M.Sc. Chemistry

Scheme and Syllabus

Outcome Based Education System (OBES)/
Learning Outcomes based Curriculum Framework (LOCF)

Choice Base Credit System (CBCS)

ACADEMIC SESSION

(w.e.f. 2026-2027)

DEPARTMENT OF CHEMISTRY

FACULTY OF SCIENCES

J C BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA,
FARIDABAD HARYANA -121006

J C BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

VISION

J C BOSE University of Science and Technology, YMCA aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres which transforms the life of students through integration of teaching, research and character building.

MISSION

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the art technological exposure to its scholars.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities

DEPARTMENT OF CHEMISTRY

VISION

To develop into a department that can effectively harness its multispecialty strengths to create an academically stimulating atmosphere; evolving into a well-integrated system by developing in students heightened intellectual, cultural, ethical, and humane sensitivities; to foster a scientific temper, and to promote professional and technological expertise.

MISSION

- To create well-rounded individuals ready to comprehend scientific and technical challenges offered in the area of specialization.
- To awaken the young minds and discover their talents both in theory and in practical chemistry, through dedication to teaching, commitment to students and innovative instructional methods.
- To encourage critical thinking and develop research acumen by aiding the nascent spirit for scientific exploration.
- To infuse intellectual audacity that makes them take bold initiatives to venture into alternative methods and modes to achieve technological breakthroughs.
- Lead in fostering solutions to problems of global significance by collaborating across many disciplines both within and external to University.

ABOUT THE PROGRAM: M.Sc. Chemistry

Chemistry is a fundamental science and has contributed immensely to the improvement of the life of human beings by providing many of human requirements and essentialities. The developments in Chemistry during last few decades are phenomenal. New branches of chemistry are emerging and gaining importance, such as bioorganic chemistry, materials chemistry, computational chemistry, etc. The practice of Chemistry at industrial scale also is undergoing radical changes and is more and more based on deep understanding the chemical phenomena. The emerging Chemical Technologies are highly science based. The aid of computers has not only accelerated growth in the practice of Chemistry, but revolutionized the entire field. A Chemist cannot isolate himself from other disciplines. Thus, after a long span of more and more specialization in graduate and post-graduate syllabi, a symbiotic interdisciplinary approach now seems to be more relevant.

PROGRAM OUTCOMES OF PG PROGRAM OF FACULTY OF SCIENCES

PO1	**Knowledge**	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
PO2	**Research Aptitude**	Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis
PO3	**Communication**	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large
PO4	**Problem Solving**	Capability of applying knowledge to solve scientific and other problems
PO5	**Individual and Team Work**	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
PO6	**Investigation of Problems**	Ability of critical thinking, analytical reasoning and research-based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PO7	**Modern Tool usage**	Ability to use and learn techniques, skills and modern tools for scientific practices
PO8	**Science and Society**	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices
PO9	**Life-Long Learning**	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
PO10	**Ethics**	Capability to identify and apply ethical issues related to one's work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work
PO11	**Project Management**	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

PROGRAM SPECIFIC OUTCOMES (PSOs)

The program specific outcomes (PSO's) are the statement of competencies/abilities that describes the knowledge and capabilities of the post-graduate will have by the end of program studies.

After successful completion of M. Sc. Chemistry, the students will be able to

PSO1	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry.
PSO2	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.
PSO3	To understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.
PSO4	Provide opportunities to excel in academics, research or Industry.

J C BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

DEPARTMENT OF CHEMISTRY

SCHEME M.Sc. CHEMISTRY

SEMESTER I

Subject Code	Title	Teaching Hours per week			Maximum Marks			Credits	Category Code
		L	T	P	Sessional Marks	End-semester Examination	Total Marks		
CHP-101-V1	Inorganic Chemistry (General-I)	4			40	60	100	4	DCC
CHP-103-V1	Organic Chemistry (General-I)	4			40	60	100	4	DCC
CHP-105-V1	Physical Chemistry (General-I)	4			40	60	100	4	DCC
CHP-107-V1*	Mathematics for Chemists	3			40	60	100	3	FC
CHP-109-V1*	Chemistry of life processes	3			40	60	100	3	FC
CHP-111-V1	Inorganic Chemistry Lab-I			6	50	50	100	3	DCC
CH-113-V1	Organic Chemistry Lab-I			6	50	50	100	3	DCC
CH-115-V1	Physical Chemistry Lab-I			6	50	50	100	3	DCC
XXX	MOOC**								
	Total	**18**		**18**			**700**	**24**	

DCC – Discipline Core Course; FC – Foundation Course; MOOC – Massive Open Online Course
L – Lecture; T - Tutorial; P - Practical

* Candidates with Biology background will appear for CHP-107V1 and Candidates with Mathematical background will appear for CHP-109-V1

**The students have to pass at least one mandatory MOOC course with 4-6 credits (12-16 weeks) from the list given on the Swayam portal or the list given by the Department/ University from 1st semester to 3rd semester as notified by the University. (Instructions to students overleaf)

J C BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

DEPARTMENT OF CHEMISTRY

SCHEME M.Sc. CHEMISTRY

SEMESTER II

Subject Code	Title	Teaching Hours per week			Maximum Marks			Credits	Category Code
		L	T	P	Internal Assessment	End-semester Examination	Total Marks		
CHP-102-V1	Inorganic Chemistry (General-II)	4			40	60	100	4	DCC
CHP-104-V1	Organic Chemistry (General-II)	4			40	60	100	4	DCC
CHP-106-V1	Physical Chemistry (General-II)	4			40	60	100	4	DCC
CHP-108-V1*	Computational Techniques	3			40	60	100	3	FC
CHP-110-V1	Chemistry of Supramolecules	3			40	60	100	3	FC
CHP-112-V1	Inorganic Chemistry Lab-II			4	50	50	100	2	DCC
CHP-114-V1	Organic Chemistry Lab-II			4	50	50	100	2	DCC
CHP-116-V1	Physical Chemistry Lab-II			4	50	50	100	2	DCC
CHP-118-V1	Seminar	1			50	--	50	1	SEC
AEC-306-V1	Modern Science Writing and Journalism	2	0	0	40	60	100	0	AUD
	Total	**18**		**12**			**700**	**21**	

- DCC – Discipline Core Course; FC – Foundation Course ; SEC – Skill Enhancement Course; AUD-Audit Course; L – Lecture; T – Tutorial; P - Practical
- **provided by the Department/ University along with subject code and syllabus. Only passing of the Audit course is mandatory.

Instructions to the students regarding MOOC

1. Two types of courses will be circulated: branch-specific and general courses from the website https://swayam.gov.in or https://nptel.ac.in/ in the month of June and November every year for the forthcoming semester.
2. The department coordinators will be the course coordinators of their respective departments.
3. Every student has to pass a selected MOOC course within the duration as specified below:

Programme	**Duration**
B. Tech.	Sem. I to Sem. VII
M.Sc./M.Tech./M.A./MBA	Sem. I to Sem. III
B.Sc./MCA	Sem. I to Sem. V

The passing of a MOOC course is mandatory for the fulfillment of the award of the degree of concerned programme.

4. A student has to register for the course for which he is interested and eligible which is approved by the department with the help of the course coordinator of the concerned department.
5. A student may register in the MOOC course of any programme. However, a UG student will register only in UG MOOC courses and a PG student will register in only PG MOOC courses.
6. The students must read all the instructions for the selected course on the website, get updated with all key dates of the concerned course, and must inform his/her progress to their course coordinator.
7. The student has to pass the exam (online or pen-paper mode as the case may be) with at least 40% marks.
8. The students should note that there will be a weightage of Assessment/quiz etc. and final examination appropriately as mentioned in the instructions for a particular course.
9. A student must claim the credits earned in the MOOC course in his/her marksheet in the examination branch by forwarding his/her application through the course coordinator and chairperson.

M.Sc. CHEMISTRY SEMESTER I
CODE: CHP-101-V1
SUBJECT NAME: INORGANIC CHEMISTRY (GENERAL-I)
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 40
			FINAL EXAM	: 60
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 8 questions of equal marks covering the entire syllabus. Any four questions have to be attempted out of six from Part-2.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: Understand symmetry, group theory, and Stereochemistry
CO2: Understand Metal-Ligand Equilibria in solution
CO3: Understand the bonding concepts involved in Coordination compounds
CO4: Utilize this knowledge for complex formation of research interest.

UNIT-I: Symmetry and Group Theory in Chemistry-I

Definitions of group, subgroup, relation between orders of a finite group and its subgroup. Conjugacy relation and classes. Symmetry elements and symmetry operation, Point symmetry group. Schönflies symbols, representations of groups by matrices (representation for the *Cn, Cnv, Cnh, Dnh* etc. groups to be worked out explicitly).

UNIT-II: Symmetry and Group Theory in Chemistry-II

Character of a representation, reducible and irreducible representations, The great orthogonality theorem (without proof) and its importance, Derivation of character tables of *C2v, C3v* and *D2h* Character tables and their use. Molecular asymmetry, dissymmetry and optical activity.

UNIT-III: Metal-Ligand Equilibria in solution

Stepwise and overall formation constants and their interactions, trends in stepwise constants, factors affecting 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 and spectrophotometry. Substitution reactions in octahedral complexes, theories of trans effect with respect to Pt(II) complexes, brief account of electron transfer reactions, inert and labile complexes.

UNIT-IV: Bonding in Main Group compounds and Metal-Ligand Bonding

VSEPR theory, dπ–pπ bonds, Bent rule and energetic of hybridization. Walsh Diagram, Limitation of crystal field theory, crystal field effects, John Teller distortion, nephelauxetic series, molecular orbital theory of octahedral, tetrahedral and square planar complexes (with and without π - bonding).

REFERENCE BOOKS:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.

2. Inorganic Chemistry, J.E. Huhey, Harper & Row.
3. Chemical Applications of Group Theory; F.A. Cotton, Wiley, New York.
4. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
5. The Chemical bond; J.N.Murre l, SFA Kettle and JM. Tedder; Wiley, New York.
6. Modern Aspects of Inorganic Chemistry; H.J. Emeleus and Sharpe.
7. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDanie l and. J.J.Alexander; John Wiley and Sons.
8. Inorganic Chemistry, A Modern Introduction; T Moeller, John Wiley and Sons.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for CH-101B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3
CO4	3	3	3	3	2	3	3	3	3	3	3	3	3	2	3

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

M.Sc. CHEMISTRY SEMESTER I
CODE: CHP-103-V1
SUBJECT NAME: ORGANIC CHEMISTRY (GENERAL-I)
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	**:** 40
			FINAL EXAM	: 60
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 8 questions of equal marks covering the entire syllabus. Any four questions have to be attempted out of six from Part-2.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1 Describe reaction intermediates, energy profile diagrams and establish mechanism of organic reaction simultaneously understand effect of structure on reactivity and application of Hammett /Taft equations, Curtin-Hammett principles, Hammond postulates in theoretical treatment of organic reactions.

CO2 Understand mechanistic details of different types of and factors affecting aliphatic nucleophilic substitution reactions and the terminology involved therein.

CO3 Master stereo-chemical terms, inter-convert stereo-structural formulae of organic molecules, analyze configurations, create stereo-structures and correlate configuration by applying the concept of chemical correlation.

CO4 Realize the concepts of prochirality, topicity and related terms, asymmetric synthesis, application of Cram's, Prelog and Horeaus rule.

CO5 Describe stability of different configurations and conformations of acyclic and cyclic organic compounds, sugars, decalins.

UNIT-I:

Reaction Mechanism: Structure and Reactivity

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, effect of structure on reactivity - resonance and field effects, steric effect, quantitative treatment-The Hammett equation and linear free energy relationship, substituent and reaction constants and Taft equation. Kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining reaction mechanisms. Generation, structure, stability and reactivity of carbocations, carbanions, carbenes and nitrenes.

UNIT-II:

Aliphatic Nucleophilic Substtitution:

The SN^2, SN^1, mixed SN^1 and SN^2, SN^i, $SN^{1'}$, $SN^{2'}$, $SN^{i'}$ and SET mechanisms. Reactivity- Effects of substrate structure, attacking nucleophile, leaving group and reaction medium. Ambident nucleophile, regioselectivity. The neighbouring group mechanisms, neighbouring group participation by n electrons, π and σ bonds, Anchimeric assistance. Classical and nonclassical carbocations, phenonium ions, Common carbocation rearrangements.

UNIT-III:

Stereochemistry-I:

Symmetry elements, D-L, R-S, E-Z and threo-erythro nomenclature, interconversion of Fischer, Newman, Sawhorse and flying wedge formulae. conformational analysis, enantiomerism and diastereomerism of simple, cyclic (chair and boat configuration) and acyclic systems. Axial and planer chirality, optical somerism in allenes, biphenyls (atropoisomerism), spiranes, hemispiranes. elementary ideas about stereochemistry of tertiary amines, quaternary salts, sulphur and phosphorous compounds.

UNIT-IV:

Stereochemistry – II:

Topicity of ligands and faces, their nomenclature and prostereoisomerism, stereogenecity, chirogenicity, pseudoasymmetry and prochiral centre. stereospecific and stereoselective reaction.
Elementary idea of principle categories of asymmetric synthesis, Cram's rule and its modification, Prelog rule and horeaus rule.

Stereochemistry of sugars- C1 and 1C conformations of hexoses, c_2'-endo and c_3'-endo conformation of pentoses, homomorphous sugars, abnormal mutarotation and Δ-2 instability factor. Stereochemistry of decalins,

Chemical correlation of configuration -determination of relative configuration of 2-butanol, isoserine, alanine, malic acid, lactic acid and mandelic acid.

REFERENCE BOOKS:

1. Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice -Hall.
6. Modern Synthetic Reactions, H. O. House, Benjamin.
7. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional.
8. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.
9. Organic Chemistry, J. Clayden, N. Greeves, S.Warren, P. Wothers, Oxford Press.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for CH-102B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO2	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**1**	**3**
CO4	**2**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**1**

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

M.Sc. CHEMISTRY SEMESTER I
CODE: CHP-105-V1
SUBJECT NAME: PHYSICAL CHEMISTRY (GENERAL-I)
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 40
			FINAL EXAM	: 60
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 8 questions of equal marks covering the entire syllabus. Any four questions have to be attempted out of six from Part-2.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:
CO1: Handle the thermodynamics of a chemical process.
CO2: Understand the basic concept of quantum mechanics.
CO3: Understand the basic concept of statistical mechanics.
CO4: Apply Schrödinger equation for various chemical systems.

UNIT-I: Quantum Mechanics - I
The postulates of quantum mechanics, Linear and Hermitian operators. Commutation of operators and Uncertainty Principle. Schrödinger equation, eigen function and eigen values, free particle, Schrödinger equation for a particle in a box, the degeneracy, particle in a box with a finite barrier, Schrödinger equation for linear harmonic oscillator and its solution, zero-point energy, Energy levels and wave-functions of Rigid rotator. Quantum Mechanical Tunneling: Tunneling through a rectangular barrier.

UNIT-II: Quantum Mechanics – II
Quantum-mechanical treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy. Radial and angular parts of the hydrogen atom wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals. Radial and angular nodes and their significance. Average and most probable distances of electron from nucleus. Shapes of s, p and d atomic orbitals, nodal planes. Angular momentum and its directional quantization, Angular momentum operators, commutation relation.

UNIT-III: Thermodynamics
Brief recapitulation of first and second Law of thermodynamics. Entropy changes in reversible and irreversible processes; variation of entropy with temperature, pressure and volume, entropy concept as a measure of unavailable energy and criteria for the spontaneity of reaction; entropy of mixing; free energy functions and their significance, criteria for spontaneity of a process; partial molar quantities (Chemical Potential, free energy, volume, heat concept), Gibb's-Duhem equation. Concept of Fugacity, Activity, and their applications

UNIT-IV: Statistical Mechanics

Ensemble averaging, postulates of ensemble averaging. Microcanonical, canonical and grand canonical ensembles, corresponding distribution laws (using Lagrange's method of undetermined multipliers). Distinguishable and Indistinguishable/ Identical Particles. Maxwell-Boltzmann statistics, Boltzmann distribution, derivation of the Boltzmann distribution expression, determination of the Boltzmann constant, Maxwell distribution law of velocities from Boltzmann distribution expression. Quantum statistics: Bose-Einstein statistics and Fermi-Dirac statistics, Bose-Einstein condensation & distribution function. Derivation of Fermi-Dirac distribution function and its comparison.

REFERENCE BOOKS:

1. D. A. McQuarrie and J. D. Simon, "Physical Chemistry. A Molecular Approach" University Science Books, Sausalito 1997
2. Attila Szabo and Neil S. Ostlund, "Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory" Dover Books on Chemistry, 1996
3. D. A. McQuarrie, "Quantum Mechanics" University Science Books, Mill Valley, CA, 1983
4. D. A. McQuarrie, "Statistical Mechanics" Viva Books Pvt. Ltd.: New Delhi, 2003
5. P.W. Atkins and Julio de Paula, "Physical Chemistry", 8th Ed., W. H. Freeman Publication, 2006.
6. G.M. Barrow, "Physical Chemistry" Tata McGraw-Hill Education, 2008.
7. R.K. Prasad, "Quantum Mechanics" New Age Publication, 2009.
8. Engel, T. & Reid, P. Physical Chemistry 3rd Ed. Pearson (2013).

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for CH-103B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**3**	**3**	**3**
CO2	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**1**	**2**	**2**	**3**	**3**	**3**
CO3	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**1**	**2**	**2**	**3**	**3**	**3**

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

M.Sc. CHEMISTRY SEMESTER I
CODE: CHP-107-V1
SUBJECT NAME: MATHEMATICS FOR CHEMISTS
NO. OF CREDITS: 3

L	T	P		
			SESSIONAL	: 40
			FINAL EXAM	: 60
3	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 8 questions of equal marks covering the entire syllabus. Any four questions have to be attempted out of six from Part-2.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:
CO1: solve numerical problems of chemistry.
CO2: explain deviations of theories and principles.
CO3: handle concepts of computational chemistry and modelling
CO4: do mathematical treatment of chemistry problems

UNIT: I
Vectors: Examples of scalar and vectors, definitions of vectors in two, three spaces, representation and simple properties of vectors, addition and subtraction of vectors, vector addition by the method of triangles, resolution of vectors into rectangular components, addition of vectors by components, multiplication and differentiation of vectors. Scalar product of vectors, vector product
Matrices and Determinants: Definition of matrix, types of matrices, viz. row matrix, column matrix, null matrix, square matrix, diagonal matrix, addition, subtraction and multiplication by a number, matrix multiplication. Transpose and adjoint of matrix, elementary transformation, representation and applications (without development of theory) to solution of linear equations. Definition, properties and evaluation of determinants.

UNIT: II
Logarithm: definition of logarithm, common logarithms, natural logarithms, laws of logarithm, expressing the logarithm of a number, simplifying expressions using laws of logarithm, change of base, calculating antilogs.
Graphical Representation of Equations: Rectangular coordinates, straight lines, slope and intercept of the equation, slope and point equation, two point equation, parallel lines , points of intersection, distance between two points, change of origin. Curve fitting for least squares method.

UNIT: III
Differential Calculus: Theory, rules of differentiation, powers, added and subtracted functions, constants, products, quotients, functions of a function, logarithmic differentiation, and parametric functions. Algebraic simplification, differentiation of implicit functions, graphical significance of differentiation, rate of change of slope, successive differentiation.
Partial Differentiation: The fundamental theorem, geometrical significance of partial differentiation, special cases of fundamental theorem, successive partial differentiation. Integral

transforms (Fourier and Laplace). Reduction formulae. Methods of Lagrangian multipliers, Sterling's approximation, probability and errors.

UNIT: IV

Integral Calculus: Integral theory, rules of integration between limits, significance of 'e' exponential equations, methods of integration, viz. algebraic simplifications, substitution, integration by parts, integration by partial fractions, coordinate transformation (e.g., cartesian to spherical polar), curve sketching, integral as area

Reference Books

1. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill.
2. Mathematical Preparation for General Physics, J.B. Marian, R.C. Davidson Saunder Company.
3. Mathematical Methods for Science Students, G. Stephemen, ELBS.
4. Chemical Thermodynamics, R.C. Reid.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for CH-104X-B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**3**	**3**	**3**
CO2	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**1**	**2**	**2**	**3**	**3**	**3**
CO3	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**1**	**2**	**2**	**3**	**3**	**3**

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

M.Sc. CHEMISTRY SEMESTER I
CODE: CHP-109-V1
SUBJECT NAME: CHEMISTRY OF LIFE PROCESSES
NO. OF CREDITS: 3

L	T	P		
			SESSIONAL	: 40
			FINAL EXAM	: 60
3	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 8 questions of equal marks covering the entire syllabus. Any four questions have to be attempted out of six from Part-2.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: Understand the metabolism and energy cycle of living beings.
CO2: Corelate the metabolism of a body and chemical reactions responsible for it.
CO3: Predict biochemistry of any metabolism
CO4: Solve problems of genetic engineering.

UNIT: I

Introduction to metabolic processes: Catabolism and anabolism, ATP, currency of biological energy, energy rich and energy poor phosphates, role of NADH, NADPH, FADH2, TPP, coenzyme A, lipoic acid and biotin. Introduction to photosynthesis.

UNIT: II

Carbohydrates

Structure (excluding conformational analysis) and biological functions of monosaccharides (glucose, fructose and galactose) and their derivatives like glycosides, deoxy sugars, myoinositol. Disaccharides- sucrose, lactose and maltose.

Structure and biological functions of Structural polysaccharides (cellulose and chitin) and Storage polysaccharides (starch and glycogen) Heteropolysaccharides-Glucosaminoglycans / mucopolysaccharides.

UNIT: III

Lipids: Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Lipoproteins - composition and function, role in atherosclerosis.

Lipid metabolism - β-oxidation of fatty acids.

Protiens: Primary, secondary, tertiary and quaternary structures, enzymes, active sites, allosteric sites and mechanism of their action, e.g. Chymotrypsin

UNIT: IV

Nucleic Acids and Genetic Code: Structure of nucleotides, nucleosides, DNA (Watson-Crick model) and RNA, Replication of DNA (semi-conservative, conservative and dispersive replication

Maselson-Stahl experiment), transcription, translation of genetic material, genetic code, universality of the code, codon, anticodon pairing.

Reference Books

1. Principles of Biochemistry, A. L. Lehninger, Worth Publishers.
2. Biochemistry, L.Stryer, W.H.Freeman.
3. Biochemistry, J. David Rawn, Neil Patterson.
4. Biochemistry, Voet and Voet, John Wiley.
5. Outlines of Biochemistry, E. E.Conn and P. K. Stumpf, John Wiley.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for CH-104Y-B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**3**	**3**	**3**
CO2	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**1**	**2**	**2**	**3**	**3**	**3**
CO3	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**1**	**2**	**2**	**3**	**3**	**3**

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

M.Sc. CHEMISTRY SEMESTER I
CODE: CHP-111-V1
SUBJECT NAME: INORGANIC CHEMISTRY LAB-I
NO. OF CREDITS: 3

			SESSIONAL	: 50
L	T	P	FINAL EXAM	: 50
0	0	6	TOTAL	: 100

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: Fundamental understanding of Qualitative Analysis
CO2: identify a given mixture of inorganic salts qualitatively by experiments.
CO3: interpretation of the results
CO4: to learn comprehensive laboratory techniques

Qualitative Analysis:

Less common metal ions- W, Tl, Mo, Se, Ti, Zr, Th, V, U, Ce, Be. (two metal ions in cationic/anionic forms)

Insolubles- Oxides (Al_2O_3, Cr_2O_3, SnO_2, TiO_2, SiO_2 WO_3,); Sulphates (Lead Sulphate, Barium Sulphate Strontium Sulphate and Calcium Sulphate); Halides (Calcium fluoride and silver halides) (2 less common metal ions and 1 insoluble to be given)

Titrations:

Cerimetric / Iodometric / Oxidimetry titrations.

Experiment: 20 marks
Lab Record: 10 marks
Viva-voce: 20 marks

REFERENCE BOOKS:

1. A Text Book of Macro and Semi-micro Quantitative Analysis, A.I.Vogel, Orient Longman.
2. A Vogel's Text Book of Quantitative Inorganic Analysis, J. Bassett, R.C. Denney, G.B. Jaffery and J. Menaham, Longman, London.
3. Synthesis and Characterization of Inorganic Compounds, W.B. Jolly, Prentice Hall, Englewood.
4. Synthesis and Physical Studies of Inorganic Compounds, C.F. Bell, Pergamon Press
5. Inorganic Preparations; W.G. Palmer.
6. Virtual Lab - https://vlab.amrita.edu

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for CH-105B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	2	2	2	3	3	2	2	3	3	2	3
CO2	3	2	3	2	3	3	2	2	3	3	2	3	2	3	2
CO3	3	3	3	2	3	2	3	3	2	3	3	2	3	3	2
CO4	2	3	3	3	3	2	3	3	2	3	3	3	3	2	2

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

M.Sc. CHEMISTRY SEMESTER I
CODE: CHP-113-V1
SUBJECT NAME: ORGANIC CHEMISTRY LAB-I
NO. OF CREDITS: 3

			SESSIONAL	: 50
L	T	P	FINAL EXAM	: 50
0	0	6	TOTAL	: 100

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: analyse a given mixture of compounds qualitatively in laboratory.
CO2: synthesise various organic compounds in laboratory.
CO3: analyse the monofunctional compounds.
CO4: analyse common name reactions in laborartory.
CO5: analyse the bifunctional compounds.

Experiments

- Qualitative analysis of mono and bi-functional compounds.
- Synthesis of organic compounds involving some of the following reactions: acylation reaction, Oxidation and reductions, Coupling reactions, Diels-Alder reaction, Nucleophilic substitution reaction, Condensation reaction, Diazotization reactions.

Experiment: 20 marks
Lab Record: 10 marks
Viva-voce: 20 marks

REFERENCE BOOKS:

1. A Hand book of Organic Analysis -Qualitative and Quantitative by H.T. Clarke, and revised by B.Haynee, Edward Arnold, London 1975.
2. Vogel's Text Book of Practical Organic Chemistry by B.S. Furhen et. al, Longman-Group Ltd.
3. Systematic Qualitative Organic Analysis by H. Middleton, Edward Arnold (Publishers) Limited, London 1959.
4. Elementary Practical Organic Chemistry by Arthur I. Vogel, Ex CBS Publishers and Distributors.
5. Experiments in Organic Chemistry by Louis, F.Fieser, D.C. Heath and Company Boston, 1955.
6. Virtual Lab - https://vlab.amrita.edu

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for CH-106B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**3**	**3**	**2**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

M.Sc. CHEMISTRY SEMESTER I
CODE: CHP-115-V1
SUBJECT NAME: PHYSICAL CHEMISTRY LAB-I
NO. OF CREDITS: 3

			SESSIONAL	: 50
L	T	P	FINAL EXAM	: 50
0	0	6	TOTAL	: 100

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:
CO1: Handle electrodes, conductivity meter and pH meter to perform physical property analysis.
CO2: Determine rate and estimate molecular mass of polymer system.
CO3: Determine rate constant for various chemical reactions.
CO4: Determine the viscosity of liquids.

1. **Conductometry**
   - i. Determine the strength of strong acid by conductometric titration with strong base.
   - ii. Determine the strength of weak acid by conductometric titration with strong base.
   - iii. Determine the strength of strong acid and weak acid in a mixture by conductometric titration with strong base.
   - iv. Study precipitation titration between KCl and $AgNO_3$ conductometrically.
   - v. Determine the basicity of mono-, di-, and tri- basic acids conductometrically.
   - vi. Determine solubility and solubility product of sparingly soluble salts like PbSO4, $BaSO_4$.

2. **pH-metry**
   - i. Determine the strength of strong acid by pH-metric titration with strong base.
   - ii. Determine the strength of weak acid by pH-metric titration with strong base.
   - iii. Determine the dissociation constant of acetic acid using pH-meter.

3. **Chemical Kinetics**
   - i. Study the hydrolysis of methyl acetate in presence of hydrochloric acid.
   - ii. Study saponification of ethyl acetate by sodium hydroxide solution taking the initial concentration of ester and base to be different.

4. **Viscosity**
   - i. Determine the viscosity of liquids (environment friendly) using Ostwald viscometer.
   - ii. Study the variation of viscosity with concentration for a glycerol solution using Ostwald viscometer and thereafter determine the concentration of unknown solution of glycerol.
   - iii. Determination of molar mass of a polymer.

Experiment: 20 marks

Lab Record: 10 marks
Viva-voce: 20 marks

REFERENCE BOOKS:

1. R.C. Das and Behera 'Experiments in Physical Chemistry' Tata McGraw- Hill, 1983.
2. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).
3. F. Daniel, 'Experimental physical Chemistry' McGraw Hill 1962.
4. M. Jaffar, 'Experimental Physical Chemistry' University Grants Commission 1989.
5. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
6. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
7. J.B. Yadav, "Advanced Practical Physical Chemistry" 29th Ed. Krishna Prakashan Media (p) Ltd, 2010.
8. J. N. Gurtu, Amit Gurtu, "Advanced Physical Chemistry Experiments" Pragati Prakashan, 2008.
9. Virtual Lab - https://vlab.amrita.edu

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lab demonstration, experimentation discussion, assignments, quizzes; **LMS/ICT Tools:** Virtual Labs, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for CH-107B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**3**	**3**	**3**	**3**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**1**	**2**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**1**	**2**	**3**	**3**	**3**	**3**

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

M.Sc. CHEMISTRY SEMESTER II
CODE: CHP-102-V1
SUBJECT NAME: INORGANIC CHEMISTRY (GENERAL-II)
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 40
			FINAL EXAM	: 60
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 8 questions of equal marks covering the entire syllabus. Any four questions have to be attempted out of six from Part-2.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: Correlate structure of a metal compound and its magnetic properties.
CO2: Design a complex with required magnetic properties.
CO3: Explore more about complexes like boranes, carboranes, metal carbonyl etc and their applications.
CO4: Insights and behaviour of metal clusters

UNIT-I: Electronic Spectra and Magnetic Properties of Transition Metal Complexes -I

Electronic arrangements of microstates, calculation of the number of microstates in various electronic arrangements, spectroscopic term symbols, vector diagrams to indicates coupling of orbital angular momenta in p^2, p^3, d^2 configurations and spin orbit coupling for p^2 arrangement, spectroscopic terms, spectral terms of d^2 to d^8 metal ions, determining the ground state terms - Hund's rules, derivation of the term symbol for a closed subshell.

UNIT-II: Electronic Spectra and Magnetic Properties of Transition Metal Complexes -II

Interpretation of electronic spectra, Orgel diagrams, Tanabe-Sugano diagrams for transition metal complexes (d^1 –d^9 states), calculations of Dq, B and β parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, magnetic moment calculations spin only, orbital contribution quenching of magnetic moment, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

Circular Dichroism and Optical Rotatory Dispersion

Polarized light, fundamental symmetry requirements, for optical activity, interaction of polarized light with optically active matter, optical rotation, Cotton effect, configuration of Tris -chelated complexes.

UNIT-III: Metal л-Complexes

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 nitrosyl, dinitrogen and dioxygen complexes; Carbonyl cations and anions and carbonyl hydrides; tertiary phosphine as ligand.

UNIT-IV: Metal Clusters

Higher boranes, structure types, nido, arachano, closo etc structure prediction of boranes using styx formulae, Wades rule, Wades Mingo rules, Isolobal analogy, carboranes, metalloboranes and metallocarboranes. Metal carbonyl and halide clusters, compounds with metal-metal

REFERENCE BOOKS:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harper & Row.
3. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
4. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
5. Introduction to Ligand fields; B.N. Figgis, Wiley, New York.
6. Modern Aspects of Inorganic Chemistry; H.J. Emeleus and Sharpe.
7. Introduction to Ligand Field Theory; C. J. Ballahyen, McGraw Hill, New York.
8. Organometallic Chemistry; R.C.Mehrotra and A.Singh, New Age International.
9. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H.McDaniel and J.J.Alexander; John Wiley.
10. The Organometallic Chemistry of the Transit ion Metals; R.H. Crabtree, John Wiley.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for CH-201B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2	3	2	3	3	2	3	3	3	2	3
CO2	3	3	3	3	2	2	2	3	3	3	2	3	3	2	3
CO3	3	2	3	2	3	2	3	3	2	3	3	2	3	3	2
CO4	2	3	3	3	3	2	3	3	2	3	3	2	2	3	3

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

M.Sc. CHEMISTRY SEMESTER II
CODE: CHP-104-V1
SUBJECT NAME: ORGANIC CHEMISTRY (GENERAL-II)
NO. OF CREDITS: 4

L	T	P		
4	0	0	SESSIONAL	: 40
			FINAL EXAM	: 60
			TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 8 questions of equal marks covering the entire syllabus. Any four questions have to be attempted out of six from Part-2.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1 To know the concept of Aromatic Electrophilic Substitution and their applications and to understand the mechanisms of Aromatic Nucleophilic Substitution by diazonium salts, arynes

CO2 To understand the concept of aliphatic electrophilic substitution reaction, carbocation rearrangement and elimination reactions. To know mechanistic details of different types of elimination reactions, Saytzeff and Hoffman rules and application of these in prediction of product formation in various elimination reactions.

CO3 To describe the generation, structure, stability and reactivity of free radicals. To know the mechanisms of addition alkenes and alkynes.

CO4 To study addition to C=O group of aldehydes, ketones and acids. To understand and reactivity of carbonyl compounds in various reactions. To learn various name reactions related to ketones and aldehydes.

UNIT-I:

Aromatic Electrophilic Substitution: The arenium ion, mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Vilsmeir reaction, Gattermann-Koch reaction.

Aromatic Nucleophilic Substitution: The $ArSN^1$, $ArSN^2$, and Benzyne mechanisms. Generation, structure and reaction of arynes. Reactivity – effect of substrate structure, leaving group and attacking nucleophile. The von-Richter, Sommelet-Hauser, and Smiles rearrangements.

UNIT-II:

Aliphatic Electrophilic Substitution: Bimolecular mechanisms - SE2 and SEi. The SE1 mechanism, Electrophilic substitution accompained by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Elimination Reactions: The E2, E1 and E1cB mechanisms. Orientation of the double bond. Reactivity –effects of substrate structures, attacking base, the leaving group and the medium. Stereochemistry of E2 Elimination, Reaction and Eclipsing Effects in E2 Eliminations. Dehydration of Alcohols, Elimination not involving C-H Bonds, Mechanism and orientation in pyrolytic eliminations.

Carbocation Rearrangements: Wagner Meerwin rearrangement, Pinacol-pinacolone rearrangements, Aldehyde-Ketones, Demjanov ring expansion & contraction and Transannular rearrangement.

UNIT-III:

Addition to Carbon-Carbon Multiple Bonds: Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio – and chemo-selectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.

Free Radicals: General aspects of generation, structure, stability and reactivity of free radicals, types of free radical reactions, halogenation including allylic halogenation (NBS), autooxidation, decomposition of azo compounds and peroxides, coupling of alkynes, homolytic aromatic substitution, Sandmeyer reaction and Hunsdiecker react ion.

UNIT-IV:

Addition to Carbon-Hetero Multiple Bonds: Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction. Mechanism of condensation reactions involving enolates – Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters, Reformatsky reaction, Dieckman reaction, Cannizzaro reaction, Robinson-Mannich reaction.

REFERENCE BOOKS:

1. Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice -Hall.
6. Modern Organic Reactions, H. O. House, Benjamin.
7. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional.
8. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.
9. Organic Chemistry, J. Clayden, N. Greeves, S.Warren, P. Wothers, Oxford Press.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for CH-202B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

M.Sc. Chemistry SEMESTER II
CODE: CHP-106-V1
SUBJECT NAME: PHYSICAL CHEMISTRY (GENERAL-II)
NO. OF CREDITS: 4

			SESSIONAL	: 40
L	T	P	FINAL EXAM	: 60
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 8 questions of equal marks covering the entire syllabus. Any four questions have to be attempted out of six from Part-2.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:
CO1: Calculate energy of activation.
CO2: Understand enzyme catalysis.
CO3: Understand and apply electrochemistry.
CO4: Apply adsorption models to various chemical systems.

UNIT-I: Chemical Kinetics I
London-Eyring-Polanyi method of calculation of energy of activation. Application of activated complex theory of reaction rates. Temperature dependence of pre-exponential factor. Thermodynamic aspects of reaction rates. Chain reactions: Photochemical and thermolytic reactions. Steady-state approximation, General treatment of chain reactions (ortho -para hydrogen conversion and hydrogen - halogen reactions), apparent activation energy of chain reactions, chain length, Branching chain reactions leading to explosions; explosion limits, H2 - O2 reaction. Kinetics of one-substrate one-enzyme reactions: Michaelis-Menton treatment, evaluation of Michaelis's constant for enzyme: Lineweaver-Burk plot, Eadie plot. Competitive and Non-competitive Inhibition.

UNIT-II: Electrochemistry - I
Ion - Ion Interactions: The Debye -Huckel theory of ion- ion interactions: potential and excess charge density as a function of distance from the central ion, Debye Huckel reciprocal length, ionic cloud and its contribution to the total potential, Debye – Huckel limiting law of activity coefficients and its limitations, ion - size effect on potential, ion - size parameter and the theoretical mean - activity coefficient in the case of ionic clouds with finite - sized ions. Debye - Huckel -Onsager treatment for aqueous solutions and its limitations Debye- Huckel- Onsager theory for non-aqueous solutions.

UNIT-III: Electrochemistry - II

Ion Transport in solutions: Ionic movement under the influence of an electric field, mobility of ions, ionic drift velocity and its relation with current density, Einstein relation between the absolute mobility and diffusion coefficient, the Stokes- Einstein relation, the Nernst-Einstein equation, Walden's rule, the Rate-Process approach to ionic migration, the Rate process equation for equivalent conductivity, total driving force for ionic transport, Nernst - Planck Flux equation, ionic drift and diffusion potential, the Onsager phenomenological equations. Planck- Henderson equation for the diffusion potential.

UNIT-IV: Surface Chemistry and Porous Materials

Gibb's adsorption equation, Langmuir adsorption isotherm and its kinetic derivation for non-dissociative and dissociative adsorption, BET adsorption isotherm, its kinetic derivation and applications Heterogeneous catalysis, surface heterogeneity, surface catalyzed unimolecular and bimolecular reactions, activation energy for surface reactions. Comparison of homogeneous and heterogeneous reaction rates. Porous Structures, Types of Pores, Porous materials – Metal Organic Frameworks, Current trends, and applications. Hysteresis Curve: Adsorption-Desorption characteristics. Pore size, surface charge interactions with guest molecules and cross-channel pore adsorption.

REFERENCE BOOKS:

1. D. A. McQuarrie and J. D. Simon, "Physical Chemistry. A Molecular Approach" University Science Books, Sausalito 1997.
2. K. J. Laidler and J. H. Meiser, "Physical Chemistry" 3rd Ed. Houghton Mifflin Company, Boston 1999.
3. K. J. Laidler, "Chemical Kinetics" Pearson Education India; 3rd Ed., 2003.
4. Houston, P. Chemical Kinetics and Reaction Dynamics. New York, NY: McGraw-Hill, 2001.
5. Ira N. Levine, "Physical Chemistry" Tata McGraw-Hill Education, 2011.
6. P.W. Atkins and Julio de Paula, "Physical Chemistry", 8th Ed., W. H. Freeman Publication, 2006.
7. G.M. Barrow, "Physical Chemistry" Tata McGraw-Hill Education, 2008.
8. John O'M. Bockris and Amulya K.N. Reddy, "Volume 1: Modern Electrochemistry: Ionics" Springer, 2nd Ed., 1998.
9. John O'M. Bockris and Amulya K.N. Reddy, "Modern Electrochemistry 2B: Electrodics in Chemistry, Engineering, Biology and Environmental Science" Springer, 2nd Ed., 2000.
10. A. J. Bard and L.R. Faulkner, "Electrochemical Methods Fundamentals and Applications", Wiley, 2nd Ed. 2000.
11. J. Rajaram and J. C. Kuriacose, "Kinetics and mechanism of chemical transformation" Macmillan Publishers India Limited, 2000.
12. Sawyer, Sobkowaik, and Roberts, "Electrochemistry for Chemists", 2nd Ed.,1996.
13. Engel, T. & Reid, P. Physical Chemistry 3rd Ed. Pearson (2013).
14. Julian R.H. Ross, "Heterogeneous Catalysis: Fundamentals and Applications, Wiley-VCH; 2nd Revised Edn., 2007.
15. A. W. Adamson and A. P. Gast, "Physical Chemistry of Surfaces", 6th Edn., John Wiley & Sons, Inc. 1997.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for CH-203B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**3**	**3**	**3**
CO2	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**1**	**2**	**2**	**3**	**3**	**3**
CO3	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**1**	**2**	**2**	**3**	**3**	**3**

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

M.Sc. CHEMISTRY SEMESTER II
CODE: CHP-108-V1
SUBJECT NAME: COMPUTATIONAL TECHNIQUES
NO. OF CREDITS: 3

			SESSIONAL	: 40
L	T	P	FINAL EXAM	: 60
3	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 8 questions of equal marks covering the entire syllabus. Any four questions have to be attempted out of six from Part-2.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: Understand quantum computational chemistry.

CO2: Explore various quantum computational models.

CO3: Learn the basic concept of molecular dynamics.

CO4: Investigate various algorithms in molecular dynamics.

UNIT-I: Quantum Computational Chemistry

Scope of computational chemistry, Restricted and Unrestricted Hartree-Fock, Basis Sets: Slater and Gaussian Type Orbitals, Polarization and Diffuse Functions, Split-valence Sets, Core-valence Sets; Potential energy surfaces: Geometry optimization, local and global minima, transition state theory, and pair potentials.

UNIT-II: Fundamentals of Molecular Dynamics

Introduction to Computer Simulation – Visual Representation of Molecular Systems using VMD, Lennard Jones potentials – Bonding Potentials and Force-Fields, Phase Space, Periodic Boundary Conditions, Minimum Image convention. Propagation of Newton's Equation, Time Step and Energy Minimization.

UNIT-III: Molecular Dynamics Algorithms and Application to water

MD algorithms, Thermostats - types and temperature fluctuations, Treatment of Statistical Mechanical Ensembles – Averages – Fluctuations – Time Correlation Function – Radial Distribution Function, Mean-Square Displacement - Diffusion coefficient. Simulations of water molecules. Structure and physical property of water: Aspects from simulations and limitations of experiment.

UNIT-IV: Basic Statistics

Mean, Median, Mode, Variance, Standard deviation, Moments, Properties and effect of change of origin and scale; using computational techniques

Probability: rules of probability, conditional probability, independent events, Bays theorem, Random variable, Discrete and continuous random variable; using computational techniques

REFERENCE BOOKS:

1. M. P. Allen and D. J. Tildesley, "Computer Simulations of Liquids" Oxford Science Publications, 1989.
2. Attila Szabo and Neil S. Ostlund "Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory" Dover Books on Chemistry, 1996.
3. Mark Tuckerman, "Statistical Mechanics: Theory and Molecular Simulation" by Oxford Graduate Texts, 2010.
4. Andrew R. Leach, "Molecular Modeling: Principles and Applications" Addison Wesley Publishing Company, 1997.
5. Daan Frenkel, "Understanding Molecular Simulation: From Algorithms to Applications" Computational Science Series, Vol 1, 2001.
6. Frank Jensen, "Introduction to Computational Chemistry" John Wiley & Sons, 2007.
7. Richard M. Martin, "Electronic Structure: Basic Theory & Practical Methods" Cambridge University Press.
8. Errol Lewars "Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics" Kluwer Academic Publishers, New York, 2004

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for CH-204X-B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**3**	**3**	**3**
CO2	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**1**	**2**	**2**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**1**	**2**	**2**	**3**	**3**	**3**

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

M.Sc. CHEMISTRY SEMESTER II
CODE: CHP-110-V1
SUBJECT NAME: CHEMISTRY OF SUPRAMOLECULES
NO. OF CREDITS: 3

			SESSIONAL	: 40
L	T	P	FINAL EXAM	: 60
3	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 8 questions of equal marks covering the entire syllabus. Any four questions have to be attempted out of six from Part-2.

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:
CO1: learn the basic concepts of supramolecular chemistry
CO2: understand the concept of self-assembly
CO3: analyse the role of supramolecular chemistry in nature
CO4: acquire the knowledge of recent advancement in supramolecules

UNIT-I: Basic Concepts

Terminology and definitions in supramolecular chemistry, Chemical interactions leading to supramolecular assemblies, nature of supramolecular interactions: Ion pairing, ion-dipole and dipole-dipole interactions; hydrogen bonding; cation-pi, anion pi, pi-pi interactions and Van der Waal forces. Solvent and solution properties, solvation and hydrophobic effect.

UNIT-II: Host Guest Chemistry

Macrocyclic effect and their thermodynamic origin, Step-wise and overall binding constant in host-guest chemistry, kinetic and thermodynamic selectivity. Principle of molecular recognition, host-guest complementarity, Synthesis and structure of crown ethers, lariat ethers, podands, cryptands, spherands, calix[4]arenes, cyclodextrins, cyclophanes, cryptophanes, carcerands, and hemicarcerands, host-guest interactions, pre-organization and complementarity, lock and key analogy, binding of cationic, anionic, ion pair and neutral guest molecules.

UNIT-III: Self Assembly and supramolecular catalysis

Self-assembly of molecules: Design, synthesis and properties of the molecules, self-assembling by H-bonding, metal-ligand interactions and other weak interactions, metallomacrocycles, catenanes, rotaxanes, helicates and knots, examples of recent developments in supramolecular chemistry. Organocatalysis mediated through hydrogen bonding, preconcentration, self-assembly of catalysts and preorganisation of catalyst-substrate systems. Influence of organisation (effective molarity) on catalysis, Catalytic acyl transfer, acid-base catalysis, catalysis hydrolysis as ATPase mimic.

UNIT-IV: Molecular Devices

Molecular devices: Molecular electronic devices, molecular wires, molecular rectifiers, molecular switches, molecular logic. Relevance of supramolecular chemistry to mimic biological systems: ion channel mimics. Importance of molecular recognition in nucleic acids and protein. Applications of supramolecular complexes in medicine- targeted drug delivery.

REFERENCE BOOKS:

1. J.M. Lehn, Supramolecular Chemistry-Concepts and Perspectives, Wiley-VCH, 1995.
2. P. D. Beer, P. A. Gale and D. K. Smith, Supramolecular Chemistry, Oxford University Press, 1999.
3. J. W. Steed and J. L. Atwood, Supramolecular Chemistry, 1st Ed., Wiley, 2000.
4. J.W. Steed, Core Concepts in Supramolecular Chemistry and Nanochemistry, 1stEd., John Wiley & Sons, 2007.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for CH-204Y-B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	3	3	3	2	3	3	2	3	3
CO2	3	3	3	3	3	2	3	3	3	1	3	3	2	2	2
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	2	3	3	3	1	3	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

M.Sc. CHEMISTRY SEMESTER II
CODE: CHP-112-V1
SUBJECT NAME: INORGANIC CHEMISTRY LAB-II
NO. OF CREDITS: 2

			SESSIONAL	: 50
L	T	P	FINAL EXAM	: 50
0	0	4	TOTAL	: 100

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: Analyse a given salt quntitatively
CO2: Synthesise an inorganic complex on his own
CO3: Design and synthesize a complex of interest
CO4: Experimental part and interpretation of the results

EXPERIMENTS

Quantitative Analysis

Separation of the metal ions and determination of any one of them using volumetric/gravimetric methods.
Cu-Ni, Cu-Zn, Cu-Al, Ca-Ba, Fe -Mg, Fe-Ni etc.

Preparations:

Preparation of selected inorganic compounds and their spectroscopic studies.

1. $Hg[Co(SCN)_4]$
2. $Ni(dmg)_2$
3. $[Cu(NH_3)_4]SO_4\ H_2O$
4. Prussian Blue and Turnbull's Blue.
5. $Na[Cr(NH_3)_2(SCN)_4]$
6. $Mn(acac)_3$
7. $[Ni(NH_3)_6]Cl_2$
8. $VO(acac)_2$

Experiment: 20 marks
Lab Record: 10 marks
Viva-voce: 20 marks

REFERENCE BOOKS:

1. A Text Book of Macro and Semi-micro Quantitative Analysis, A.I.Vogel, Orient Longman.
2. A Vogel's Text Book of Quantitative Inorganic Analysis , J. Bassett, R.C. Denney, G.B. Jaffery and J. Menaham, Longman, London.
3. Synthesis and Characterization of Inorganic Compounds, W.B. Jolly, Prentice Hall, Englewood.
4. Synthesis and Physical Studies of Inorganic Compounds, C.F. Bell, Pergamon Press
5. Inorganic Preparations; W.G. Palmer.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for **CH-205B**

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	2	3	3	3	2	2	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	2	2	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

M.Sc. CHEMISTRY SEMESTER II
CODE: CHP-114-V1
SUBJECT NAME: ORGANIC CHEMISTRY LAB-II
NO. OF CREDITS: 2

L	T	P		
0	0	4	SESSIONAL	: 50
			FINAL EXAM	: 50
			TOTAL	: 100

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: To perform experimentation and evaluation the results.

CO2: To understand the methods of separations of binary organic mixtures.

CO3: To purify various organic compounds using different techniques in laboratory.

CO4: To study about UV and IR spectra of simple compounds.

Experiments

1. Qualitative analysis of mixture of organic compounds
2. Purification of organic compounds involving fractional crystallization, fractional distillation, steam distillation, sublimation and extraction.

Experiment: 20 marks
Lab Record: 10 marks
Viva-voce: 20 marks

REFERENCE BOOKS:

1. A Hand book of Organic Analysis -Qualitative and Quantitative by H.T. Clarke, and revised by B.Haynee, Edward Arnold, London 1975.
2. Vogel's Text Book of Practical Organic Chemistry by B.S. Furhen et. al, Longman-Group Ltd.
3. Systematic Qualitative Organic Analysis by H. Middleton, Edward Arnold (Publishers) Limited, London 1959.
4. Elementary Practical Organic Chemistry by Arthur I. Vogel, Ex CBS Publishers and Distributors.
5. Experiments in Organic Chemistry by Louis, F.Fieser, D.C. Heath and Company Boston, 1955.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lecture, demonstration, E-tutoring, discussion, assignments, quizzes, case study, power point; **LMS/ICT Tools:** Digital Classrooms, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for CH-206B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**
CO2	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**3**
CO4	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

M.Sc. CHEMISTRY SEMESTER II
CODE: CHP-116-V1
SUBJECT NAME: PHYSICAL CHEMISTRY LAB-II
NO. OF CREDITS: 2

			SESSIONAL	: 50
L	T	P	FINAL EXAM	: 50
0	0	4	TOTAL	: 100

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: Use refractive index, refractivity, and molar refractivity properties of liquids in analysis.

CO2: Solve wet-lab practical difficulties related to kinetics of inversion,

CO3: Use electrode potential for various applications

CO4: Use distribution properties of two liquids.

Refractometry

i. Determine the refractive index of simple organic liquids (environment friendly).
ii. Determine the refractivity and molar refractivity of some organic liquids to determine the molar refractivity's for CH_2, C, H and Cl.
iii. Study the variation of refractive index with concentration for KCl solution and thereafter determine the unknown concentration of given KCl solution.

Polarimetry

i. Study the variation of angle of optical rotation with the concentration of any optically active substance (sucrose or glucose) and determine the unknown concentration of given solution.
ii. Determine the specific and molecular rotation of sucrose or glucose at number of concentrations.
iii. Study the kinetics of inversion of cane sugar (sucrose) in presence of an acid.

Potentiometry

i. Determine the standard electrode potential of Cu and Zn.
ii. Determine the strength of a given solution of ferrous ammonium sulphate by potentiometric titration with $K_2Cr_2O_7$ solution.
iv. Study the precipitation titration between KCl and $AgNO_3$ potentiometrically.
iv. Determine the strength of iodide, bromide and chloride in a mixture by potentiometric titration with silver nitrate.

Distribution Law

i. Determine distribution coefficient of ammonia between chloroform and water.
ii. Determine the formula of the complex formed between copper (II) ion and ammonia using distribution method.

Experiment: 20 marks
Lab Record: 10 marks
Viva-voce: 20 marks

REFERENCE BOOKS:

1. Practical Physical Chemistry, A. M. James and F. E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B. P. Lavitt, Longman.
3. Practical Physical Chemistry, S. R. Palit and S.K. De, Science.
4. Experimental Physical Chemistry, R. C. Das and B. Behera, Tata McGraw Hill.
5. Experiments in Physical Chemistry, D. P. Shoemaker
6. Experiments in Physical Chemistry, D. V. Jahagirdhar.
7. Senior Practical Physical Chemistry by B. D. Khosla, V. Garg and A. Gulati.
8. Advanced Practical Physical Chemistry, J. B. Yadav, Goel Publishing House

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lab demonstration, experimentation discussion, assignments, quizzes; **LMS/ICT Tools:** Virtual Labs, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for CH-207B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**3**	**3**	**3**	**3**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**1**	**2**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**1**	**2**	**3**	**3**	**3**	**3**

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

M.Sc. CHEMISTRY SEMESTER II
CODE: CHP-118-V1
SUBJECT NAME: SEMINAR
NO. OF CREDITS: 1

L	T	P
1	0	0

SESSIONAL : 50
FINAL EXAM : 0
TOTAL : 50

COURSE OUTCOMES:

The student will be able to
CO1: Learn to review and correlate the literature reports related to a particular topic.
CO2: Acquire skills of presentations through computer program.
CO3: Develop skills of effective verbal scientific communication.
CO4: Develop the ability to present and defend their studies in an intellectual way.

COURSE DESCRIPTION:

Students are required to deliver a Seminar on a recent topics related to Chemistry through power point presentation followed by Q/A session. Seminar may be delivered in any thrust area of subject (Experimental or theoretical). Every student shall be required to submit the topic of his/her seminar in consultation with Faculty members well in advance.

Mapping of CO and PO for CH-208B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	3	3	3	2	3	2	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3
CO4	3	3	3	3	3	3	3	2	3	2	3	2	3	3	3

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

M.Sc. CHEMISTRY SEMESTER II
CODE: AEC-306-V
SUBJECT NAME: MODERN SCIENCE WRITING AND JOURNALISM (Audit Course)
NO. OF CREDITS: 0

			SESSIONAL	: 40
L	T	P	FINAL EXAM	: 60
2	0	0	TOTAL	: 100

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: Foundation of the English language.
CO2: Familiarize themselves with the essentials of English grammar.
CO3: Inculcate creative and aesthetic sensitivity and develop critical thinking through the comprehension, appreciation, and analysis of the prescribed literary texts.
CO4: Understand proper pronunciation and accent of the English language.

UNIT I

Basic Grammar: Noun, Pronoun, Adjective, Verb, Adverb, Prepositions.

Vocabulary Building: Suffix, Prefix, Synonyms, Antonyms.

UNIT II

Essentials of Grammar – I: Articles, Subject–Verb Agreement, Parts of Speech, Tenses.

UNIT III

Essentials of Grammar – II: Vowels, Consonants, Diphthongs, Clusters and Syllables, Direct and Indirect Speech.

UNIT IV

Spoken English Communication: Speech Drills, Pronunciation, Accent, Stress, and Intonation.

Reference Books:

1. Madhulika Jha, *Echoes*, Orient Blackswan Pvt. Ltd., Telangana, India.
2. Ramon & Prakash, *Business Communication*, Oxford University Press, India.
3. Greenbaum S., *Oxford English Grammar*, Oxford University Press.
4. M. Ashraf Rizvi, *Effective Technical Communication*, McGraw Hill, New Delhi.

SUGGESTED WEB SOURCES:

1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry

MODE OF TRANSACTION: Lab demonstration, experimentation discussion, assignments, quizzes; **LMS/ICT Tools:** Virtual Labs, DLMS, ZOOM, G-Suite, MS Power-Point, Online Resources.

Mapping of CO and PO for ACH-211B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**3**	**3**	**3**	**2**
CO2	**3**	**2**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**
CO3	**2**	**3**	**2**	**2**	**3**	**3**	**1**	**3**	**3**	**1**	**2**	**3**	**3**	**2**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**1**	**2**	**3**	**3**	**3**	**3**

**Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

MAPPING OF THE SUBJECTS WITH THE FOLLOWING

COURSE NAME	Course code	Employ ability	Entrepreneurship	Skill Development
INORGANIC CHEMISTRY (GENERAL-I)	CHP-101-V1	√		√
ORGANIC CHEMISTRY (GENERAL-I)	CH-103-V1	√		√
PHYSICAL CHEMISTRY (GENERAL-I)	CH-105-V1	√		√
MATHEMATICS FOR CHEMISTS	CHP-107-V1			√
CHEMISTRY OF LIFE PROCESSES	CHP-109-V1			√
INORGANIC CHEMISTRY LAB-I	CHP-111-V1	√	√	√
ORGANIC CHEMISTRY LAB-I	CHP-113-V1	√	√	√
PHYSICAL CHEMISTRY LAB-I	CHP-115-V1	√	√	√
INORGANIC CHEMISTRY (GENERAL-II)	CHP-102-V1	√		√
ORGANIC CHEMISTRY (GENERAL-II)	CHP-104-V1	√		√
PHYSICAL CHEMISTRY (GENERAL-II)	CHP-106-V1	√		√
COMPUTATIONAL TECHNIQUES	CHP-108-V1	√	√	√
CHEMISTRY OF SUPRAMOLECULES	CHP-110-V1	√		√
INORGANIC CHEMISTRY LAB-II	CHP-112-V1	√	√	√

ORGANIC CHEMISTRY LAB-II	CHP-114-V1	√	√	√
PHYSICAL CHEMISTRY LAB-II	CHP-116-V1	√	√	√
MODERN SCIENCE WRITING AND JOURNALISM	AEC-306-V			√