetic Resonance of Paramagnetic Substances in Solution: The chemical shift in diamagnetic and paramagnetic molecules, The contact and Pseudocontact shifts, Factors affecting nuclear relaxation,

Nuclear Quadrupole Resonance (NQR) spectroscopy: Introduction, Quadrupole moment and field gradient, Quadrupole relaxation energies of quadrupole states, Effect of magnetic field on the NQR spectra, Applications and structural informations from NQR spectra.

UNIT-III: Electron Spin Resonance Spectroscopy (12 hours)

Basic Principle, Spin Hamiltonian, Hyperfine coupling, Spin polarization and McConnell relationship, Isotropic and anisotropic hyperfine coupling constants, Spin-orbit coupling and significance of g- tensor, Application to transition metal complexes (having one unpaired electron) including biological systems and inorganic free radical viz. BF₂, F₂, PH₄, etc.

UNIT -IV: Mossbauer Spectroscopy (12 hours)

Basic Principles, Spectral parameters and spectrum display, Application of the technique to the studies of:

- Bonding and structure of Fe²⁺ and Fe³⁺ compounds including those of intermediate spin,
- Sn²⁺ and Sn⁴⁺ compounds, Nature of M-L bond, Coordination number and structure, and
- Detection of oxidation state and inequivalent MB atoms.

UNIT-V: Ligand Field Photochemistry (12 hours)

Electronically excited states of metal complexes, Energy dissipation by radiative and non-radiative processes, Franck-Condon Principle, Mechanism of photo substitution reaction of Cr(III) complexes, Examples, Adamson's rule, Photo substitution and photo reduction reactions of Co(III) complexes, Photo substitution reactions of Rh(III) complexes.

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BOOKS RECOMMENDED

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood.
3. Vibrational Spectroscopy- Modern Treheh, Barnes, A.J., and W.J. Orville-Thomas, Elsevier, 1977.
4. Chemical Applications of Group Theory, F.A. Cotton.
5. Introduction to Magnetic Resonance, A. Carrington and A.D. MacLachlan, Harper & Row.
6. Fundamentals of Molecular Spectroscopy. C.N. Banwell, Tata McGraw Hill.
7. Concepts of Inorganic Photochemistry, A. W. Adamson and P. D. Fleischauer, Wiley.
8. Physical Methods for Chemistry, R. S. Drago, Saunders Company.
9. Infrared and Raman Spectra : Inorganic and coordination compounds, K. Nakamoto, Wiley.
10. Structural Methods in Inorganic Chemistry, E.A. V. Ebsworth, D. W. H. Rankin and S. Craddock, ELBS.
11. Progress in Inorganic Chemistry, Vol. 8, ed., F. A. Cotton, Vol. 15, ed. S.J. Lippard, Wiley.
12. Applications of physical methods to Inorganic and Bioinorganic Chemistry, Robert A. Scott, Charles M. Lukehart, Wiley.
13. Inorganic Reaction Mechanism F. Basolo & R.G. Pearson
14. Inorganic Reaction Mechanism J.O. Edwards.
15. Photochemistry – Rohtagi Mukherjea.

PATTERN OF EXAMINATION

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Course Code: PSCHTE324

Nature of Course: Elective

Title: Heuristic Approach to Organic Synthesis

Credits: 04

Maximum Marks: 100

No. of hours: 60

Course Outcome: On successful completion of this course, the students will gain knowledge about disconnection approach, planning the synthesis of organic compounds and natural products, photochemistry and asymmetric cycloaddition reactions.

The learning from this course will help the students to get jobs in R & D laboratories, pharmaceutical industry and academics.

UNIT-I: Disconnection Approach**(14 hours)**

An introduction to synthons and synthetic equivalents, Disconnection approach, Functional group inter-conversions, Importance of the order of events in organic synthesis, One group C-X and two group C-X disconnections (1,2 and 1,3-difunctionalised compounds), Chemoselectivity, Reversal of polarity.

Protecting Groups

Principle of protection of alcohol (Acetal, Acetyl and silyl ethers) and carbonyl groups.

UNIT-II: One Group C-C Disconnections**(10 hours)**

Alcohols and carbonyl compounds, Regioselectivity, Use of acetylenes and aliphatic nitro compounds in organic synthesis.

Two Group C-C Disconnections

Biological, Cope and Claisen reaction, Diels-Alder reaction, 1,3-difunctionalised compounds, α , β -unsaturated carbonyl compounds, 1,5-difunctionalised compounds, Michael addition and Robinson annelation.

UNIT-III: Retrosynthesis and Synthesis of Following Compounds**(12 hours)**

Reserpine (Woodward synthesis), Longifolene (Corey synthesis), Hirsutene [Paquette (1990) and Oppolzer (1994) synthesis].

UNIT-IV: Photochemistry**(12 hours)**

General principles. Photochemistry of alkenes, dienes and polyenes: *cis-trans* isomerisation, photoisomerization of 1,3-butadiene; orbital symmetry considerations (alkenes and dienes). Photochemistry of carbonyl compounds, Hydrogen abstraction and fragmentation reactions; cycloaddition and rearrangement reactions of cyclic unsaturated ketones. Photochemistry of aromatic compounds.

UNIT-V: Cycloadditions**(12 hours)**

Diels-Alder reactions, Inverse electron demand Diels-Alder reactions, Hetero-Diels Alder reactions, 1,3-dipolar cycloaddition reactions, [2+2] Cycloadditions, Pauson-Khand type reactions.

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Syllabus for the examinations to be held in Dec. 2024, Dec. 2025 & Dec. 2026

BOOKS RECOMMENDED

1. Designing Organic Synthesis, S. Warren, John Wiley & sons.
2. Organic Synthesis- Concept, Methods and Starting Materials, J. Fuhrhop and G. Penzillin, Verlage VCH (1997).
3. Progress in Total Synthesis Vol. 1, E. Danishetsky and S. Danishetsky, Appleton Century Crafts, N.Y.
4. The Logic of Chemical Synthesis, E.J. Corey and X.M. Cheng, John Wiley and Sons, New York, N.Y.
5. Art in Organic Synthesis, Nitya Anand, Jasjit S. Bindra, S. Randanathan, Wiley-Blackwell.
6. Principles of Organic Synthesis, R.O.C. Norman and J. M. Coxon, CRC Press, Taylor & Francis (3rd Edition, 2017).
7. Greene's Protective Groups in Organic Synthesis by Peter G. M. Wuts, Theodora W. Greene, Fourth Edition. Wiley 2007
8. Catalysis in Asymmetric Synthesis; Vittoria Caprio and M.J. Williams, Wiley (2nd ed., 2008).
9. Advanced Organic Chemistry, Part-A - Str. & Mech., F.A. Carey and R.J. Sundberg, Springer (5th ed., 2007).

PATTERN OF EXAMINATION

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
Minor Test - I (after 30 days)	Upto 20%	1½ hour	20
Minor Test - II (after 60 days)	Upto 40%	1½ hour	20
Major Test (after 90 days)	Upto 100%	3 hours	60

The **Minor Test** would consist of two **Sections (A & B)**.

Section A would consist of two short answer type questions of 05 marks each and students are required to answer both questions.

Section B would consist of two long answer type questions of 10 marks each. Students are required to answer one question from **Section B**.

The **Major Test** will have seven questions (each of twelve marks). The students have to attempt five questions in all. Question no. 1 (short answer type) will be compulsory and will be set out from 40% of syllabus covered in Minor I & II. The remaining six questions will be from across the syllabus of 41% to 100% i.e. beyond Minor I & II. The student has to attempt any four questions out of six questions.

NOTE: Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.

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Course Code: PSCHTE325

Nature of Course: Elective

Title: Bio-Organic and Medicinal Chemistry

Credits: 04

Maximum Marks: 100

No. of hours: 60

Course Outcome: The aim of this course is to let the students understand enzymatic action, coenzymes, chemistry of vitamin B complex, co-crystals, carbohydrates metabolism, drug design, chemistry of antibiotics, mechanism of action of vitamins etc. This paper has scope of employability in medicinal chemistry and as scientist in research laboratories.

UNIT-I: Enzymes, Co-enzymes and Chemistry of Vitamin B-Complex (12 hours)

Introduction, Remarkable properties of enzymes, Reversible and irreversible inhibition, Fischer's lock and key and Koshland's induced fit hypothesis, Concept and identification of active site by the use of inhibitors, Enzyme modification by site-directed mutagenesis, Baker Yeast and its applications.

Functions and mechanism of action of thiamine, Riboflavin and Pantothenic acid, Cofactors as derived from vitamins, Coenzymes, Prosthetic groups, Apoenzymes, Structure and biological functions of coenzyme A, Thiamine pyrophosphate, Pyridoxal phosphate, NAD⁺, NADP⁺, FMN, FAD, Lipoic acid.

UNIT-II: Carbohydrates Metabolism (12 hours)

Introduction, classification, General properties with reference to mutarotation, Lobry-D-Bruylen Van Ekinstein rearrangement, Epimerization, Fischer Killani synthesis, Wohl's and Ruffs method.

Glycolysis, Gluconeogenesis, Glycogenolysis, Citric acid cycle (Krebs Cycle), Pentose phosphate pathway, Conversion of pyruvate to phosphoenol pyruvate, Conversion of glyceraldehyde-3-phosphate to Phosphoenolpyruvate.

Polysaccharides and disaccharides (Glycogen breakdown by glycogen phosphorylase), Conversion of fructose to glyceraldehyde-3-phosphate, galactose to glucose-1-phosphate.

UNIT-III: Drug-design and Co-crystals (12 hours)

Introduction, Concept of Lead compounds, Factors governing drug design and rational approach, Drug design through method of variations, Disjunction and conjunction, Bioisosteric replacement, Rigid analogs, Homologation of alkyl chains, Changes in ring size and ring position isomers, Alteration of stereochemistry, Fragments of lead molecules.

Co-crystals: General introduction, Designing and characterization techniques, Factors affecting designing of co-crystals and applications in pharmaceuticals.

UNIT-IV: Structure and mode of action (12 hours)

Cardiovascular drugs: Antihypertensive and hypotensive drugs:

Hydralazine (Apresoline hydrochloride), Methyldopa (Aldomet), Procainamide (Pronestyl), Antisymphathetic drugs- Propanolol (Indral), Verapamil (Isoptin) and Prenylaminelactate (Synadrin), Rosuvastatin (Crestor)

Antiparkinsonian Agents: Biperiden hydrochloride (Akineton hydrochloride), Ethopropazine hydrochloride (Profenamine) and Levodopa (Bendopa).

Anticancer drugs: Texol, Tamoxifen.

Antihistaminic drugs: Cetrizine, Promethazine hydrochloride and Chloropheniramine melete (Alermine).

Antimalarials: Chloroquine phosphate (Resochin) and Mepacrine hydrochloride (Quinacrine).

Antidiabetic: Sitagliptin (Januvia), Metformin (Glucophage)

UNIT-V: Antibiotics and Vitamins**(12 hours)****Antibiotics:** Introduction, Classification, Isolation and chemistry of Pencillins, Chloramphenicol and Cephalosporin.**Vitamins:** Occurrence, Chemistry, Functions and Mechanism of action of Ascorbic acid, α -Tocopherol and Vitamin K₁ & K₂.**BOOKS RECOMMENDED**

1. Bio-organic Chemistry: A Chemical Approach to enzyme Action, Hermann Dugas and C. Penny, Springer-Verlag.
2. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer, Philip L.R. Bonner, 2nd edition.
3. Principles of Bio Chemistry, Lehninger, 4th edition.
4. Enzymatic Reaction Mechanism, C. Walsh and W.H. Greeman.
5. Enzyme Structure and Mechanism, A. Fersht and W.H. Freeman.
6. Textbook of Organic Medicinal and Pharmaceuticals Chemistry, 8th Ed., Edited by R.F. Doerge, J.B. Lippincott Co., Philadelphia 1982.
7. Pharmaceutical Chemistry in Perspective, B.G. Reuben and H.A. Wittcoff, John Wiley and Sons., N.Y.
8. Principles of Medicinal Chemistry, Lea and Febiger, Philadelphia, USA.
9. Strategies of Organic Drug Synthesis and design, D. Lendnicer, John Wiley and Sons, N.Y.
10. Burger's Medicinal Chemistry, Drug Discovery and Development, John Wiley and Sons.
11. Crystal Engineering: Desi Raju, World scientific publishing Singapore 2011.

PATTERN OF EXAMINATION

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
Minor Test – I (after 30 days)	Upto 20%	1½ hour	20
Minor Test – II (after 60 days)	Upto 40%	1½ hour	20
Major Test (after 90 days)	Upto 100%	3 hours	60

The **Minor Test** would consist of two **Sections (A & B)**.

Section A would consist of two short answer type questions of 05 marks each and students are required to answer both questions.

Section B would consist of two long answer type questions of 10 marks each. Students are required to answer one question from **Section B**.

The **Major Test** will have seven questions (each of twelve marks). The students have to attempt five questions in all. Question no. 1 (short answer type) will be compulsory and will be set out from 40% of syllabus covered in Minor I & II. The remaining six questions will be from across the syllabus of 41% to 100% i.e. beyond Minor I & II. The student has to attempt any four questions out of six questions.

NOTE: Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.

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Course Code: PSCHTE326

Nature of Course: Elective

Title: Thermodynamics and Statistical Mechanics

Credits: 04

Maximum Marks: 100

No. of hours: 60

Course Outcome: This course will be useful in understanding the non-equilibrium thermodynamics, transport phenomenon, thermodynamics of mixtures, statistical mechanics / thermodynamics and their applications.

Unit –I: Non Equilibrium Thermodynamics (12 hours)

Thermodynamic criteria for non-equilibrium states, Entropy production and entropy flow, Entropy balance equations for different irreversible processes (e.g. heat flow, chemical reaction etc.), Transformation of the generalized fluxes and forces, Non equilibrium stationary states, Phenomenological equations, Microscopic reversibility and Onsager's reciprocity relations, Electro kinetics phenomena, Diffusion, Electric conduction, Irreversible thermodynamics for biological systems, Coupled reactions.

Unit –II: Transport Phenomenon (12 hours)

Mass Transport: Diffusion, Diffusion coefficient, Time evaluation of concentration gradient, Fick's first and second laws, Statistical view of diffusion, Einstein-Smoluchowski equation, Thermal conductivity, Viscosity of gases and fluids, Poiseuille's law, Einstein relation, Nernst-Einstein equation, Stokes-Einstein equation, Relation between flux and viscosity, Diffusion coefficient and mean free path, Thermal conductivity/viscosity and mean free path, Sedimentation and centrifugation, Ionic conduction, Strong and weak electrolytes.

Unit –III: Thermodynamics of Mixtures (12 hours)

Brief resume of classical concepts of thermodynamics including free energy, Chemical potential and entropies, Partial molar properties: Partial molar free energy, Partial molar volume and partial molar heat content and their significances, Determinations of these quantities, Concepts of fugacity and determination of fugacity.

Non ideal systems: Excess functions for non-ideal solutions, Activity, Activity coefficient, Debye-Huckel theory for activity coefficient of electrolytic solutions, Determination of activity and activity coefficients, Ionic strength.

Unit –IV: Statistical Mechanics (12 hours)

Role of statistical mechanics, Ensemble: Micro canonical, Canonical and Grand canonical, Postulates of ensemble averaging, Phase space, Stirling's approximation, Occupation number, Micro and macro states, Statistical weight factor, Probability, Concept of distribution, Thermodynamic probability, Types of statistics: Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics, Most probable distribution of three types of statistics, Lagrange's undetermined multipliers, Evaluation of β , Comparison of three statistics, Molecular partition function and its significance, Thermodynamic properties in terms of partition function, Numericals

Unit –V: Applications of statistical mechanics (12 hours)

Factorisation of molecular partition function, Canonical ensemble partition function (Independent and distinguishable molecules or particles; Independent and indistinguishable molecules or particles), Evaluation of translational, rotational, vibrational, electronic and nuclear partition functions, Contribution of translational, rotational and vibrational partition functions to thermodynamic functions, Effect of nuclear spin on diatomic molecules,

Equilibrium constant of ideal gas in terms of partition function. Heat capacities of solids: Einstein theory and Debye theory, Numericals.

BOOKS RECOMMENDED

1. Thermodynamics for Chemists: S. Glasstone.
2. Statistical Thermodynamics: M.C. Gupta.
3. Physical Chemistry: P.W. Atkins.
4. Chemical Thermodynamics: R.P. Rastogi and R.R. Misra.
5. Statistical Mechanics and Properties of Matter: E.S.R. Gopal.
6. Statistical Mechanics, D.A. McQuarrie.
7. Thermodynamics of Irreversible Processes, Rolf Haase.
8. Fundamental of Chemical Thermodynamics, E.N. Yeregin.
9. Introduction to Irreversible Thermodynamics, Prigogine.
10. Modern Thermodynamics, D. KondePudi and I. Prigogine.
11. Physical Chemistry, Engel and Reid.

PATTERN OF EXAMINATION

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
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Course Code: PSCHTE327

Nature of Course: Elective

Title: Nano-Chemistry

Credits: 04

Maximum Marks: 100

No. of hours: 60

Course Outcome: The aim of this course is to inculcate the knowledge among students related to the basics of Nano-materials, their synthesis, characterization, properties and applications. The course will have employability in the industry, research and academic fields.

UNIT-I: Fundamentals of Nanoscience and Nanotechnology (12 hours)

Solid materials and their strength, Perspective of length, Nanomaterials, Nanoscience and Nanotechnology, Nanostructures in nature, Prime materials, Carbon nanostructures viz. Carbon nanotube (Single-walled and multi-walled), Fullerenes, Surface effects of Nanomaterials, Surface plasmon resonance, Quantum size effects.

UNIT-II: Synthesis of Nanomaterials (12 hours)

Introduction, Nanomaterials synthesis, Top-Down and Bottom-Up Approaches, Solvothermal synthesis, Hydrothermal synthesis, Reverse micellar/Micro-emulsion method, Reverse micelles works as nano reactor, Mechanism for nanoparticle synthesis inside the reverse micelles, Co-precipitation, Sol-Gel Method, Polymeric Precursor Method and Sono-chemical Methods. Theory, Experimental conditions, Kinetics of solid state reactions and molten-salt routes.

UNIT-III: Characterization of Nanomaterials (12 hours)

X-Ray Diffraction Technique: Structure of nanomaterials, X-ray diffraction (XRD), The Powder method, Determination of grain size/crystallite size using X-ray line broadening studies (Scherrer's formula), Determination of crystallite size distribution using X-ray line shape analysis.

Electron Microscopic Techniques: Principles of electron microscopy, Scanning Electron Microscopy (SEM), Strengths and limitations of Scanning electron microscopy, Energy dispersive X-ray analysis (EDX), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM) and Scanning Tunneling microscopy (STM).

Dynamic Light Scattering (DLS) Studies: Principle, Theory and Methodology.

BET Surface Area Studies: Principle, Theory and Methodology.

Thermal techniques: Principles, Instrumentation data analysis and applications of DSC, TGA and DTA and their special features.

UNIT-IV: Properties of Nanomaterials (12 hours)

Introduction: Formation of Dangling bonds, Atom like behavior of Nanoparticles; Physicochemical Properties; Optical properties: Semi-conductor Nanoparticles, Metal Nanoparticles; Electrical and electronic properties: Electronic properties of carbon nanotubes; Redox properties: Semi-conductor nanoparticles; Mechanical properties: Elastic properties, Hardness and strength, Ductility and Toughness, Superplastic behavior; Magnetic properties: Magnetic properties of Fe₂O₃ nanoparticles, Superparamagnetism; Chemical sensing properties; Catalytic properties.

UNIT-V: Applications of Nanomaterials (12 hours)

Importance of Nanomaterials (Gold, Silver, Dielectric and Magnetic Oxide Nanoparticles), Some selected applications like, Nanomaterials in medicine, Nanomaterials for energy sector,

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Kinetic energy (KE) penetrators with enhanced lethality, High energy density batteries, Nanomaterials in Next-Generation Computer, Nanomaterials in catalysis and sensors, Nanomaterials for water purification, Nanomaterials in communication sector, Nanomaterials in food, Nanomaterials for the environment, Nanomaterials in automobiles, Nanomaterials in ceramics industry.

Books Suggested:

1. Principals of Nanoscience and Nanotechnology, M. A. Shah and Tokeer Ahmad, Narosa Publications, 2010.
2. Nano Materials, B. Viswanathan, Narosa Publications, 2009.
3. Nano: The Essentials, T. Pradeep, Tata Mcgraw Hill, 2009.
4. Chemistry of Nanomaterials: Synthesis, Properties and Applications by C.N.R. Rao, A. Muller and A. K. Cheetham (eds.), Wiley-VCH, Weinheim, 2004.
5. Nanoscale Materials by Luis M. Liz-Marzan and Prashant V.Kamat, Kluwer Academic Publishers (Boston), 2003.
6. "Nanomaterials Chemistry: Recent Developments and New Directions", ed. by C.N.R. Rao, A. Muller & A.K. Cheetham (Eds.), Wiley-VCH, 2007.
7. Solid State Chemistry and its applications, Anthony R. West, John Wiley & Sons.
8. Physical Principles of Electron Microscopy: An introduction to TEM, SEM and AFM by R.F. Egerton, Springer, 2008.
9. Introduction to Atomic Force Microscopy, Paul E. West, Pacific Nanotechnology, USA.
10. Solid State Chemistry Techniques, A. K. Cheetham and Peter Day, Oxford Science Publications.
11. Scanning Probe Microscopy and Spectroscopy, Ronald Weisendanger, Cambridge University Press.
12. Nano Materials, A. K. Bandyopadhyay, New Age Internationals (P) Limited, Publishers

PATTERN OF EXAMINATION

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
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Course Code: PSCHTE351

Nature of Course: Elective MOOC

Title: Title of the MOOC/SWAYAM course opted by students

CREDITS: 04

Maximum Marks: 100

Course Description:

One 04 credit MOOC (Massive Open Online Course) selected from SWAYAM (Study Webs of Active-Learning For Young Aspiring Minds) UGC (University Grant Commission) portal. SWAYAM is a programme initiated by Government of India to achieve the three cardinal principles of Education policy viz, access, equity and quality.

Course Objectives:

- To provide the students high quality learning experience using multimedia on anytime, anywhere basis.
- To acquaint the students with online mode of learning using ICT platform.
- To diverse the knowledge of students through open learning and help them to access different disciplines online and thus promoting interdisciplinary knowledge.
- To provide the students a hybrid model of learning that adds to the quality of classroom teaching.

Course Selection Guidelines for Students:

- The students are required to enroll and qualify any one of the MOOC course from SWAYAM (UGC) portal that should of 04 credits.
- The course can be selected from the SWAYAM platform depending upon the availability of courses as notified by UGC generally on predefined dates, 1st June or 1st November respectively, every year.
- The students are required to enroll for the SWAYAM course immediately after the commencement of 1st Semester as per notified dates by UGC for SWAYAM courses.
- The course should be completed before the completion of 3rd Semester of M.Sc.
- Student ideally should not select self-paced MOOCs, and the courses selected must be different from one offered in the course curriculum of semesters in order to duplication.
- The student must fill an undertaking form, as given in the brochure, and submit the same after duly filled form to their respective Departments/ Colleges for future reviews and record purposes.
- SWAYAM Examination fees (if any), or any other fee prescribed, shall be borne by the students only.

Course Content:

To be provided by the Course Coordinator of SWAYAM Course through online mode.

Examination:

To be conducted by the host Institution offering SWAYAM course selected by the student. The students are required to submit the qualifying mark sheet/certificate to the office of the Department of Chemistry.

Course Code: PSCHLE328
 Title: Laboratory Course: Inorganic Chemistry
 Maximum Marks: 200

Nature of Course: Elective
 Credits: 08
 No. of hours: 240

Course Outcome: This course aims to develop an understanding of synthesis, quantitative and qualitative analysis, separation of cations by Paper, Thin layer and Column chromatography. The students will also be trained to prepare and characterise the compounds using the available techniques.

Preparation of selective inorganic compounds and their study by IR, electronic spectra, NMR and magnetic susceptibility measurement. Handling of air and moisture sensitive compounds involving vacuum lines.

Selection can be made from the following:

1. Preparation of Trioxalato salts $M'_3[M''(C_2O_4)_3] \cdot 3H_2O$ ($M' = K$ and $M'' = Al, Fe, Co$ or Cr); record and interpret IR spectra; Inorg. Synth. 1, 35, (1939).
2. Prepare $[Ni(NH_3)_6]Cl_2$ and carry out its ligand exchange reactions with bidentate ligands like Oxalate (ox), Glycine(gly), acetylacetonone (acac) and dimethyl glyoxime(dmg) by substitution method, record and interpret UV and IR spectra.
3. Prepare $Al(acac)_3$ and $VO(acac)_2$ complexes, record and interpret IR and NMR spectra.
4. Preparation of tetraamminecarbonatocobalt(III) nitrate and its conversion to pentaamminechlorocobalt(III) chloride; Inorganic Syntheses; Wiley-Interscience: pp 103 (1983).
5. Preparation of pentaamminechlorocobalt(III) chloride $[Co(NH_3)_5Cl]Cl_2$ and study of Linkage isomers by its conversion to nitropentaamminecobalt(III) chloride and then to nitropentaamminecobalt(III) chloride isomer followed by IR characterization;
6. Preparation of pentaamminechlorocobalt(III) chloride and study of Linkage isomers by its conversion to pentaamminenitritocobalt(III) chloride and to nitro isomer followed by IR characterization; Inorganic Chemistry 18, 1869 (1979).
7. Preparation of phosphine, Ph_3P , and its transition metal complexes; Inorg. Synth. 15, 45 (1974).
8. Reaction of Cr(III) with a multidentate ligand: a kinetic experiment (visible spectra Cr-EDTA complex); J.A. C. S., 1953, 75, 5670.
9. Preparation of Chromium(III) complexes, $[Cr(H_2O)_6]NO_3 \cdot 3H_2O$, $[Cr(H_2O)_4Cl_2]Cl \cdot 2H_2O$, $[Cr(en)_3]Cl_3$, $Cr(acac)_3$, followed by IR characterisation; Inorg. Synth., 13, 184 (1972).
10. Synthesis and characterization of cis- and trans-isomer of $[Co(en)_2Cl_2]Cl$; Inorganic Syntheses. Vol. 14. p. 63-77(1973).
11. Synthesis and studies on Ligand Field Strength: Chromium Complexes $K_3[Cr(C_2O_4)_3] \cdot 3H_2O$ and $[Cr(H_2NCH_2CH_2NH_2)_3]_2(SO_4)_3$ with Ligands of different Δ_o .
12. Solid phase synthesis of *trans*- bis glycinatocopper(II).
13. Preparation of silver nano-particles using silver nitrate solution and their spectroscopic characterization using UV-Visible spectrophotometry.

Gravimetric and Volumetric analysis: Copper, Cobalt, Iron, Nickel, Chromium, Vanadium, Aluminium, Chloride (Volhard's method) etc.

Separation by Paper/TLC/Column Chromatography:

Paper, Thin layer and Column chromatography: Principle, separation process, technique, design of mobile phase, methods of paper chromatography (Ascending, Descending and Radial, comparative mobile phase study of separating mixtures, chromatogram analysis and

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Interpretation. Chromatographic media coating materials, applications, activation of adsorbent, sample development, solvent systems, development of chromatoplate, visualization methods and applications in the separation. Adsorption isotherms, chromatographic media, nature of forces between adsorbent and solutes, eluents (mobile phase), column chromatography without detectors and liquid chromatography with detectors and applications.

1. Separation, identification and determination of R_f value of two cations by paper chromatography (Ascending, Descending and Radial).
2. Separation, identification and determination of R_f value of three cations by paper chromatography (Ascending, Descending and Radial).
3. Separation and determination of R_f value of two cations by thin layer chromatography.
4. Determination of ionisable chloride in a complex by cation exchange column (separation followed by Mohr's titration of elute for estimation).
5. Separation of Cobalt(II) and Nickel(II) on anion exchange column followed by estimation through EDTA titrations.
6. Separation of Permanganate and Bichromate ions on Alumina column and their Estimation from Beer Law plots.

Any other practical introduced by the teacher.

BOOKS RECOMMENDED

1. Vogel's textbook of quantitative chemical analysis (5th and 6th edition).
2. G. R. Chatwal, Instrumental Methods for Chemical Analysis, 5th ed., Himalaya Publications (India).
3. V. K. Ahluwalia and S. Dingra, Advanced experimental Inorganic Chemistry, Manakin Press Pvt. Ltd., 2016.
4. R. P. W Scott, Techniques and practice of Chromatography, Marel Dekker Inc., New York.
5. M. N. Sastri, Separation methods, Himalaya Publishing Company, Mumbai.
6. E. Helfman, Chromatography, Van Nostrand, Reinhold, New York.
7. E. Lederer and M. Lederer, Chromatography, Elsevier, Amsterdam.
8. H.M Mc Nair and J. M. Miller, Basic Gas Chromatography, John Wiley, New York.

PATTERN OF EXAMINATION

The daily evaluation of practical records, assignments, viva-voce and attendance shall have marks weightage of 50% of the total marks. The final practical performance test along with viva-voce examination will be held at the end of semester covering 100% of the syllabus and having marks weightage of 50% of the total marks.

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Course Code: PSCHLE329
Title: Laboratory Course in Organic Chemistry
Credits: 08
No. of hours: 240

Nature of Course: Elective

Maximum Marks: 200

Course Outcome: In this course, students will be trained to employ critical thinking and the scientific method to design, carry out, record and analyze the results of chemical experiments and get an awareness of the impact of chemistry on the environment and, society.

This paper has scope of employability in academics and in research institution and pharmaceutical industries.

Two/three step synthesis of organic compounds

The exercise should illustrate the use of organic reagents and may involve purification of the products by chromatographic techniques.

Benzpinacolone from benzophenone, Benzilic acid from benzoin, Fischer-indole synthesis, dihydropyrimidinones and dihydropyridines.

Use of microwaves/ultrasounds for the synthesis of coumarins.

Extraction of organic compounds from natural sources

1. Isolation of casein from milk
2. Isolation of lactose from
3. Isolation of piperine from black pepper
4. Isolation of lycopene from tomatoes
5. Isolation of β -carotene from carrot.

Estimations of the following compounds :

1. Amino acids [UV-Visible spectrophotometry]
2. Carbohydrates [UV-Visible spectrophotometry]
3. Phenol [Chemical methods]
4. Acetyl group [Chemical methods]

Spectroscopy

Identification of some organic compounds by the analysis of available spectral data (UV, IR, PMR, CMR and MS).

Any other experiment introduced by the concerned teacher.

BOOKS RECOMMENDED

1. Elementary Practical Organic Chemistry, Part-1, 2nd ed., Vogel.
2. Monograph on Green Chemistry by Green Chemistry Task Force Committee, DST.
3. Spectrophotometric determination of amino acid by Michail A. Alterman, Peter Hunziker, Vol. 828, Print ISBN: 978-1-61779-444-5.
4. Microwave-assisted organic synthesis, Vol. 25, D. Bogdal, Elsevier Science, 2005.

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Semester - III

Syllabus for the examinations to be held in Dec. 2024, Dec. 2025 & Dec. 2026

5. Laboratory experiment using microwave heating, N.E. Leadbeater and C.B. McGowan, CRC Press, 2013.
6. Experiments in green and sustainable chemistry, H.W. Roesky and D. Kennepohl, Wiley-VCH, 2009.
7. Advanced Practical Chemistry by LDS Yadav, Pragati tenth edition 2022.

PATTERN OF EXAMINATION

The daily evaluation of practical records, assignments, viva-voce and attendance shall have marks weightage of 50% of the total marks. The final practical performance test along with viva-voce examination will be held at the end of semester covering 100% of the syllabus and having marks weightage of 50% of the total marks.

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Course Code: PSCHLE330
Title: Laboratory Course in Physical Chemistry
Credits: 08
No. of hours: 240

Nature of Course: Elective

Maximum Marks: 200

Course Outcome: Students will employ critical thinking and the scientific method to design, carry out, record and analyze the results of chemical experiments and get an awareness of the impact of chemistry on the environment, society, and other cultures outside the scientific community. There will also be a course based on review of literature on any modern scientific topic.

1. Determination of Planck's constant by means of LED's method based on expression of diode current for $V < V_0$. The dependence of current with temperature is to be measured, keeping the V slightly below V_0 and material constant η to be obtained from V - I characteristics of the diode.
2. Four Probe set-up for measuring the resistivity of very low to highly resistive samples at temperature up to 200°C with PID controlled oven, having the following setup:
 - (i) Four Probe Arrangement with built-in RTD sensor & PID controlled Oven
 - (ii) D.C. Microvoltmeter
 - (iii) Constant Current Source for low resistivity samples like thin films for metals and alloys
 - (iv) Low Current Source
3. Measurement of Magnetoresistance of Semiconductors with the apparatus consisting of:
 - a) Four Probe Arrangement
 - b) Sample: Ge Crystal (n-type)
 - c) Magnetoresistance setup
 - d) Electromagnet
 - e) Constant Current Power Supply
 - f) Digital Gaussmeter
4. Study of Dependence of Hall Coefficient on Temperature by the following setup:
 - a) Hall Effect Setup
 - b) Hall Probe (Ge: p-type) with a small oven
 - c) Electromagnet
 - d) Constant Current Power Supply
 - e) Digital Gaussmeter
5. Study of the energy band-gap and diffusion potential of P-N Junctions.

X-ray diffraction studies

6. To the X-ray diffraction pattern of a given compound
 - (i) Assign lattice planes to different peaks of XRD pattern
 - (ii) Determine lattice parameters
 - (iii) Determine crystallite size and lattice strain.

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Magnetic measurements

7. To determine the magnetic susceptibility of a given compound using Faraday's method and hence determine different magnetic parameters.

Spectrophotometry

8. To determine the specific rate constant for the oxidation of ethanol by potassium dichromate using spectrophotometer.
9. To determine the critical micelle concentration of a surfactant using spectrophotometer.

Viscometric measurements

10. Determine the molecular mass of polystyrene from viscometric measurements.

Polarimetry

11. To determine the rate constant for the inversion of sucrose by polarimetry.

Ultrasonic interferometry

12. To find the velocity of sound in liquids using ultrasonic interferometer.

Thermogravimetry

13. To determine the transition temperature and the heat of transition of the given hydrated salt by differential thermal analyzer.

Chemical Kinetics

14. To Study the kinetics of bromination of phenol by bromide-bromate mixture in an acid medium as a clock reaction.
15. To find out the order of reaction between potassium bromate and potassium iodide.

Thermodynamics

16. To determination of partial molar volume of solute (e.g. KCl) and solvent in a binary mixture.
17. Determination of temperature dependence of solubility of compound in two solvents having similar intermolecular interactions (benzoic acid in water and in DMSO-water mixture) and calculate the partial molar heat of solution.

Conductivity measurements

18. To determine the degree of hydrolysis and hydrolysis constant of (i) aniline hydrochloride (ii) sodium acetate and (iii) ammonium chloride by conductometric measurements.
19. Estimate the concentration of HCl, CH₃COOH and CuSO₄.5H₂O in a given solution by carrying out conductometric titration with NaOH solution.
20. Determine the equivalent conductance of a strong electrolyte i.e. NaCl, KCl at several concentrations and hence verify Debye Huckel Onsager equation.

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21. Determine the equivalent conductance of a weak electrolyte i.e. CH_3COOH at infinite dilution by Kohlrausch law.

pH metry

22. To determine the strength of unknown solution of HCl by titrating it with NaOH solution using pH meter.
23. To find the strength of unknown solution of NH_3 solution by titrating it with CH_3COOH solution.
24. To find the strength of unknown solution of Na_2CO_3 solution by titrating it with HCl solution.
25. To find out the dissociation constant of polybasic acid e.g. phosphoric acid by titrating it with NaOH solution.
26. Determine the degree of hydrolysis and hydrolysis constant of (i) aniline hydrochloride (ii) sodium acetate and (iii) ammonium chloride by conductometric measurements.

Any other practical introduced by the teacher.

BOOKS RECOMMENDED

1. Practical Physical Chemistry, A. M. James and F. E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B. P. Levitt, Longman.
3. Experimental Physical Chemistry, R. C. Das and B. Behera, Tata McGraw Hill.
4. Experiments in Physical Chemistry by Shoemaker.
5. Practical Physical Chemistry by Viswanathan and Raghavan.

PATTERN OF EXAMINATION

The daily evaluation of practical records, assignments, viva-voce and attendance shall have marks weightage of 50% of the total marks. The final practical performance test along with viva-voce examination will be held at the end of semester covering 100% of the syllabus and having marks weightage of 50% of the total marks.

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Course Code: PSCHE421

Nature of Course: Elective

Title: Analytical Chemistry-II

Credits: 04

Maximum Marks: 100

No. of Hours: 60

Course Outcome: This course is focused on various advanced analytical techniques and its applications.

After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

UNIT-I: Potentiometry**(12 hours)**

Introduction, Indicator electrodes; electrodes of the first kind, metal electrodes for measuring metal cations, electrodes of the second kind, metal-metal salt electrodes for measuring the salts anion, redox electrodes, inert metals, voltaic cells without and with liquid junction, reference electrodes, measurement of potential, determination of concentration from potential measurements, residual liquid-junction potential, accuracy of direct potentiometric measurements,

Ion selective electrodes; glass pH electrode, fluoride electrode, solid state electrode based on silver compounds, liquid membrane electrodes, gas sensing electrodes, commercially available ion selective electrodes

UNIT-II: Potentiometric Titrations**(12 hours)**

Potentiometric titrations; classical method, location of end point, experimental details for potentiometric titrations involving neutralisation reactions, redox reactions, precipitation reactions, pH titrations using pH electrodes, precipitation titration using silver electrodes, redox titration using platinum electrodes, ion selective electrodes in potentiometric titrations measuring pM, derivative titrations, applications

UNIT-III: Voltametry**(12 hours)**

Voltametric Cell, current-voltage curve, stepwise reduction or oxidation, supporting electrolyte, irreversible reduction or oxidation, working potential range depending on electrode, polarography, dropping mercury electrode, Ilkovic equation, half wave potentials, polarographic analysis of mixtures, polarographic maxima, irreversible waves, polarography of complexes, anodic polarographic wave, inorganic applications

Anodic stripping Voltametry, Cyclic Voltametry, Practical considerations for potential sweep methods, Example of application of CV to study Rh complexes, Surface- attached analytes in CV

UNIT-IV: Electron Spectroscopy**(12 hours)**

Definition of a solid surface, Types of surface measurements, X-Ray photoelectron spectroscopy (XPS/ESCA): Introduction, principle, chemical shifts as a function of oxidation states, Instrumentation, Applications. Auger electron spectroscopy: Principle, instrumentation- Radiation source, Energy analyzer, Detector, Auxiliary system, Applications- Quantitative analysis.

UNIT-V: Electron Microscopy**(12 hours)**

Scanning electron microscopy (SEM): Basics, Instrumentation, Applications, Transmission electron microscopy (TEM): Introduction, Basic theory, Electron gun, Electromagnetic

Syllabus for the examination to be held in May 2025, May 2026 & May 2027

lenses, Imaging, Operating parameters- Magnification, Resolution, Depth of field, Sample preparation, Specimen orientation and manipulation, Applications, Selected Area Electron Diffraction, Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM) and Scanning Tunnelling microscopy (STM).

BOOKS RECOMMENDED

1. Instrumental Analysis, 2nd Ed., Bauer, Christian, O'Reilly, Allyn and Bacon, 1978.
2. Principles of Instrumental Analysis, 5th Ed- Indian Reprint, Skoog, Holler, Nieman, Harcourt Asia, 2001.
3. Instrumental Analysis, Skoog, Holler, Crouch, Brooks Cole- Cengage Learning, 2003.
4. Transmission Electron Microscopy, Williams and Carter, Plenum Press, New York and London, 1996.
5. Nature and Science, 4(3), 2006, Ma, et al, Transmission & Scanning Electron Microscopy.
6. Instrumental Methods of Analysis, 7th edn. H.H. Willard, L.L. Merritt, Jr. and J.A. Dean and F.A. Settle, Jr. Publishers and Distributors, New Delhi, 1986.
7. Instrumental Analysis, G. D. Christian, (Second Edition) James E. Reilly, Allyn and Bcon, Inc., Bostan London.
8. Fundamental of Analytical Chemistry, D.A. Skoog D.M. West and F.J. Holler, Saunders College Publishing, New York, 1988.
9. Principles of Instrumental Analysis by Skoog Holler, Neiman (2001). V. Edn.
10. Solid State Chemistry and its applications, Anthony R. West, John Wiley & Sons.
11. Physical Principles of Electron Microscopy: An introduction to TEM, SEM and AFM by R.F. Egerton, Springer, 2008.
12. Solid State Chemistry Techniques, A. K. Cheetham and Peter Day, Oxford Science Publications.
13. Scanning Probe Microscopy and Spectroscopy, Ronald Weisendanger, Cambridge University Press.
14. Vogel's Textbook of Quantitative Inorganic Analysis, 4th Edition, The English Language Book Society & Longman
15. Vigel's Textbook of Quantitative Chemical Analysis, 6th Edition, Pearson
16. Analytical Chemistry: Principles, John H. Kennedy, 2nd Edition, Saunders College Publishing.
17. Analytical Chemistry, Gary D. Christian, 6th Edition, Wiley

PATTERN OF EXAMINATION

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
Minor Test – I (after 30 days)	Upto 20%	1½ hour	20
Minor Test – II (after 60 days)	Upto 40%	1½ hour	20
Major Test (after 90 days)	Upto 100%	3 hours	60

Semester - IV

Syllabus for the examination to be held in May 2025, May 2026 & May 2027

The **Minor Test** would consist of two **Sections (A & B)**.

Section A would consist of two short answer type questions of 05 marks each and students are required to answer both questions.

Section B would consist of two long answer type questions of 10 marks each. Students are required to answer one question from **Section B**.

The **Major Test** will have seven questions (each of twelve marks). The students have to attempt five questions in all. Question no. 1 (short answer type) will be compulsory and will be set out from 40% of syllabus covered in Minor I & II. The remaining six questions will be from across the syllabus of 41% to 100% i.e. beyond Minor I & II. The student has to attempt any four questions out of six questions.

NOTE: Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.

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Course Code: PSCHTE422
 Title: Organotransition Metal Chemistry
 Maximum Marks: 100

Nature of Course: Elective
 Credits: 04
 No. of hours: 60

Course Outcome: This course will enable the students to learn basic concepts, different bonding behaviour, synthetic and structural aspects of transition metal-carbon bond. Students will also gain the knowledge of applications of these compounds in various fields as catalyst with full understanding of their mechanism.

UNIT-I: σ -Bonded Transition Metal Complexes (Hydrocarbyls/aryls) (12 hours)

Definition, brief introduction, types and classification of σ -hydrocarbyls/aryls, nomenclature, bonding and structure of hydrocarbyls, routes of synthesis from group 3 (d^1) metal to group 10 (d^8) metals, Properties, stability factors, kinetic vs thermal stability of σ -hydrocarbyls, various decomposition pathways: hydride (α , β and γ) eliminations, Reductive elimination, characteristic chemical reactions.

Organo-copper compounds: Lithium dialkylcuprates and Lithium diarylcuprates (Gilman-type reagents), composition and structure of $LiCuR_2$, mechanism, Reactions with alkyl/aryl halides, ketones & α -haloketones, Acid chlorides, α , β -unsaturated carbonyls, disubstituted acetylenes, Primary and secondary amines, S-alkyl thioesters, epoxides. Introduction to alkenylcopper(I) reagents.

UNIT-II: Complexes of Transition Metal-Carbon Multiple Bonds (12 hours)

Alkylidenes and alkylidyne: Introduction, Low valent (Fischer) and high valent (Schrock) carbenes, singlet and triplet carbenes, nature of bonding and structures of metal carbenes, synthetic methods, spectral behaviour, electrophilicity and nucleophilicity of metal carbenes, reactivity and chemical reactions, reactive sites on metal carbenes, applications of metal carbenes.

Low valent (Fischer) and high valent (Schrock) carbynes: Doublet and quartet carbynes, Bonding model, synthetic methods and chemical reactions, Alkyne metathesis reactions and their mechanism, Schrock's 3rd generation catalysts.

UNIT-III: Transition Metal - π Complexes (12 hours)

Transition metal-alkene complexes: Introduction, Bonding model, structure, types, synthesis, physical and chemical properties. Transition metal-alkyne complexes: Bonding model and structural features, synthesis, chemical reactions and alkyne metathesis reactions; Transition metal-allyl complexes: Types, bonding model and structural features, η^1 - η^3 conversion, *syn* and *anti* conversion of protons, 1H NMR analysis in metal-allyls, synthesis and chemical reactions; Transition metal-butadiene complexes: Types, Bonding model, different extremes of bonding, synthesis and chemical properties; Metal-cyclobutadiene complexes; Metal-cyclopentadiene complexes: Bonding, synthesis and chemical reactions; Transition metal-arene and $\eta(1-5)$ cyclohexadienyl complexes: Properties and structural features, synthesis and chemical reactions; Cycloheptatriene (CHT) and cyclooctatetraene (COT) metal complexes.

UNIT-IV: Organometallic compounds in Catalysis (12 hours)

Stoichiometric reactions for catalysis, activation of H-H and C-H bond; Homogeneous hydrogenation catalysis: Wilkinson's Catalyst, monohydride and dihydride hydrogenation, mechanism of catalytic cycle (CC), selected applications of Wilkinson's catalyst, Asymmetric hydrogenation using Chiral Catalyst; Polymerization of olefins: Zeigler-Natta catalyst and its possible mechanisms (Cossee Arlman, Alkylidene & Agostic hydrogen) of polymerization of propene, stereo specific nature; Hydrocarbonylation of olefins (oxo reaction): Mechanism

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Semester - IVth
Syllabus for the examination to be held in May 2025, May 2026 & May 2027

using Cobalt and Rhodium catalyst; Methanol carbonylation: Mechanism of catalytic cycle of Monsanto and Cativa process; Olefin oxidation of alkenes (Wacker process): Basic reactions involved and mechanism of catalytic cycle.

UNIT-V: Fluxional organometallic compounds and transition metal compounds with bonds to hydrogen (12 hours)

Basics and concepts of non-rigidity, Rate of rearrangements and techniques of study, Non-rigid molecules in different coordination geometries (4, 5 & 6), Berry's mechanism of pseudorotation, Hopping pattern, Classification and their fluxionality in alkenes and allyls (η^2 and η^3), σ -Bonded cyclic alkenes and π -Bonded cyclic alkenes, Rotation and scrambling of ligands on metals.

Transition metal hydrides: Types, Mononuclear polyhydrides, homoleptic polyhydride anions, carbonyl hydrides, molecular hydrogen compounds; synthesis, properties like spectral behaviour, acidity and chemical reactions; Open and closed M...H--C interactions, Transition metal-aluminohydrides and -borohydrides.

BOOKS RECOMMENDED

1. Principles and Applications of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
2. The Organometallic Chemistry of the Transition Metals, R.H. Crabtree, John Wiley.
3. Metallo-organic Chemistry, A.J. Pearson, Wiley.
4. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.
5. Basic Organometallic Chemistry, Concepts, Syntheses and Applications, B.D. Gupta and A.J. Elias, University Press.
6. R. H. Crabtree, The Organometallic Chemistry of the Transition Metals., Wiley, New York,
7. A. Dedieu. Transition Metal Hydrides, Wiley-VCH.

PATTERN OF EXAMINATION

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
Minor Test - I (after 30 days)	Upto 20%	1½ hour	20
Minor Test - II (after 60 days)	Upto 40%	1½ hour	20
Major Test (after 90 days)	Upto 100%	3 hours	60

The Minor Test would consist of two Sections (A & B).

Section A would consist of two short answer type questions of 05 marks each and students are required to answer both questions.

Section B would consist of two long answer type questions of 10 marks each. Students are required to answer one question from Section B.

The Major Test will have seven questions (each of twelve marks). The students have to attempt five questions in all. Question no. 1 (short answer type) will be compulsory and will be set out from 40% of syllabus covered in Minor I & II. The remaining six questions will be from across the syllabus of 41% to 100% i.e. beyond Minor I & II. The student has to attempt any four questions out of six questions.

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Course Code: PSCHTE423
Title: Bioinorganic and Supramolecular Chemistry
Maximum Marks: 100

Nature of Course: Elective
Credit: 04
No. of hours: 60

Course Outcome: The focus of this course is to enable the students to learn about the bioinorganic and molecular recognition and design of molecules for the beneficial of society.

UNIT-I: Metal complexes in transmission of energy, Nitrogen fixation and Transport and storage of dioxygen (12 hours)

Metal complexes in transmission of energy: Chlorophyll's, Photosystem I and photosystem II in cleavage of water.

Nitrogen fixation: Biological nitrogen fixation and its mechanism, Nitrogenase, Chemical nitrogen fixation.

Transport and storage of dooxygen: Heme proteins and oxygen uptake, Structure and function of hemoglobin, Myoglobin, Hemocyanins and hemerythrin, Model synthetic complexes of iron, cobalt and copper.

UNIT-II: Structure, function and biochemistry of enzymes containing following metals (12 hours)

a) Zinc

Zinc Fingers, Carboxy peptidase, Carbonic anhydrase.

b) Copper Type I, Type II, Type III

Blue Proteins: Azurins, Plastocynins & Blue Oxidases, Model compounds of Blue copper proteins.

Non Blue Proteins: Tyrosinase, Galactose oxidase, SOD.

c) Cobalt

Vitamin B12 co enzymes and model compounds, Actions of Cobalamines, Adenosylcobalamine as a coenzyme, Ribonucleotide reductase, Methylcobalamine as cofactor.

UNIT-III (12 hours)

Metal Storage, Transport and Biomineralization: Ferritin, Transferrin and Siderophores. Structure and function of metalloproteins in electron transport processes – Cytochromes and Iron-Sulphur proteins.

Iron enzymes – catalase, peroxidase and cytochrome P-450.

Molybdenum oxotransferase enzymes–Xanthine oxidase, Mo-cofactors, Antagonism between Cu and Mo, Hydroxylase.

UNIT-IV: Molecular recognition (12 hours)

Introduction to recognition, Information and complementarity, Molecular receptors- Design principles, Spherical recognition- Cryptates of metal cations, Tetrahedral recognition by macrocyclic cryptands, Recognition of ammonium ions and related substrates, Recognition of neutral molecules, Recognition of anionic substrates (anionic coordination).

Intermolecular Interactions: General Properties, van der Waals Interactions, Hydrogen bonds, Halogen bonds, Other interactions.

UNIT- V (12 hours)

Multi-component Crystals: General classification and nomenclature, Solid solutions, Hostguest compounds, Solvates and hydrates, Donor-acceptor complexes, Co-crystals.

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Transport processes and carrier design:

Carrier – mediated transport, Cation transport processes – Cation carriers, Anion transport processes – anion carriers, Coupled processes.

Molecular and Supramolecular devices: Supramolecular photochemistry, Supramolecular electronic devices, Supramolecular ionic devices.

Books Suggested:

1. Principles of Bioinorganic Chemistry, S. J. Lippard and J. M. Berg, University Science Books.
2. Bioinorganic Chemistry, I. Bertini, H. B. Gray, S. J. Lippard and J. S. Valentine, University, Science Books.
3. Inorganic Biochemistry Vols. I and II ed., G. L. Eichhorn, Elsevier.
4. Progress in Inorganic Chemistry, Vols. 18 and 38 ed., J.J. Lippard, Willey.
5. Supramolecular Chemistry, J. M. Lehn, VCH.
6. Bioinorganic Chemistry: A Short Course-Rosette M.Malone, Wiley Interscience, 2002.
7. Biological Inorganic Chemistry-An Introduction, Robert Crichton, Elsevier Science, 2007.
8. Supramolecular Chemistry: A Concise Introduction, J. L. Atwood and J. W. Steed, John Wiley & Sons, 2000.
6. Perspectives in Supramolecular Chemistry, G. R. Desiraju, Vol. 2, John Wiley & Sons.
7. Crystal Engineering, G. R. Desiraju, Cambridge university Press India Pvt. Ltd., 2011.

PATTERN OF EXAMINATION

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
Minor Test – I (after 30 days)	Upto 20%	1½ hour	20
Minor Test – II (after 60 days)	Upto 40%	1½ hour	20
Major Test (after 90 days)	Upto 100%	3 hours	60

The **Minor Test** would consist of two **Sections (A & B)**.

Section A would consist of two short answer type questions of 05 marks each and students are required to answer both questions.

Section B would consist of two long answer type questions of 10 marks each. Students are required to answer one question from **Section B**.

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Course Code: PSCHTE424
Title: Chemistry of Heterocyclic Compounds
Credits: 04
No. of hours: 60

Nature of Course: Elective

Maximum Marks: 100

Course Outcome: An exhaustive study of heterocyclic chemistry will be presented which will help the students to grasp its chemistry. This paper includes the different types of reaction mechanism in the preparation of different ring size heterocyclic compounds and also their biological importance. This will help students to get employability in Research and Development.

UNIT-I: Nomenclature of Heterocycles (12 hours)
 Replacement and systematic nomenclature (Hantzsch-Widmann system) for monocyclic, Fused and bridged heterocycles and simple spiroheterocycles, Carbocycles, Ring assemblies, Same repeating units, Different repeating units.

UNIT-II: Ring synthesis via different types of reactions (12 hours)
 Introduction, Cyclization reactions (Displacement at tetrahedral carbon, Intramolecular nucleophilic addition to carbonyl group, intramolecular addition of nucleophiles to other double bond, cyclization onto triple bond, radical cyclization, carbene and nitrene cyclization, electrocyclic reactions). Cycloaddition reactions (1,3-Dipolar cycloaddition, Hetero Diels Alder reaction, [2+2] cycloaddition, cheletropic reactions, Ene reaction).

UNIT-III: Bicyclic and tricyclic ring systems with one heteroatoms (10 hours)
 Synthesis and Chemical reactions including biological importance of quinoline, isoquinoline, acridine.
Bicyclic ring systems with two heteroatoms
 Synthesis and Chemical reactions including biological importance of Cinnoline, Phthalazine, quinazoline, quinoxaline.

UNIT-IV: (14 hours)
Six-Membered Heterocycles with One heteroatom: Synthesis and reactions of pyridine, pyridine-*N*-oxide, pyrilium salts. Biological importance, Synthesis and reactions of Coumarins (4-Hydroxy coumarin, 4-Methyl coumarin) and chromones.
Six Membered Heterocycles with two Heteroatoms: Synthesis and reactions of diazines (Pyrazines, Pyridazines, Pyrimidines and Barbiturates).
Seven- and Large-Membered Heterocycles: Synthesis and reactions of azepines, oxepines and thiepinines.

UNIT-V (12 hours)
Four membered heterocyclic compounds with one heteroatom: Synthesis and chemical reactions of azetidines, Oxetanes, Thietanes
Five membered heterocyclic compounds with two heteroatoms: Biological importance, Synthesis and chemical reactions of pyrazole, imidazole, oxazole, thiazole.
Benzo-Fused Five Membered Heterocycles with one heteroatom : Synthesis and reactions including medicinal applications of benzopyrrole, Benzofuran and benzothiophene.

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BOOKS RECOMMENDED

1. Heterocyclic Chemistry, Thomas L. Gilchrist, 3rd Edition, Addison Wesley Longman Limited 1997.
2. Chemistry of Heterocyclic Compounds, RakeshK. Prashar, Beena Negi, Anne Books Pvt. Ltd., 2022
3. Heterocyclic Compounds, Rashmi Jain, Alok Sahay, Usha Soni, Sandhya Pimplapure, Pragati Prakashan , 6th Edition , 2021.
4. Heterocyclic Chemistry, J.A. Joule and K. Mills, Black well Publishing, 4th Edition, 2004.
5. Heterocyclic Chemistry, Vol. 1-3, R.R. Gupta, M. Kumar and V. Gupta, Springer Verlag.
6. The Chemistry of Heterocycles, J.A. Joule, K. Mills and G.F. Smith, Chapman and Hall.
7. Contemporary Heterocyclic Chemistry, G.R. Newkome and W.W. Pandler, Wiley Interscience.
8. An Introduction to Heterocyclic Compounds, R.M. Acheson, John Wiley and Sons.
9. Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, Eds. Pergamon Press.
10. G. Solladie, J.D. Morrison (ed.), Asymmetric Synthesis, Academic Press.
11. Organic Synthesis, Michael B. Smith, McGraw Hill, International Edition.

PATTERN OF EXAMINATION

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
Minor Test – I (after 30 days)	Upto 20%	1½ hour	20
Minor Test – II (after 60 days)	Upto 40%	1½ hour	20
Major Test (after 90 days)	Upto 100%	3 hours	60

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Course Code: PSCHTE425
 Title: Catalysis in Organic Synthesis
 Credits: 04
 No. of hours: 60

Nature of Course: Elective

Maximum Marks: 100

Course Outcome: On successful completion of this course, the students will gain knowledge about asymmetric catalysis including organocatalysis and metal catalysis. This will train the students to perform asymmetric organic transformations. In addition, the learning from this course will help the students to get employment in industry and academia.

UNIT-I: Asymmetric Organocatalysis: A New Stream in Organic Synthesis (10 hours)
 Introduction, historical background, catalysts, privileged catalysts, Proline, Cinchona Alkaloids, TADDOLs and derivatives, Binaphthol derivatives, reaction types, covalent catalysis, non-covalent organocatalysis.

UNIT -II: Aldol and Mannich-Type Reactions (14 hours)
 Introduction, Aldol reactions of alkyl ketone donors, α -oxyketone donors, and aldehyde donors; Aldol reactions with ketone acceptors, Intramolecular aldol reactions. Mechanism and transition states of aldol reactions; effects of water on aldol reactions, catalyst recycling, and catalyst development strategies. Mannich-type reactions of aldehyde donors with glyoxylate imines, and with other preformed imines, Three-component Mannich reactions using aldehyde donors, Mannich-type reactions of ketone donors.

UNIT-III : Reduction of Alkenes (12 hours)
 Asymmetric hydrogenation with Rhodium complexes, Ruthenium complexes, Titanium and Zirconium catalysts, Iridium catalysts, and with organocatalysts.

UNIT-IV: Reduction of Ketones and Imines (12 hours)
 Hydrogenation of ketones, Hydrogenation and transfer hydrogenation of Imines and related compounds, Transfer hydrogenation of ketones, Heterogeneous hydrogenation, Reduction of ketones using enantioselective Borohydride reagents, Hydrosilylation of ketones, imines and nitrones.

UNIT-V: Catalytic Carbon-Carbon/Nitrogen Bond-Formation Reactions (12 hours)
 General introduction to cross-coupling reactions, Metal-catalysed allylic substitutions, Alkyl metalation of alkenes. Suzuki, Heck, Sonogashira and Negishi couplings; Buchwald-Hartwig aminations.

BOOKS RECOMMENDED

1. Advanced Organic Chemistry, Part-A – Structure & Mechanism, F.A. Carey and R.J. Sundberg, Springer (5th ed., 2007).
2. Enantioselective Organocatalysis: Reactions and Experimental Procedures, Peter I. Dalko, Wiley (2007).
3. Catalysis in Asymmetric Synthesis; Vittoria Caprio and Jonathan M.J. Williams, Wiley (2nd ed., 2008).

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Semester-IVth
Syllabus for the examination to be held in May 2025, May 2026 & May 2027

PATTERN OF EXAMINATION

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
Minor Test – I (after 30 days)	Upto 20%	1½ hour	20
Minor Test – II (after 60 days)	Upto 40%	1½ hour	20
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Course Code: PSCHTE426

Nature of Course: Elective

Title: Chemistry of Natural Products

Credits: 04

Maximum Marks: 100

No. of hours: 60

Course Outcome: After successful completion of this course, the student will gain knowledge about various natural products such as terpenoids, carotenoids, alkaloids, steroids, plant pigments and marine natural products, and their biosynthetic pathways.

UNIT-I: Terpenoids and Carotenoids**(12 hours)**

Classification, Occurrence and isoprene rule, General methods for the determination of structure of terpenoids; Structure determination, Stereochemistry and synthesis of the following representative molecules:

α -Terpineol, Menthol, Farnesol, Santonin, β -Carotene and Squalene.

UNIT-II: Alkaloids**(12 hours)**

Definition, Physiological action, Occurrence and isolation, General methods for the structure determination of alkaloids; Structure elucidation, and synthesis of Quinine, Morphine, Atropine and Papaverine.

UNIT-III: Steroids and Plant pigments**(12 hours)**

Occurrence, Basic skeleton, Diel's hydrocarbon and stereochemistry, Isolation, Structure determination and synthesis of Cholesterol, Testosterone, Estrone, Progesterone.

Occurrence and general methods of structure determination of anthocyanins. Synthesis of Apigenin, Quercetin, Cyanin, and Butein.

UNIT-IV: Marine natural products**(12 hours)**

General introduction, Isolation of marine natural products, Detailed study of following marine natural products:

Marine toxins (Saxitoxin and Tetrodotoxin), Nucleosides (pyrimidines and purines D-arabinosides and pyrimidines and purines 1- β -D-ribosides).

UNIT-V: Biosynthesis of Natural products**(12 hours)**

Biosynthesis and biogenesis, methods of investigation of the biosynthesis of secondary metabolites. Biosynthesis of terpenes (squalene and phytoene); Prostaglandins, and flavonoids (Acetate pathway and Shikimic acid pathway).

BOOKS RECOMMENDED

1. Natural Products: Chemistry and Biological Significance, J. Mann, R.S. Davidson, J. B. Hobbs, D. V. Banthrope and J. B. Harborne, Longman, Harlow, Essex, England (1994).
2. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Ed. Kurt Hostettmann, M. P. Gupta and A. Marston, Harwood Academic Publishers.
3. New Trends in Natural Product Chemistry, Atta-ur-Rahman and M. I. Choudhary, Harwood Academic Publishers.
4. Chemistry of Natural Products, S. V. Bhat, B. A. Nagasampagi and M. Sivakumar,

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Semester-IVth
Syllabus for the examination to be held in May 2025, May 2026 & May 2027

Narosa Publishing House, New Delhi.

5. Bioactive Marine Natural Products, D. S. Bhakuni and D. S. Rawat, Anamaya Publishers, New Delhi (2005).

PATTERN OF EXAMINATION

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
Minor Test – I (after 30 days)	Upto 20%	1½ hour	20
Minor Test – II (after 60 days)	Upto 40%	1½ hour	20
Major Test (after 90 days)	Upto 100%	3 hours	60

The **Minor Test** would consist of two **Sections (A & B)**.

Section A would consist of two short answer type questions of 05 marks each and students are required to answer both questions.

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The **Major Test** will have seven questions (each of twelve marks). The students have to attempt five questions in all. Question no. 1 (short answer type) will be compulsory and will be set out from 40% of syllabus covered in Minor I & II. The remaining six questions will be from across the syllabus of 41% to 100% i.e. beyond Minor I & II. The student has to attempt any four questions out of six questions.

NOTE: Candidates who have appeared in Minor Tests and failed to get the minimum required marks i.e. 14 out of 40 will not be allowed to take Major Test. Such candidates shall have to re-appear in the Minor Test/s only once in which he/she has failed, to be conducted at least fifteen days before the Major Test.

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Semester - IVth
Syllabus for the examination to be held in May 2025, May 2026 & May 2027

Course Code: PSCHTE427
Title: Solid State Chemistry
Credits: 04
No. of hours: 60

Nature of Course: Elective

Maximum Marks: 100

Course Outcome: The students will have an understanding of general principles of solid state reactions, preparation, methods and crystal symmetry, defects/structure of solids and their electronic, ionic conduction and magnetic properties.

UNIT-I: Structure of Solids (12 hours)

Closed packed structures: cubic close packing and hexagonal close packing, Some important structure types: NaCl, ZnS, CsCl and perovskite (SrTiO_3), Crystal systems, Bravais lattice, Lattice planes, Symmetry: Point symmetry, Space symmetry and point groups, Representation of point groups and selected examples, Space groups.

UNIT-II: Preparative Methods (10 hours)

General Principles of Solid State Reactions, Preparation of materials in solid state: Precursor, ceramic, Sol-gel, Hydrothermal, Electrochemical reduction methods, Vapour phase transport and high pressure methods, Preparation of thin films, Growth of single crystals.

UNIT-III: Crystal Defects and Solid Solutions (12 hours)

Crystal defects - Perfect and imperfect crystals, Intrinsic and extrinsic defects, Point defects (Schottky and Frenkel defects), Thermodynamics of Schottky and Frenkel defect formation, Colour centres, Plane defects: Grain boundary and Staking faults, Topochemical control of solid state organic reactions: Conformational effects, Molecular packing effects, Electrically conducting organic solids: conjugated systems, organic charge transfer complexes (New superconductors), Solid solutions: Substitutional solid solutions, Interstitial solid solutions, More complex solid solutions mechanisms, Requirements for solid solutions and formation.

UNIT-IV: Electronic and Ionic Conduction (12 hours)

Metals, insulators and semiconductors, Electronic structure of solids, Chemical and physical approaches- Band theory, Band structure of metals, Insulators and Semiconductors, Intrinsic and extrinsic semiconductors, Doping of semiconductors, Applications of semiconductors, Ionic conductivity in solids, Solid electrolytes- Fast ion conductors: α -AgI, β -Alumina, Oxide ion conductors, Superconductivity: The discovery of superconductors, Bardeen-Cooper-Schrieffer (BCS) theory of superconductivity, Effect of magnetic field, Applications of High T_c superconductors.

UNIT-V: Magnetic and Dielectric Properties (12 hours)

Magnetic properties - Classification of materials, Behaviour of substances in a magnetic field, Effect of temperature: Curie and Curie-Weiss laws, Calculation of magnetic moments, Mechanisms of ferro and anti-ferromagnetic ordering, Super exchange and double exchange, Ferromagnetic domains and hysteresis, Soft and hard magnetic materials, Dielectric materials, Ferroelectricity, Pyroelectricity, Piezoelectricity, Applications of Ferro-, Piezo- and Pyroelectrics.

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BOOKS RECOMMENDED

1. Solid State Chemistry and its applications, A.R. West, John Wiley, New York.
2. Principles of the Solid State, H.V. Keer, New Age International (P) Limited, India.
3. Solid State Chemistry, An Introduction, L. Smart and E. Moore, Nelson Thrones Ltd, U.K.

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Course Code: PSCHTE428

Nature of Course: Elective

Title: Polymer Chemistry

Credits: 04

Maximum Marks: 100

No. of hours: 60

Course Outcome: Basic aspects of polymer chemistry and their characterization, structure and properties of polymers, polymer processing and properties of commercial polymers are discussed in this course work.

UNIT-I: General Aspects**(12 hours)**

Importance of polymers, Basic concepts: Monomers, Repeat units, Degree of polymerization, Linear branched and network polymers, Classification of polymers, Polymerization: Condensation, Addition, Radical chain-ionic, Co-ordination and co-polymerization, Polymerization conditions and polymer reactions, Polymerization in homogenous and heterogeneous systems.

UNIT-II: Polymer Characterization**(14 hours)**

a) **Polydispersion** – average molecular weight concept, Number and Weight average molecular weight, Molecular weight distribution, Measurement of molecular weights: viscosity, osmometric, light scattering, ultracentrifugation methods.

(b) Analysis and testing of polymers, Chemical analysis of polymers, Spectroscopic methods, X-ray diffraction study, Microscopy, Thermal analysis and physical testing, Tensile strength, Fatigue, Impact, Tear resistance, Hardness, Abrasion resistance.

UNIT-III:**(12 hours)****(a) Thermodynamics of Solutions of High Polymers**

Entropy of mixing of solvent and solute, Enthalpy of mixing of solvent and polymeric solute, Free energy of mixing of polymeric solute with solvent, Chemical potential and activity of solvent, Osmotic pressure of polymeric solutions.

(b) Structure and Properties

Morphology and order in crystalline polymers, Configurations of polymer chains, Crystal structures of polymers, Crystallization and melting, Polymer structure and physical properties: Crystalline melting point, T_m -melting points of homogeneous series, Effect of chain flexibility and other steric factors, Entropy and heat of fusion, Glass transition temperature, Effect of molecular weight, Diluents, Chemical structure, Chain topology, Branching and cross linking.

UNIT-IV: Polymer Processing**(10 hours)**

Property requirements and polymer utilization, Plastics, Elastomers and fibres, Processing techniques: Compounding, Calendaring, Die casting, Rotational casting, Film casting, Injection moulding, Blow moulding, Extrusion moulding, Thermoforming, Foaming, Reinforcing and fibre spinning.

UNIT-V: Properties of Commercial Polymers**(12 hours)**

Polyethylene, Polyvinyl chloride, Polyamides, Polyesters, Phenolic resins, Epoxy resins and silicon polymers, Functional polymers, Fire retarding polymers and electrically conducting polymers, Biomedical polymers, Contact lens, Dental polymers, Artificial heart, Kidney, Skin and blood cells.

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Semester - IVth

Syllabus for the examination to be held in May 2025, May 2026 & May 2027

BOOKS RECOMMENDED

1. Textbook of Polymer Science, F.W. Billmeyer Jr. Wiley.
2. Polymer Science, V.R. Gowariker, N.V. Viswanathan and J. Sreedhar, Wiley-Eastern.
3. Functional Monomers and Polymers, K. Takemoto, Y. Inaki and R.M. Otanbrite.
4. Contemporary Polymer Chemistry, H.R. Alcock and F.R. Lambe, Prentice Hall.
5. Physics and Chemistry of Polymers, J.M.G. Cowie, Blackie Academic and Professional.

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Course Code: PSCHTE429

Nature of Course: Elective

Title: Chemistry of Materials and Liquids

Credits: 04

No. of hours: 60

Maximum Marks: 100

Course Outcome: Students will acquaint knowledge about chemistry of different materials like alloys, ceramics, composites and liquid crystals. The properties of liquids along with the various theories of liquids also form a part of discussion in this course.

This course also offers employability in the field of research and development, research institutes besides academics.

UNIT-I**(12 hours)**

Multipurpose Materials: Ferrous alloys and its classification, Fe-C phase transformations in ferrous alloys, Cast irons, Stainless steels, Non-ferrous alloys, Mechanical properties of ferrous and non-ferrous alloys and their applications.

Ceramics: Types and Applications: Ceramics, Classification of Ceramics; Glasses and glass ceramics, Clay products, refractories, Abrasives, Cements, Advanced ceramics; Piezoelectric ceramics, Microelectrochemical systems (MEMS), Optical fibers, Ceramic ball bearings, Properties of different types of ceramics and their applications.

UNIT-II**(12 hours)**

Fabrication and Processing of Ceramics: Fabrication and processing of glasses; Glass properties, Glass forming, Heat treatment of glasses; Annealing and glass tempering, Fabrication and processing of clay products; Characteristics of clay, Compositions of clay products, Fabrication techniques; Hydroplastic forming, Slip casting, Drying, Firing.

Liquid Crystals: Mesomorphic behavior, Classification of liquid crystals; Polymer, Discotic, Thermotropic and lyotropic liquid crystals, Nematic and smectic mesophases, Structure of nematic phase; Ordinary nematic and Twisted nematic (Cholesteric) structures, Molecular arrangement in smectic A and smectic C phases, Optical properties of liquid crystals, Dielectric susceptibility and dielectric constants.

UNIT-III: Composites**(12 hours)**

Particle-reinforced composites; Large particle composites and Dispersion strengthened composites, Fiber-reinforced composites, Influence of fiber length, Influence of fiber orientation, Fiber phase, Matrix phase, Polymer matrix composites; Glass fiber-reinforced polymer and Carbon fiber-reinforced polymer composites, Carbon-carbon composites, Hybrid composites, Processing of fiber-reinforced composites; Pultrusion and Filament winding, Structural composites; Laminar composites, Sandwich panels.

UNIT-IV: General Properties of Liquids**(12 hours)**

Liquids as dense gases, Critical constants, Comparison between van der Waals constants and critical constants, Some thermodynamic relations, Internal pressure and its significance in liquids, Various equations of state, Different types of intermolecular forces in liquids, Different potential functions for liquids, Additivity of pair potential approximation, Configurational integral, Liquids as disordered solids.

UNIT-V: Theories of Liquids**(12 hours)**

Partition function method (model approach), Simple cell model, LJD model, Communal energy and entropy, Significant structure model (hole theory of liquids).

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Semester-IVth
Syllabus for the examination to be held in May 2025, May 2026 & May 2027

Methods of Structure Determination and Computational Techniques: Spectroscopic techniques for liquid dynamic structure studies; Neutron and X-ray scattering spectroscopy, Computation Techniques - Monte Carlo and Molecular dynamics methods.

BOOKS RECOMMENDED

1. Solid State Physics, N.W. Ashcroft and N.D. Mermin, Saunders Collage.
2. Materials Science and engineering, An Introduction, W.D. Callister, Wiley.
3. Principles of the Solid state, H.V. Keer, Wiley Eastern.
4. Materials Science, J.C. Anderson, K.D. Leaver, J.M. Alexander and R.D. Rawlings, ELBS.
5. Thermotropic Liquid Crystals, Ed., G.W. Gray, John Wiley.
6. Handbook of Liquid Crystals, Kelker and Hatz, Chemie Verlag.
7. An Introduction to Liquid State, P.A. Egelstaff, Academic Press.
8. The Dynamic Liquid State, A.F.M. Barton, Longman.
9. The Liquid State, J.A. Pryde.
10. Significant Liquid Structures, H. Eyring and M.S. John.
11. The Liquid Phase, D.H. Trevena, WYKEHAM Publications.

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Semester - IVth
Syllabus for the examination to be held in May 2025, May 2026 & May 2027

Course Code: PSCHTO430
Title: Chemistry in Daily life
Credits: 04
No. of hours: 60

Nature of Course: Open

Maximum Marks: 100

Course Outcome: It is an open choice course not for the students of chemistry but for the students from other streams. The course is designed in such a way that the students from different streams get a flavour of the things in their day to day activities.

UNIT-I: Water and its treatment (14 hours)

Water and water formation, Importance of water, Water requirements (Domestic, Industrial, Institutional, Public and Agriculture), Water quality standards: Desirable limits, Permissible limits, PPM and PPB, Drinking water physical parameters: Color, Taste-odor, Turbidity, Suspended solids and temperature, Hard and soft water, Hardness of water, Disadvantages of hard water, Mineral and distilled water, Water softening by lime-soda, zeolite, Ion-Exchange method and demineralization processes (Reverse Osmosis), Defects like scale and sludge formation, Caustic embrittlement, Corrosion, Priming and foaming caused in boilers by impure water and their remedies.

Waste water characteristics, Waste water treatment, Flowchart of waste water treatment plant: Sedimentation, Coagulation Flocculation, Settling tanks, Disinfection (Chlorination, UV, Ozonization).

UNIT-II: Green Chemistry (10 hours)

Introduction and basic principles, Designing of a green chemical syntheses, Green solvents and catalysts in organic synthesis, The revolution in biology in relation to green chemistry, Feedstocks: Maximum utilization of renewable and biological materials, green chemistry in sustainable development.

UNIT-III: Fuel Chemistry (12 hours)

Classification of fuels and their calorific value.

(a) **Coal:** Composition, Carbonization, Coal gas, Producer gas and water gas, Uses of coal tar based chemicals, Coal gasification (Hydro Gasification and Catalytic gasification).

(b) **Petroleum:** Composition of crude petroleum, Refining and different types of petroleum products and their applications, Fractional distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), Advantages of gaseous fuel over solid and liquid fuel, Classification of three stages of fuel used in cryogenic engines

UNIT-IV: Polymer (10 hours)

Classification, Preparation, Structure, Properties and applications of the polymers, (Polyolefins, Polystyrene) and styrene copolymers, Poly (vinyl chloride), Poly (vinyl acetate), Acrylic polymers, Fluoro Polymers, Polyamides, Phenol formaldehyde Resins (Bakelite, Novalac), Polyurethanes, Silicone Polymers, Conducting Polymers, Biomedical polymers: implants, contact lens and dental polymers.

UNIT-V: Drugs and Agrochemicals (14 hours)

(a) **Drugs:** Drugs classes and side effects: Analgesics agents, Antipyretic agents, Anti-inflammatory agents (Aspirin, paracetamol, Ibuprofen); Antibiotics (Chloramphenicol); antibacterial and antifungal agents (sulphonamides; sulphamethoxazol, sulphacetamide, trimethoprim); Antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone).

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Semester - IVth
Syllabus for the examination to be held in May 2025, May 2026 & May 2027

(b) **Agrochemicals:** Definition, importance and general classification of agrochemicals, Classification of pesticides on chemical nature and according to target species and mode of action, Physical and chemical properties, Degradation, Mode of action, Uses and toxicity of Organophosphorus like Acephate, Dimethoate, Chlorpyrifos, Temephos, Quinolphos, methyl parathion; Organochlorines like Endosulfan and Carbamate like Cartap hydrochloride.

BOOKS RECOMMENDED

1. B.S.N. Raju, *Water Supply and Wastewater Engineering*, Tata Mcgraw Hill Publishing Co Ltd, 2001.
2. Kent James A. (ed.), *Reigel's Handbook of Industrial Chemistry*, Kluwer Academic/Plenum Publishers, 10th edition, New York.
3. V.K. Ahluwalia & M.R. Kidwai: *New Trends in Green Chemistry*, Anamalaya Publishers (2005).
4. Seymour/Carraher's *Polymer Chemistry: Sixth Edition, Revised and Expanded*, Charles E Carraher, Jr. Marcel Dekker, inc. New York.
5. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
6. Shreve R.N. Brink. J.A., *Chemical Process Industries*, International student edition, Pubs: McGraw Hill Book Co. New York, 1960.
7. Melnikov N.N., *Chemistry of Pesticides*, Pubs: Springer-Verlag, New York, 1971.
8. Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan, Pitampura, New Delhi.
9. *Agricultural insect pests of the topics and their control*-D.S.Hill, Cambridge Univ. Press, 1983.
10. *Chemistry of Insecticides and Fungicides*: U.S. Shree Ramulu Oxford & IBH Pub., 2nd, 1995.

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Semester - 10th

Syllabus for the examination to be held in May 2025, May 2026 & May 2027

Course Code: PSCHDE431
Title: Project in Inorganic Chemistry
Credits: 08
No. of hours: 240

Nature of Course: Elective

Maximum Marks: 200

Course Outcome: The Projects have been designed so as to provide exposure to students in various experimental aspects of Inorganic Chemistry. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

The students will be assigned mentor under whose guidance they have to complete a project based on the research work. In the end of the semester, the students have to submit a project report in the form of dissertation.

Evaluation Scheme: Project examination consists of two parts – Internal and External. Internal part is 50% of the total marks and external is 50% of the total marks.

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Semester-IVth

Syllabus for the examination to be held in May 2025, May 2026 & May 2027

Course Code: PSCHDE432
Title: Project in Organic Chemistry
Credits: 08
No. of hours: 120

Nature of Course: Elective
Maximum Marks: 200

Course Outcome: The Projects have been designed so as to provide exposure to students in various experimental aspects of Organic Chemistry. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

The students will be assigned mentor under whose guidance they have to complete a project based on the research work. In the end of the semester, the students have to submit a project report in the form of dissertation.

Evaluation Scheme: Project examination consists of two parts – Internal and External. Internal part is 50% of the total marks and external is 50% of the total marks.

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Semester - IVth.
Syllabus for the examination to be held in May 2025, May 2026 & May 2027

Course Code: PSCHDE433
Title: Project in Physical Chemistry
Credits: 08
No. of hours: 120

Nature of Course: Elective

Maximum Marks: 200

Course Outcome: The Projects have been designed so as to provide exposure to students in various experimental aspects of Physical Chemistry. After completing this course, students will be employable in R & D divisions of Industries Research and Academic Institutes.

The students will be assigned mentor under whose guidance they have to complete a project based on the research work. In the end of the semester, the students have to submit a project report in the form of dissertation.

Evaluation Scheme: Project examination consists of two parts – Internal and External. Internal part is 50% of the total marks and external is 50% of the total marks.

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