



# UNIVERSITY OF JAMMU

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

Academic Section

Email: [academicsectionju14@gmail.com](mailto: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 and2027	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](http://www.jammuuniversity.ac.in)

*Anju Basu*  
DEAN, ACADEMIC AFFAIRS

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

*Sumit*  
29/9/23  
*AS*  
08/9/23  
*M*  
08/9/23

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*

*Dr. S. K. Singh*

*Dr. S. K. Singh*

*Dr. S. K. Singh*

*Dr. S. K. Singh*

**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 - 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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*S. M.*

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*ds*

# 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

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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# 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  $\sigma$  and  $\pi$  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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A large 'X' mark, a signature, and the name 'Anurag'.

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S. Me

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Manshu

# 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 (3<sup>rd</sup> 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 (4<sup>th</sup> edition, 2015).
11. Organic Chemistry, Stanley H. Pine, Tata McGraw Hill (5<sup>th</sup> Edition, 2007).

## PATTERN OF EXAMINATION

Examination (Theory)	Syllabus to be covered in exam	Time allotted for the exam	Maximum Marks
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**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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**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 - 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  $\text{H}_2\text{O}$ ,  $\text{NH}_3$  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 ( $\lambda_{\text{max}}$ ) of the complex formed between  $\text{Fe}^{2+}$  and 1,10-phenanthroline and determine concentration of ferrous ion in a sample from calibration curve.
  10. Determine composition of  $\text{Fe}^{3+}$  - salicylic acid complex in solution by Job's Method.
  11. Determine composition of  $\text{Fe}^{3+}$  -  $\text{NCS}^-$  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, 7<sup>th</sup>Edn., 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.

Cannizaro 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.

 

   