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. 2021-2022)

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		
CH-101B	Inorganic Chemistry (General-I)	4			25	75	100	4	DCC
CH-102B	Organic Chemistry (General-I)	4			25	75	100	4	DCC
CH-103B	Physical Chemistry (General-I)	4			25	75	100	4	DCC
CH-104X-B*	Mathematics for Chemists	3			25	75	100	3	FC
CH-104Y-B*	Chemistry of life processes	3			25	75	100	3	FC
CH-105B	Inorganic Chemistry Lab-I			6	30	70	100	3	DCC
CH-106B	Organic Chemistry Lab-I			6	30	70	100	3	DCC
CH-107B	Physical Chemistry Lab-I			6	30	70	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 CH-104X-B and Candidates with Mathematical background will appear for CH-104Y-B*

**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		
CH-201B	Inorganic Chemistry (General-II)	4			25	75	100	4	DCC
CH-202B	Organic Chemistry (General-II)	4			25	75	100	4	DCC
CH-203B	Physical Chemistry (General-II)	4			25	75	100	4	DCC
CH-204X/204Y-B*	Computational Techniques / Chemistry of Supramolecules	3			25	75	100	3	FC
CH-205B	Inorganic Chemistry Lab-II			4	30	70	100	2	DCC
CH-206B	Organic Chemistry Lab-II			4	30	70	100	2	DCC
CH-207B	Physical Chemistry Lab-II			4	30	70	100	2	DCC
CH-208B	Seminar	1			50	--	50	1	SEC
XXX	Audit Course**	2	0	0	25	75	100	0	AUD
	Total	**17**		**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.

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

DEPARTMENT OF CHEMISTRY

SCHEME M.Sc. CHEMISTRY

SEMESTER III

Subject Code	Title	Teaching Hours per week			Maximum Marks				
		L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
CH-301B	Spectroscopic methods in Chemistry	4			25	75	100	4	DCC
CH-302B	Advanced Spectroscopy	4			25	75	100	4	DCC
CH-303B	Instrumental Methods of Analysis	3			25	75	100	3	DCC
CH-304B	Instrumental Analysis Lab			6	30	70	100	3	DCC
CH-305/315/325B	Inorganic / Organic / Physical Chemistry Special-I*	4			25	75	100	4	DEC
CH-306/316/326B	Inorganic / Organic / Physical Chemistry Lab -Special-I*			6	30	70	100	3	DEC
XXX	Open Elective Course**	3			25	75	100	3	OEC
	Total	**18**		**12**			**700**	**24**	

DCC – Discipline Core Course; DEC – Discipline Elective Course; OEC – Open Elective Course
L – Lecture; T - Tutorial; P - Practical

- * Students have to choose one out of three specializations offered by the department. The choice will be granted on merit basis
- **OEC: A students required to choose open elective course offered by the other departments in the faculty of Sciences.

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

DEPARTMENT OF CHEMISTRY

SCHEME M.Sc. CHEMISTRY

SEMESTER IV

Subject Code	Title	Teaching Hours per week			Maximum Marks			Credits	Category Code
		L	T	P	Internal Assessment	End-semester Examination	Total		
CH-401/411/421B	Inorganic / Organic / Physical Chemistry Special-II	4			25	75	100	**4**	DEC
CH-402/412/422B	Inorganic / Organic / Physical Chemistry Special-III	4			25	75	100	**4**	DEC
CH-403/413/423B	Inorganic / Organic / Physical Chemistry Special-IV	4			25	75	100	**4**	DEC
CH-404/414/424B	Inorganic / Organic / Physical Chemistry Lab-Special-II			6	30	70	100	**3**	DEC
CH-405/415/425B	Inorganic / Organic / Physical Chemistry Lab-Special-III			6	30	70	100	3	DEC
CH-431B	Dissertation				50	150	200	8	DCC
	Total	**12**		**12**			**700**	**26**	

- DCC – Discipline Core Course; DEC – Discipline Elective Course; L – Lecture; P - Practical
- * Students will continue with the same specialization as was chosen in Semester III.
- # Students will have to complete a dissertation in the respective specialization under the guidance of the supervisor. Formatting and description for dissertation writing will be provided.

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.

Guidelines for Dissertation:

The purpose of the dissertation in M.Sc. 4th semester is to introduce research methodology to the students. It may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem related to subject, participation in some ongoing research activity, analysis of data, etc. The work can be carried out in any thrust areas of subject (Experimental or Theoretical) under the guidance of allotted supervisor of the department. The students must submit their dissertation in the department as per the date announced for the submission**.**

Internal assessment of the dissertation work will be carried out by respective supervisor through power point presentation given by candidates during the semester. External assessment of the dissertation work will be carried out by an external examiner (nominated by the Chairperson of the Department) through power-point presentation given by candidates. This load (equivalent to 2 hours per week) will be counted towards the normal teaching load of the teacher.

1. Dissertation will contain a cover page, certificate signed by student and supervisor, table of contents, introduction, Objective, Literature review, methodology, results and discussions conclusion, and references.

- The paper size to be used should be A-4 size.
- The font size should be 12 with Times New Roman.
- The text of the dissertation may be typed in 1.5 (one and a half) space.
- The print out of the dissertation shall be done on both sides of the paper (instead of single side printing)
- The total no. of written pages should be between 40 to 60 for dissertation.

2. The candidate shall be required to submit two soft bound copies of dissertation along with a CD in the department as per the date announced.

3. Dissertation will be evaluated internally by the supervisor allotted to the student during the semester.

4. The candidate will defend her/his dissertation/project work through presentation before the External examiner at the end of semester and will be awarded marks.

5. In case, a student is not able to score passing marks in the dissertation exam, he/she will have to resubmit her/his dissertation after making all corrections/improvements & this dissertation shall be evaluated as above. The candidate is required to submit the corrected copy of the dissertation in hard bound within two weeks after the viva -voce.

JC BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

DEPARTMENT OF CHEMISTRY

The department of Chemistry offers the following Audit Courses and Open Elective Courses for the students of other departments in the Faculty of Sciences:

Course	Subject	Subject Code
Audit Course	1. Green Chemistry	ACH-211B
Open Elective Course	1. Chemistry for sustainable development	OCH-311B
	2. Applied Chemistry	OCH-312B

- The students have to choose one Audit course (0 Credit) from the list provided by the department/University. Only passing of the Audit course will be mandatory.
- The students have to choose one Open Elective Course (03 credits) related to other branch of Science/Engineering/other discipline required for enhancing professional performance as provided by the department/university.

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

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: Undrestand symmetry, group theory, and Stereochemistry
CO2: Undrestand Metal-Ligand Equilibria in solution
CO3: undestand 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: CH-102B
SUBJECT NAME: ORGANIC CHEMISTRY (GENERAL-I)
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	**:** 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: CH-103B
SUBJECT NAME: PHYSICAL CHEMISTRY (GENERAL-I)
NO. OF CREDITS: 4

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: CH-104X-B
SUBJECT NAME: MATHEMATICS FOR CHEMISTS
NO. OF CREDITS: 3

L	T	P		
3	0	0	SESSIONAL	: 25
			FINAL EXAM	: 75
			TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: CH-104Y-B
SUBJECT NAME: CHEMISTRY OF LIFE PROCESSES
NO. OF CREDITS: 3

L	T	P		
			SESSIONAL	: 25
			FINAL EXAM	: 75
3	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: CH-105B
SUBJECT NAME: INORGANIC CHEMISTRY LAB-I
NO. OF CREDITS: 3

L	T	P		
0	0	6	SESSIONAL	: 30
			FINAL EXAM	: 70
			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: 45 marks
Lab Record: 15 marks
Viva-voce: 10 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: CH-106B
SUBJECT NAME: ORGANIC CHEMISTRY LAB-I
NO. OF CREDITS: 3

L	T	P		
0	0	6	SESSIONAL	: 30
			FINAL EXAM	: 70
			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: 45 marks
Lab Record: 15 marks
Viva-voce: 10 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: CH-107B
SUBJECT NAME: PHYSICAL CHEMISTRY LAB-I
NO. OF CREDITS: 3

L	T	P		
			SESSIONAL	: 30
			FINAL EXAM	: 70
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: 45 marks

Lab Record: 15 marks
Viva-voce: 10 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: CH-201B
SUBJECT NAME: INORGANIC CHEMISTRY (GENERAL-II)
NO. OF CREDITS: 4

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: Corelate 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 carbonyles 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: CH-202B
SUBJECT NAME: ORGANIC CHEMISTRY (GENERAL-II)
NO. OF CREDITS: 4

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: CH-203B
SUBJECT NAME: PHYSICAL CHEMISTRY (GENERAL-II)
NO. OF CREDITS: 4

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: CH-204X-B
SUBJECT NAME: COMPUTATIONAL TECHNIQUES
NO. OF CREDITS: 3

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
3	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: CH-204Y-B
SUBJECT NAME: CHEMISTRY OF SUPRAMOLECULES
NO. OF CREDITS: 3

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
3	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: CH-205B
SUBJECT NAME: INORGANIC CHEMISTRY LAB-II
NO. OF CREDITS: 2

			SESSIONAL	: 30
L	T	P	FINAL EXAM	: 70
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: 45 marks
Lab Record: 15 marks
Viva-voce: 10 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: CH-206B
SUBJECT NAME: ORGANIC CHEMISTRY LAB-II
NO. OF CREDITS: 2

L	T	P		
			SESSIONAL	: 30
			FINAL EXAM	: 70
0	0	4	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: 45 marks
Lab Record: 15 marks
Viva-voce: 10 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: CH-207B
SUBJECT NAME: PHYSICAL CHEMISTRY LAB-II
NO. OF CREDITS: 2

L	T	P		
0	0	4	SESSIONAL	: 30
			FINAL EXAM	: 70
			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.

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: CH-208B
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: ACH-211B
SUBJECT NAME: GREEN CHEMISTRY (Audit Course)
NO. OF CREDITS: 0

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
2	0	0	TOTAL	: 100

COURSE OUTCOMES:

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

CO1: understand the meaning and concept of green chemistry
CO2: design environment sustainable and economical route of a synthesis.
CO3: appreciate renewable and alternate resources of energy and their utilization
CO4: realize the importance of concept with respect to industrial processes

UNIT I

PRINCIPLES & CONCEPT OF GREEN CHEMISTRY: Introduction, Concept and Principles, development of Green Chemistry, Atom economy reactions –rearrangement reactions, addition reactions, atom uneconomic-sublimation, elimination, Wittig reactions, toxicity measures, Need of Green Chemistry in our day-to-day life.

UNIT II

EMERGING GREEN TECHNOLOGY AND ALTERNATIVE ENERGY SOURCES: Design for Energy efficiency, Photochemical reactions, Advantages & Challenge faced by photochemical process. Microwave technology on Chemistry, Microwave heating, Microwave assisted reactions, Sono chemistry and Green Chemistry, Electrochemical Synthesis, Examples of Electrochemical synthesis.

UNIT III

RENEWABLE RESOURCES: Biomass, Renewable energy, Fossil fuels, Energy from Biomass, Solar Power, Other forms of renewable energy, Fuel Cells, Alternative economics, Syngas economy, hydrogen economy, Some other natural chemical resources.

UNIT IV

INDUSTRIAL CASE STUDIES: Methyl Methacrylate (MMA), Greening of Acetic acid manufacture, Dyeing, Application, Polyethylene, Ziegler-Natta Catalysis, Metallocene Catalysis, Eco friendly Pesticides-Insecticides.

Reference Books:

1. Mike Lancaster, Green Chemistry and Introductory text, II Edition
2. P.T. Anastas and J.C Warner, Green Chemistry theory and Practice, Oxford University press, Oxford (1988).
3. P. Tundo *et. al.*, Green Chemistry, Wiley –Blackwell, London (2007).
4. Protti D. Dondi *et.al.,* Green Chemistry

5. T.E Graedel, Streamlined Life cycle Assessment, Prentice Hall, New Jersey (1998).
6. V.K. Ahluwalia, Methods and Reagents of Green Chemistry: An Introduction by Green Chemistry.
7. www.clri.org

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)

M.Sc. CHEMISTRY SEMESTER III
CODE: CH-301B
SUBJECT NAME: SPECTROSCOPIC METHODS IN CHEMISTRY
NO. OF CREDITS: 4

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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 basic principle of all kinds of spectroscopic techniques used in organic chemistry for structural elucidation of organic compounds.
CO2: To explain the basic concept behind NMR spectroscopy and its application for the structure elucidation.
CO3: To understand the chemical shift and coupling constant in relation to stereochemical structure of the organic compound.
CO4: To know the basic concept of Ultraviolet and Visible Spectroscopy, C13-NMR spectroscopic techniques and IR spectroscopy
CO5: To apply various spectroscopic techniques discussed above for solving/determining the structure of organic compounds (composite problems)

UNIT-I:
Nuclear Magnetic Resonance Spectroscopy- I
General introduction and definition, Basic principles of NMR, theory of nuclear magnetic resonance, Nuclear relaxation, spin lattice relaxation, spin-spin relaxation, chemical shift, experimental techniques chemical shift , the δ-scale of chemical shift, spin- spin interaction, shielding mechanism, the origin of shielding constant, pattern of coupling, origin of spin -spin coupling, mechanism of measurement and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto), complex spin- spin interaction between two, three, four and five nuclei (first order spectra), spin system-Pople notation, virtual coupling.

UNIT-II:
Nuclear Magnetic Resonance Spectroscopy- II
Stereochemistry, concept of topicity, effect of enantiomeric and diastereomeric protons, hindered rotation, Karplus curve - variation of coupling constant with dihedral angle. Fourier transform technique and its advantages. Resonance of other nuclei- F, P. Tools for simplification of complex NMR spectrum (chemical and instrumental): Deuteration, changing solvent, trifluoroacetylation, basification and acidification, lanthanide shift reagents, increased magnetic field strength, Double

Resonance and Nuclear Overhauser Effect (NOE), variable temperature probe. Concept of 2D-NMR spectroscopy.

Effect of chemical exchange on spectrum and evaluation of reaction rate of fast reactions, Lanthanide shift reagents, an overview of NMR of other nuclides with emphasis on ^{31}P, ^{19}F, ^{195}Pt and ^{119}Sn NMR. Application in inorganic chemistry.

UNIT-III:

Carbon- 13 NMR Spectroscopy

General considerations, Comparison of ^{1}H-NMR and ^{13}C-NMR, Proton coupled and proton decoupled ^{13}C-NMR, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants. Nuclear Overhauser effect.

Ultraviolet and Visible Spectroscopy:

Introduction and understanding of UV phenomenon, Various electronic transitions (185- 800 nm), Beer- Lambert law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser- Woodward rules for conjugated dienes and carbonyl compounds.

Applications of IR spectroscopy for structure elucidation of organic compounds.

UNIT-IV:

Mass Spectrometry

Introduction, ion production - EI, CI, FD and FAB, Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, Nitrogen rule, molecular weight determination molecular formula from isotopic ratio data, isotope profile of halogen compounds, fragmentation pattern - simple cleavage, retro- Diels Alder, Hydrogen transfer rearrangement like scrambling, ortho effect, Mc Lafferty rearrangement, fragmentation patterns of hydrocarbons, alcohols, phenols, ethers, aldehydes, ketones, esters, carboxylic acids, amines, nitro, amides, nitriles.

Composite Problems

Problems involving the application of the above spectroscopic techniques (UV/Visible, IR, NMR and Mass) for structural elucidation of organic molecules.

REFERENCE BOOKS:

1. Introduction to Spectroscopy- A Guide for Students of Organic Chemistry, 2nd Edn. By Donald L. Pavia, Gary M. Lampman and George S. Kriz. Saunders Golden Sunburst Series. Harcourt Brace College Publishers, New York.
2. Spectrometric Identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley.
3. Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall.
4. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming, Tata McGraw-Hill.
5. Spectroscopy of Organic Compounds by P.S. Kalsi, Wiley Estern, New Delhi.
6. Organic Spectgroscopy by William Kemp, John Wiley.
7. Organic Mass Spectrometry by K.G. Das & E.P. James, Oxford & IBH Publishing Co.
8. Organic Spectroscopy (Principles & Applications) by Jagmohan.

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-301B

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

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

M.Sc. CHEMISTRY SEMESTER III
CODE: CH-302B
SUBJECT NAME: ADVANCED SPECTROSCOPY
NO. OF CREDITS: 4

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: Illuminate the various structural parameters of molecules by using various spectroscopic technique.
CO2: Understand the theoretical aspects of ESR, Mossbauer, Raman, Microwave, IR and NQR spectroscopic techniques.
CO3: Explore the crystallographic structure and orientation of crystal plane in a molecule via XRD technique.
CO4: To solve the numerical problems based upon theoretical spectroscopic techniques.

Unit I

Electron Spin Resonance Spectroscopy: Basic principles of ESR, experimental technique, the g-value hyperfine structure, Instrumentation of ESR and its applications to the study of free radicals and fast reactions, spin densities and McConnell relationship. Hyperfine coupling, spin polarization for atoms and transition metal ions, spinorbit coupling and significance of g-tensor, application to transition metal complexes (having one unpaired electron) and inorganic free radicals such as PH4, F2 - and [BH3]-. Double resonance in EPR**.**

Unit II

Mossbauer Spectroscopy: Basic principles, hyperfine interactions, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of Fe2+ and Fe3+ compounds including those of intermediate spin, (2) Sn2+ and Sn4+ compounds – nature of M-L bond, coordination number, structure and (3) detection of oxidation state.

Nuclear Quadrupole Resonance Spectroscopy

Introduction, energies of quadroupole transitions, effect of magneticfield on the spectra, relationship between electric field gradient and molecular structure, applications, interpretations of structural information from NQR spectra

Unit III

Microwave Spectroscopy: The rotation of molecules, rotational spectra of rigid diatomic molecules, intensities of rotational spectral lines, isotopic effect, non- rigid rotator, spectra of polyatomic linear molecules and symmetric top molecules.

Infrared Spectroscopy: Principle and Theory, Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance. FT- IR. The vibrating diatomic molecule, force constant, zero point energy, simple harmonic vibrator, anharmonicity, Morse potential, overtones, hot bands, diatomic vibrating rotators, P, Q, R branches, vibration of polyatomic molecules, normal mode of vibrations.
Raman Spectroscopy: Classical and quantum theories, pure rotational Raman spectra of linear molecules, vibrational Raman spectra, mutual exclusion principle, polarization of the light and Raman effect, depolarization of Raman lines, technique. Raman spectroscopy particularly for the study of active- sites of metalloprotein**s.**

Unit IV
X-ray Crystallography: Symmetry elements in crystals, stereographic projections, Miller indices, indexing, assigning miller indices to XRD peaks, systematic absences, single crystal and powder XRD techniques, principles, instrumentation, and applications, criteria for determining unit cell of lattice, Cc X-ray emission spectra, absorption edges, X-ray filters, Reciprocal lattice concept and its importance, Definition of Reciprocal lattice vector (derivation excluded). Interplanar spacing using reciprocal lattice concept for cubic, tetragonal, orthorhombic and hexagonal crystal systems, Equivalence of Bragg's and Laue condition, Structure factor calculations for primitive, base-centered, body-centered and face centered unit cells. Relation of structure factor to electron density and intensities (derivation excluded), Interpretation of powder photographs for cubic crystals, Characteristic difference between X-ray, electron and neutron diffraction techniques.

REFERENCE BOOKS:

1. Fundamentals of Molecular Spectroscopy, C.N. Banwell, Tata McGraw Hill.
2. Modern Spectroscopy, J.M. Hollas, John Wiley.
3. Basic Principles of Spectroscopy, R.Chang, McGraw Hill.
4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
5. Physical Method in Chemistry, R.S. Drago, Saunders College.
6. Elementary Crystallography, L. Azaroff.
7. Structure Determination by X-ray Crystallography, M. Ladd and R. Palmer
8. X-Ray Structure Determination: A Practical Guide, 2nd Edition by George H. Stout and Lyle H. Jensen.
9. Essentials of Crystallography, McKie & McKie, Blackwell Scientific Publications, 1986
10. Handbook of X-rays, Emmett and F. Kaelbse, McGraw Hill

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-302B

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

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

M.Sc. CHEMISTRY SEMESTER III
CODE: CH-303B
SUBJECT NAME: Instrumental Methods of Analysis
NO. OF CREDITS: 3

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
3	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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 basics of quantitative analysis
CO2: Solve problems related to UV-Visible Spectroscopy, Infra-red Spectrometry and Flame atomic absorption and emission spectrometry
CO3: Analyze Thermal methods of analysis
CO4: X-ray methods of Analysis

Unit-I

Errors in quantitative analysis: Accuracy and precision, sensitivity, specific standard deviation in analysis, classification of errors and their minimization, significant figures, criteria for rejection of data, Q-test, t-test, and F-test, control chart, sampling methods, sampling errors, standard reference materials, statistical data treatment.

Unit II: Spectroscopic methods of Analysis

UV-Visible Spectroscopy: Lambert-Beer's Law and its limitations, Basic principles of UV-Visible spectrophotometer, Instrumentation consisting of source, monochromator, grating and detector, spectrophotometric determinations (estimation of metal ions from aqueous solutions, determination of composition of metal complexes using Job's method of continuous variation and mole ratio method).

Infra-red Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instruments, sampling techniques.

Flame atomic absorption and emission spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and burner design), techniques of atomization and sample introduction, method of background correction, sources of chemical interferences and methods of removal, techniques for the quantitative estimation of trace level metal ions. Basic principles and theory of AAS. Three different modes of AAS i.e. Flame-AAS, VG-AAS, and GF-AAS. Single beam and double beam AAS. Function of Hollow Cathode Lamp (HCL) and Electrode Discharge Lamp (EDL). Different types of detectors used in AAS. Qualitative and quantitative analysis.

Unit III

Thermal methods of Analysis: Theory of thermogravimetry (TGA), Differential thermal analysis (DTA), and Differential Scanning Calorimetry (DSC) basic principle of instrumentation. Application of TG to study of oxalates and chromates. Determination of Glass transition, Heat capacity determination, Characterization of polymer blends. Problems based on decomposition path way and % composition. Evolved gas analysis.

Unit IV

X-ray methods of Analysis: Introduction, theory of X-ray generation, X-ray spectroscopy, X-ray diffraction and X-ray fluorescence methods, instrumentation and applications. Qualitative and quantitative measurements.

Inductively coupled plasma spectroscopy, Theory and principles, plasma generation, utility of peristaltic pump, dynode / solid state detector, different types of interferences- spectroscopic and non-spectroscopic interferences, isobaric and molecular interferences, applications, ICP-AES Instrumentation, application and comparison with AAS.

REFERENCE BOOKS:

1. A Textbook of Quantitative Inorganic Analysis, A.I. Vogel; ELBS, London.
2. Fundamentals of Analytical Chemistry; D.A. Skoog, O.M. West and F.J. Holler; W.B. Saunders.
3. Instrumental methods of Analysis; L.L. Merrit, R.H. Willard and J.A. Dean; Van Nostrand-Reinhold.
4. Physical methods in Chemistry; R.S. Drago; Saunders.
5. NMR, NQR, EPR and MB Spectroscopy in inorganic Chemistry, R.V. Parish, Ellis Horwood.
6. Introduction to Magnetic Resonance; McLachan and Carrington; Chapman and Hall.

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-303B

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 III
CODE: CH-304B
SUBJECT NAME: INSTRUMENTAL ANALYSIS LAB
NO. OF CREDITS: 3

			SESSIONAL	: 30
L	T	P	FINAL EXAM	: 70
0	0	6	TOTAL	: 100

COURSE OUTCOMES:

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

CO1: understand the basics of various instrumentation techniques
CO2: prepare sample for instrumental analysis
CO3: interpret data obtained from instrumental analysis
CO4: practice various software

EXPERIMENTS

1. To analyse the purity of given compound using TLC and column chromatography.
2. Sample preparation of basic microscopic techniques such as SEM, TEM, AFM.
3. To analyse and interpret the NMR spectra of given compounds using MestReNova or Topshim software.
4. To analyse the functional groups present in the given compound using Infra-Red spectroscopy: Preparation of sample and Interpretation of IR spectrum.
5. To learn the basics of Origin plot and Sigma plot to analyse the obtained from spectroscopic techniques.
6. To learn the use of Chem Draw software to draw the chemical structures and reaction schemes.
7. To analyse and interpret the given spectra obtained using powder-XRD
8. To analyse and interpret the spectra obtained from HPLC and GC-MS data.
9. How to collect photoluminescence excitation and emission spectra of given compound?
10. Fluorescence Lifetime Measurement of a given sample using TSPC technique.

Experiment: 45 marks
Lab Record: 15 marks
Viva-voce: 10 marks

REFERENCE BOOKS:

1. Synthesis and Characterization of Inorganic compounds. W. L. Jolly, Prentice Hall, Englowood.
2. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London.
3. 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-304B

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 III
CODE: CH-305B
SUBJECT NAME: INORGANIC SPECIAL-I
NO. OF CREDITS: 4

L	T	P		
4	0	0	SESSIONAL	: 25
			FINAL EXAM	: 75
			TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: Appreciate importance of metals and their compounds in biological world.
CO2: Correlate many biological deficiencies/abnormalities with metallic mechanism
CO3: Design new medicines/drugs using concepts of bioinorganic and medicinal chemistry
CO4: Understand the research methodology to mimic the enzymes

UNIT-I

Transport and Storage of Dioxygen: Porphyrins, metalloporphyrins, Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanins and hemerythin, model synthetic complexes of iron and cobalt.

Electron Transfer in Biological Systems: Structure and function of metalloproteins in electron transport processes-cytochromes and iron-sulphur proteins, synthetic models.

UNIT-II

Alkali and alkaline earth metals in biological systems: Ionophores, active transport of cations across membranes, sodium pump, Calcium pump, Calcium carriers, role of carriers in muscle contraction, blood clotting and hormones.

Interaction of metal ions with Nucleotides: metal ions in nucleotide systems, effect of metal ions on nuclei acids.

Nitrogen fixation: Biological nitrogen fixation, Nitrogenase, model for nitrogenase, metal-N_2 complexes, photosynthesis and chlorophyll.

UNIT-III

Metalloenzymes: Zinc Enzymes – Carboxypeptidase & Carbonic anhydrase
Iron Enzymes – Catalase, peroxidase & cytochrome P- 450
Copper Enzymes – Superoxide dismutase, blue copper- proteins, Tyrosinase
Coenzymes – Vitamins B12
Molybdenum oxatransferase enzymes – Xanthine oxidase

UNIT-IV

Metals in Medicine: Biochemical bases of essential metal deficient diseases; Iron, copper and zinc deficiencies and their therapies, carcinogens and carcinostatic agents, zinc in tumour growth and

inhibition, anticancer activity and mechanism of platinum complexes, anticancer activity of Rhodium, Copper and Gold complexes, anticancer activity of Selenium, antibacterial and antiviral properties of metal complexes, polyamino carboxylic acids and polyethylene amines as chelating drugs.

Ligand Therapy: Ligand induced toxicity, interference with haemoglobin in oxygen transport system, intefererence with metallo-enzymes, beneficial effects of ligand chelation; carcinogenic ligands, carcinostatic ligands, alkylating agents as anticancer drugs, Thiosemicarbazones as anticancer drugs.

REFERENCE BOOKS:

1. Principles of Bioinorganic Chemistry: S. J. Lippard and J. M. Berg, University Science Books.
2. The Inorganic Chemistry of Biological Process; M. N. Huges; John Wiley & Sons.
3. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books.
4. A Text Book on Medicinal Aspects of Bio-Inorganic Chemistry – A.K. Das.
5. Bioinorganic Medicinal Chemistry – E.Alessio.
6. Bioinorganic Chemistry – K.H. Reddy.
7. Inorganic Chemistry: Principle of Structure Reactivity – J.E. Huheey, E.A. Keiter & R.L.Keiter.
8. Handbook of Radiopharmaceuticals: Radio Chemistry & Applications – M.J. Welch & C.S. Redvanly.
9. Perspectives on Bioinorganic Chemistry – R.W. Hay, J.R. Dilworth & K.B. Nolan.

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-305B**

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	2	3	3	2	3	3	3	3
CO2	3	3	3	3	2	3	3	3	3	3	2	3	3	3	3
CO3	3	3	3	3	2	3	3	3	3	3	2	3	3	3	3
CO4	3	3	3	3	2	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 III
CODE: CH-315B
SUBJECT NAME: ORGANIC CHEMISTRY SPECIAL-I
NO. OF CREDITS: 4

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: Appreciate the role of Molecular Orbitals in analysing Pericyclic Reactions..
CO2: Interpret the stereochemical course of a Pericyclic Reaction and identify the product.
CO3: Predict the course of an organic photochemical reaction and identify the product with the type of functional group present on the molecule.
CO4: know the concept of green chemistry and nano-chemistry.

UNIT I

Pericyclic Reactions – I: Molecular orbital symmetry, frontier orbital of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system classification of pericyclic reactions, Woodward - Hoffmann correlation diagram. FMO & PMO approach, Electrocylic reaction - conrotatory and disrotatory motions. 4n, 4n+2, allyl systems, Ring opening of cyclopropyl halides and tosylates, cycloadditions-antarafacial and suparafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3-dipolar cycloadditions and cheleotropic Reactions.

UNIT II

Pericyclic Reactions – II: Sigmatropic Rearrangements-suprafacial and entarafacial shifts of H, sigmatropic shifts involving carbon moieties, retention and inversion of configuration, [3,3] and [5,5] sigmatropic rearrangements, detailed treatment of Sommelet-Hauser, Claisen and Cope rearrangements introduction to ene reactions. Simple problems on Pericyclic reactions, Group transfers and eliminations.

Green chemistry: Basic Principle and need of green chemistry, Different tools for green synthesis (Elementary idea of green reagent, green solvent, green catalyst, solid phase, mw and ultrasound assisted) atom economy, green synthesis of BHC.

UNIT III

Photochemistry – I: Excitation and excited states, Franck-Condon Principle, Jablonski diagram, energy transfer photsensitization, quenching, quantum efficiency and quantum yield.

Photochemistry of carbonyl compounds (Norrish type I and type II changes, photoreaction of cyclic ketones, Paterno-Buchi reaction and Photoreducation. Photochemistry of olefins and 1,3-Butadiene (cis-trans isomerisation, dimerisation and cycloadditions). Di-π-methane rearrangement, enone and dienone rearrangements.

UNIT IV

Photochemistry – II: Photochemistry of aromatic compounds (substitution, isomerization, cyclization and cycloaddition reactions), Photo-Fries rearrangement, photolysis of nitrile esters and Barton reaction, Hoffman-Loeflller-Freytag reaction.

Nano-Chemistry: Introduction to nano-chemistry - fullerenes, nanotubes, carbon nano-particles, graphenes.

REFERENCE BOOKS:

1. Pericyclic Reactions, S.M. Mukherji Macmilan India.
2. Organic Photochemistry, J Coxan & B. Halton, Cambridge University Press.
3. Introductory Photochemistry,.A. Cox and T. Camp McGraw Hill.
4. The Conservation of Orbital Symmetry, R.B. Woodward and R. Hoffmann" Verlag Chemie Academic Press.
5. Problem Solving approach to Orbital Symmetry, R.E. Lehr and A.P. Merchand
6. Organic Reactions and Orbital Symmetry, T.L. Gilchrist and R.C. Storr, Cambridge University Press, Cambridge, 2nd Edn. 1979.
7. Handbook of Green Chemistry- Green Catalysis- Paul T. Anastas, Robert H. Crabtree, Wiley-VCH
8. Methods and Reagents for green synthesis: An introduction, Pietro Tundo, AlvisePerosa, F. Zecchin, 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-315B

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

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

M.Sc. CHEMISTRY SEMESTER III
CODE: CH-325B
SUBJECT NAME: PHYSICAL CHEMISTRY SPECIAL-I
NO. OF CREDITS: 4

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: Explore the approximation method for various chemical system.
CO2: Perform the matrix algebra for spin
CO3: Apply statistical thermodynamics to various chemical systems.
CO4: Learn MO and HMO treatment and their limitations.

UNIT-I: Quantum Mechanics – I
Problem of two electrons exchange interactions. Approximate methods: First order time-independent perturbation theory for non-degenerate and degenerate states, Variation theorem and Variational methods. Application of Perturbation theory and Variational method for ground state of Helium atom, Particle spin and Stern-Gerlach experiment, spin angular momentum and Pauli spin matrices, Commutation relation of spin operators and ladder operators**,** spin-orbit coupling, Coupling of angular momentum for multi-electronic system, Pauli exclusion principle, Spin-orbital wave functions for multi-electronic system (Slater determinants). Molecular Term symbols.

UNIT-II: Quantum Mechanics – II
Born-Oppenheimer approximation, the hydrogen molecule ion, the hydrogen molecule, their symmetric and antisymmetric solution (without actual evaluation of various integrals). LCAO-MO treatment of H2+ ion. Valence bond and MO (LCAO) treatment of hydrogen molecule and their limitations. Bonding and antibonding orbitals. Comparison of the MO and VB treatments and their equivalence limit. Configuration Interaction. Extension of MO theory to other systems - Homonuclear and heteronuclear diatomic, simple polyatomic molecules. Superposition principle, Hybridization and calculation of coefficients of atomic orbital's used in hybridization (sp, sp^2 and sp^3).

UNIT-III: Application of HMO theory and Electronic Structure Methods
The pi-electron approximation, Huckel theory of conjugated systems. Applications to ethylene, butadiene, cyclo-butadiene and cyclo-propenyl molecules. Calculation of properties-Delocalization energy, electron density, bond order, Walsh Diagrams and prediction of geometry (BeH_2, CH_2 and H_2O), Hellmann- Feymantheorm, Hartree-Fock-Roothaan self-consistent-field (SCF) method for

polyatomic molecules, Semi-empirical and ab-intio methods, Extended Huckel theory (EHT), Density functional theory (DFT).

UNIT-IV: Statistical Thermodynamics

Stirling's approximation, Molecular partition function and its importance. Partition function and thermodynamic properties, partition function and factorization of partition function, translational partition function, translational thermodynamic function, atoms and monoatomic molecules, Sackur-Tetrode equation, diatomic molecules, separation of internal partition function. Rotational and vibrational energies, entropy due to internal degrees of freedom. Rotational partition function, rotational partition function for polyatomic molecules, vibrational partition function.

REFERENCE BOOKS:

1. D. A. McQuarrie and J. D. Simon, "Physical Chemistry. A Molecular Approach" University Science Books, Sausalito 1997.
2. Ira N. Levine, Quantum Chemistry, 5th ed. , Prentice Hall, Englewood Cliffs, NJ, 2000.
3. Attila Szabo and Neil S. Ostlund, "Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory" Dover Books on Chemistry, 1996.
4. D. A. McQuarrie, "Quantum Mechanics" University Science Books, Mill Valley, CA, 1983.
5. R.K. Prasad, "Quantum Mechanics" New Age Publication, 2009.
6. D. A. McQuarrie, "Statistical Mechanics" Viva Books Pvt. Ltd.: New Delhi, 2003.
7. Terrell L. Hill, "An introduction to Statistical Thermodynamics" Dover Publications, 2008.
8. Ira N. Levine, "Physical Chemistry" Tata McGraw-Hill Education, 2011.
9. G.M. Barrow, "Physical Chemistry" Tata McGraw-Hill Education, 2008.
10. Engel, T. & Reid, P. Physical Chemistry 3rd Ed. Pearson (2013).
11. https://nptel.ac.in/courses/104/101/104101125/

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-325B

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 III
CODE: CH-306B
SUBJECT NAME: INORGANIC CHEMISTRY LAB -SPECIAL-I
NO. OF CREDITS: 3

			SESSIONAL	: 30
L	T	P	FINAL EXAM	: 70
0	0	6	TOTAL	: 100

COURSE OUTCOMES:

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

CO1: analyze a given salt qualitatively
CO2: synthesize an inorganic complex on his own
CO3: design and synthesize a complex of interest
CO4: do elemental and spectral analysis of a compound

1. Preparation of selected Inorganic Compounds and their Characterization by elemental analysis and spectroscopic methods (IR, NMR, EPR, Magnetic moment etc.)

    I Choloropentaamminecobalt (III) Chloride
    II Nitro/Nitritopentaamminecobalt (III) Chloride (Distinction between nitro and nitrito by IR)
    III Potassium trioxalatoferrate (III)
    IV Chromous acetate
    V Cis and trans $[Co(en)_2Cl_2]$

2 Preparation of some inorganic compounds and their spectral studies.
Tris(acetyl-acetonato) manganese (III)
Tris(acetyl-acetonato) cobaltate (III)
Preparation of Ferrocene
Tris thioureacopper(I) sulfate
Tris(acetylacetonato)chromium(III)

Experiment: 45 marks
Lab Record: 15 marks
Viva-voce: 10 marks

REFERENCE BOOKS:

1. Synthesis and Characterization of Inorganic compounds. W. L. Jolly, Prentice Hall, Englowood.
2. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London.

3. 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-306B**

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

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

M.Sc. CHEMISTRY SEMESTER III
CODE: CH-316B
SUBJECT NAME: ORGANIC CHEMISRTRY LAB-SPECIAL-I
NO. OF CREDITS: 3

			SESSIONAL	: 30
L	T	P	FINAL EXAM	: 70
0	0	6	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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 understand the concept of stepwise synthesis of a product and their purification.
CO2: To explore various combinations of reactions that can be exploited to form a product.
CO3: To have knowledge of multistep reactions the possibilities.
CO4: To develop the ability to compile interpreted information in the form of lab record.

Preparations of Organic compounds involving two and three stages:
Typical preparations from which the two and three stage preparations can be chosen are:

1. Toluene — p-nitrotoluene — p-nitrobenzoic acid — p-amino benzoic acid
2. Hydroquinone — Benzoquinone — 5- Hydroxy benzoxathiole-2-one —5-Acetoxy benzoxathiol-2-one
3. Benzene — Acetopheneone — Acetophenone oxime — Acetanilide
4. Benzaldehyde — Benzoin — Benzil — Benzillic acid
5. Acetylacetone — 4,6-dimethylpyridine-2-mercaptopyrimidine — 4,6-dimethyl-2-hydrazinpyrimidine — 1-(4'-6'-dimethylpyridine-2'yl) 3,5-dimethylpyrazole
6. Nitrobenzene — m-dinitrobenzene — m-nitroaniline — m-nitrophenol
7. Phthalic acid — phthalic anhydride – phthalimide — Anthranilic acid
8. Acetophenone — Benzalacetophenone — epoxide
9. Cyclohexanone —Cyclohexanone oxime—caprolactam
10. Phthalic anhydride—o-benzolylbenzoic acid—anthraquinone.
11. O-Cholobenzoinc acid —N-phenylanthranilic acid —acridone.
12. Cholrobenzene—2,4-dinitrochlorobenzene —2,4-dinitrophenol
13. Bromobenzene—triphenylcarbinol-tritylchloride
14. Resorcinol—resacetophenone — 4-ethyl resorcinol
15. Resorcinol — 4-methyl-7-hydroxycoumarin — 6 and 8- nitro-4-methyl-7-hydroxycoumarin
16. Phenol — salicylaldehyde —coumarin
17. Aniline — 2,4,6-tribromaniline — 1,3,5-tribromobenzene

18. Resorcinol—resacetophenone — Chalcone
19. Any other multi step reaction as per requirement

Progress of reaction and purity of Final products need to be checked for all the stages of preparation by Thin layer Chromatography.

Experiment: 45 marks
Lab Record: 15 marks
Viva-voce: 10 marks

REFERENCE BOOKS:

1. "Elementary Practical Organic Chemistry by Arthur I. Vogel Longmans, Green and Co. 1958.
2. "An Introduction to Practical Biochemistry", by David T. Plummr, Tata McGraw Hill Publishing Company, Ltd., N. Delhi, 1988.
3. Practical Organic Chemistry' by Mann and Saunders.
4. Text Book of Vogel's Practical Organic Chemistry by Longman Group, B.S. Furness et al., Ltd.
5. "Experiments in Organic Chemistry" Louis F. Fieser O.C. Heath and Company Boston, 1955.
6. "Organic Synthesis" Collective Vol. I.
7. Laboratory Manual in Organic Chemistry' by R.K. Bansal, Wiley Eastern Ltd., New Delhi-1980.
8. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975).
9. "Systematic Qualitative Organic Analysis" by H. Middleton, Edward Arnold (Publishers) Ltd., London 1959.
10. "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966.
11. "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors.
12. "A Guide to spectroscopy in Organic Chemistry' by PAVY
13. "Spectrometric Identification of Organic Compounds", Fifth Ed., R.M. Silverstein, G.S. Bassler and T.C. Morrile, John Wiley and Sons, New York.
14. "Organic Spectroscopy', 3rd Ed., by William Kamp. John Wiley & Sons.
15. "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming.
16. Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B. Maynes, Edward Arnold (Pub.)., Ltd. London, 1975).
17. "Systematic Qualitative Organic Analysis" by H. Middleton, Edward Arnold (Publishers) Ltd., London 1959.

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-316B

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**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**
CO2	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**3**	**1**	**2**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**1**	**2**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**3**

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

M.Sc. CHEMISTRY SEMESTER III
CODE: CH-326B
SUBJECT NAME: PHYSICAL CHEMISTRY LAB SPECIAL-I
NO. OF CREDITS: 3

			SESSIONAL	: 30
L	T	P	FINAL EXAM	: 70
0	0	6	TOTAL	: 100

COURSE OUTCOMES:

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

CO1: Solve problems related to the critical micelle concentration (CMC) of a surfactant by conductometric titration

CO2: Determine various parameters of reaction associated with potentiometer via potentiometrically and determine the relative strength of acids via polarimeter,

CO3: Handle data, statistical analysis, curve fitting and plotting.

CO4: Determine the relative strength of acids by polarimetry.

Potentiometry

i. Determination of activity coefficient of Ag+ in a solution of silver nitrate and to study the effect of potassium nitrate on the activity coefficient of silver nitrate.

ii. Determination of the cell Pt, H2 | HCl || AgCl | Ag with various concentrations of HCl and to obtain the activity coefficient of HCl.

iii. Determination of solubility of silver halides in water.

iv. Determination of first and second ionization constant of phosphoric acid.

v. Study of silver- ammonia complex and determination of the stability constant.

vi. Determination of strength of ferrous ammonium sulphate using potassium dichromate or ceric sulphate and determination of redox potential.

vii. Determination of strength of HCl and CH_3COOH in a mixture using NaOH.

viii. Titration of weak/strong acid with strong base using quinhydrone and determination of dissociation constant of the acid.

ix. To determine the degree of hydrolysis of aniline hydrochloride.

Polarimetry

i. Determine the percentage of two optically active substances in a mixture polarimetrically.

ii. Determination of relative strength of acids by the study of inversion of sucrose.

Conductometry

i. Determination of the equivalent conductance of weak acid (benzoic and acetic acid) at several concentrations and the dissociation constant of the acid.

ii. Determination of the equivalent conductance of strong electrolytes such as HCl, KCl, KNO_3 and NaCl and the validity of Onsagar equation

iii. Study of degree of hydrolysis of aniline hydrochloride.

iv. Determine the critical micelle concentration (CMC) of a surfactant (sodium lauryl sulphate) by conductivity method.

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-326B

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 III
CODE: OCH-311B (Open Elective)
SUBJECT NAME: CHEMISTRY FOR SUSTAINABLE DEVELOPMENT
NO. OF CREDITS: 3

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
3	0	0	TOTAL	: 100

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:
CO1: Understand role of chemistry and chemical reactions in environment
CO2: Understand the concept of thermoanalytical techniques and their application
CO3: Perform chromatographic analysis
CO4: Perform basic food analysis

UNIT I Hydrosphere:
Hydrological cycle of water, Water pollution – inorganic, organic, pesticide, agricultural, industrial and sewage, detergents, oil spills and oil pollutants. Water quality parameters – dissolved oxygen, biochemical oxygen demand, solids, metals, content of chloride, sulphate, phosphate, nitrate and micro-organisms. Water quality standards.

UNIT II Atmosphere:
Chemical composition of atmosphere – particles, ions and radicals and their formation, Chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S and their effect, air pollution controls and their chemistry.

UNIT III Thermoanalytical methods:
Introduction, Thermogravimetric analysis (TGA), Derivative Thermogravimetric analysis (DTGA), factors affecting TGA and applications, Differential thermal analysis (DTA): theory, factors affecting DTA and applications.

UNIT IV Chromatography:
Introduction, Classification of chromatographic methods; Adsorption and Partition Chromatography (Column, Paper and Thin Layer Chromatography), ion exchange chromatography: Principles and Applications.
Analysis of Food: Importance of Food analysis, Determination of approximate composition: Moisture, Fat, Protein, Fiber, Carbohydrate etc.

Reference Books:
1. Environmental Chemistry; A. K. De, Wiley Eastern.
2. Environmental Pollution Analysis; S. M. Khopkar, Wiley Eastern.
3. Environmental Chemistry; S. K. Banerji: Prentice – Hall.
4. Dynamics of Chromatography Part I; J. C. Gidding; Dekker, New York.

5. Instrumental methods of Analysis; L. L. Merits, R. H. Willard and J. A. Dean; Van Nostrand-Reinhold.

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 OCH-311B

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	1	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	2	2	3	2	3	3	2	1	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 III
CODE: OCH-312B (Open Elective)
SUBJECT NAME: APPLIED CHEMISTRY
NO. OF CREDITS: 3

L	T	P		
3	0	0	SESSIONAL	: 25
			FINAL EXAM	: 75
			TOTAL	: 100

COURSE OUTCOMES:

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

CO1: understand chemistry of polymers and polymerization
CO2: understand and analyse thermal physical and chemical properties of polymers
CO3: know about drug and drug design
CO4: have an analytical view against different types of medicines, their uses and side effects

UNIT I Polymer Chemistry-I:
Polymer basic concepts: monomers, degree of polymerization, classification of polymers, types of polymerization, Concept of no. average molecular weight and mass average molecular weight, Methods of determining molecular weights, concept of kinetic chain length Polydispersity index, kinetics of polymerization (addition and chain polymerization)

UNIT II Polymer Chemistry-II:
Thermal properties of polymers, Flame retardant polymers, Flame retarding Thermoplastics and Thermosets, physical properties of polymers (glass transition temperature, crystalline melting point), factors affecting T_g and T_m Polymer composites, its classification, polymer composites using filler reinforcement, Biocomposites, application of biocomposites in automobiles and in construction materials. Polymer nanocomposites, Properties of polymer nanocomposites, application of polymer nanocomposites

UNIT III Medicinal Chemistry-I:
Concept of drug and drug development, lead compound and lead modification, prodrugs and soft drugs, an elementary idea of structure reactivity relationship (SAR), Elementary idea about drug action: the receptor role, neurotransmitters and receptors, ion channels and their control, membrane bound enzymes-activation/deactivation, chemical basis of messenger induced change of shape by the receptor

UNIT IV Medicinal Chemistry-II:
Definition, uses and side effects of the following categories of drugs:
Antipyretics, analgesics & anti-inflammatory agents (paracetamol, asprin, mefenamic acid, ibuprofen and diclofenac), antimalarial (Chloroquine, chloroguanide), Anticancer (Chlorambucil, cyclophosphamide), Cardiovascular drugs (sorbitrate, diltiazem), Antifertility agents (introduction to hormonal and nonhormonal contraception only).

Reference Books:

1. Polymer Chemistry, Billmayer
2. Polymer Chemistry, Gowarikar
3. Principles of Polymerization, Geroge Odian
4. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, Ed. Robert F. Dorge.
5. Burger's Medicinal Chemistry and Drug Discovery, Vol-I, Ed. M.E. Wolf, John Wiley.
6. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.

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 OCH-312B

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2	3	3	3	3	2	3	3	3	3	3
CO2	3	3	2	3	3	2	1	3	3	3	2	3	3	2	3
CO3	3	2	3	2	3	3	3	2	2	1	3	3	3	3	2
CO4	3	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 IV
CODE: CH-401B
SUBJECT NAME: INORGANIC SPECIAL-II
NO. OF CREDITS: 4

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: Explain different types of chemical reactions of inorganic chemistry.
CO2: Explain photochemical reactions.
CO3: Solve problems related to nuclear chemistry
CO4: Propose new synthetic routes for the compounds

UNIT I

Reaction Mechanism of Transition Metal Complexes: Energy profile of a reaction, reactivity of metal complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favor of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage.

Electron Transfer Reactions: Kinetics and mechanism of one electron transfer reactions, outer-sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions, two electron transfer reactions, metal ion catalysed reactions, mixed valence complexes and their electron transfer.

UNIT II

Reactions of metal complexes: Reactivity of coordinated hydrocarbons: a) Nucleophilic and electrophilic addition and substitution b) Rearrangement reactions, Redistribution reactions,

Fluxional Organometallic compounds: Fluxionality and dynamic equilibria in compound such as η^2-olefin, η^3-allyl and dienyl complexes, Carbonyl scrambling.

Isopoly and Heteropoly Acids and Salts: Isopoly and Heteropoly acids and salts of Mo and W: Structures of isopoly and heteropoly anions.

.

UNIT-III

Photochemistry: Absorption, excitation, photochemical laws, quantum yield, electronically excited states- life times-measurements of the times. Energy dissipation by radiative and non radiative

processes, bimolecular quenching, absorption spectra, Franck condon principle, photochemical kinetics, photochemical stages-primary and secondary.

Excited States of Metal Complexes: Electronically excited states of metal complexes: charge-transfer spectra, charge transfer transition, photosubstitution reactions, photorearrangements, photoisomerisation, photoredox processes conditions of excited states to be useful redox reactant. Transformation of chemical energy into light energy.

UNIT-IV

Nuclear Binding Energy: Justifications and applications; nuclear stability rules and decay of unstable nuclei.

Nuclear Reactions: Energetics of nuclear reactions; various types of nuclear reactions including photonuclear, thermonuclear and spallation reactions; mechanism of nuclear reaction by compound nucleus model.

Nuclear fission – Fission probability; energy release; theories of fission.

Nuclear Fusion: Brief idea about breeder reactors; accelerators and cyclotron.

Radiochemical Techniques: NAA - Principle, Application and Limitation, IDA - Principle, Application and Limitation; Radiometric titrations.

REFERENCE BOOKS:

1. Mechanism of Inorganic Reactions; F.Basolo and R.G. Pearson, John Wiley and Sons, New York.
2. Inorganic Reaction Mechanism; M.L. Tobe; Nelson, Wlaton and Thames
3. Inorganic Chemistry; K.F. Purcell, J.C. Kotz; Holt-Sanders International Editions; Philadelphia.
4. The Chemistry of Molten Salts; H. Bloom Benjamin, New York.
5. Principles and Application of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
6. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.
7. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International
8. Coordination Chemistry; Banerjea; Tata McGraw Hill.
9. Inorganic Chemistry, A Modern Introduction; T. Moeller; John Wiley and Sons.
10. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J.J. Alexander; John Wiley and Sons Inc.
11. Essentials of Nuclear Chemistry – H. J. Arnikar.
12. Radio Chemistry & Nuclear Chemistry – G.Choppin, J.O. Liljenzin & J.Rydberg.
13. Nuclear Chemistry – M. Sharon.
14. Modern Nuclear Chemistry – W.D. Loveland, D.J. Morrissey & G.T. Seaborg.
15. Handbook of Nuclear Chemistry: Instrumentation, Separation Techniques, Environmental issues – A. Vertes, S. Nagy & Z. Klencsar.
16. Concepts of Inorganic Photochemistry, A.W. Adamson and P.D. Fleischauer, Wiley.
17. Photochemistry of coordination compounds, K.Balzani and V.Carassti, Academic press.
18. Elements of Inorganic Photochemistry; G.J. Ferraudi, 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-401B**

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

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

M.Sc. CHEMISTRY SEMESTER IV
CODE: CH-402B
SUBJECT NAME: Inorganic Special-III
NO. OF CREDITS: 4

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: Explain structure and bonding of organometallic compounds and further can synthesize new such compounds.
CO2: Understand the Transition Metal π-Complexes
CO3: Suggest catalysts and catalytic action for various reactions.
CO4: Solve problems related to analysis of compounds using electro-analytical methods.

UNIT-I Alkyls and Aryls of Transition Metals

Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis.

Compounds of Transition Metal-Carbon Multiple Bonds: Alkylidenes, alkylidynes, low valent carbenes and carbynes- synthesis, nature of bond, structural characteristics, nucleophilic and electrophilic reactions on the ligands, role in organic synthesis

UNIT-II Transition Metal π-Complexes

Transition metal π-complexes with unsaturated organic molecules, alkenes, alkynes, allyl, diene, dienyl, arene and trienyl complexes, preparations, properties, nature of bonding and structural features. Important reactions relating to nucleophilic and electrophilic attack on ligands and to organic synthesis.

UNIT-III Homogeneous Catalysis

Stoichiometric reactions for catalysis, homogeneous catalytic hydrogenation, alkene hydrogenation-Wilkinson's catalysis, Zeigler-Natta polymerization of olefins, Monsanto acetic acid process, catalytic reactions involving carbon monoxide such as hydrocarbonylation of olefins (oxo reaction), oxidation of olefins-Wacker's process; oxopalladation reactions, activation of C-H bond.

UNIT-IV Electro analytical methods of Analysis

Electrogravimetry: Current-voltage relationship during an electrolysis, decomposition potential, constant current electrolysis, constant cathode potential electrolysis, apparatus, electrodes, mercury cathode, applications physical properties of electrolytic precipitates, chemical factors of importance in electrodeposition.
Electrolytical methods without cathode potential control, Polarography
Coulometric analysis: Coulometric methods of constant electrode potential and coulometric titrations. Apparatus and applications.
Amperometric titrations, anodic stripping voltammetry, and cyclic voltammetry

REFERENCE BOOKS:

1. Mechanism of Inorganic Reactions; F.Basolo and R.G. Pearson, John Wiley and Sons, New York.
2. Inorganic Chemistry; K.F. Purcell, J.C. Kotz; Holt-Sanders International Editions; Philadelphia. .
3. Principles and Application of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
4. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.
5. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.
6. Coordination Chemistry; Banerjea; Tata McGraw Hill.
7. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J.J. Alexander; John Wiley and Sons Inc.
8. A Textbook of Quantitative Inorganic Analysis, A.I. Vogel; ELBS, London.
9. Fundamentals of Analytical Chemistry; D.A. Skoog, O.M. West and F.J. Holler; W.B. Saunders.
10. Instrumental methods of Analysis; L.L. Merrit, R.H. Willard and J.A. Dean; Van Nostrand-Reinhold.
11. Basic concepts of Analytical Chemistry – S.M. Khopkar

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-402B

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	2	3	3	2	3	3	3	3
CO2	3	3	3	3	2	3	3	2	3	3	2	3	3	3	3
CO3	3	3	3	3	2	3	3	2	3	3	2	3	3	3	3
CO4	3	3	3	3	2	3	3	2	3	3	2	3	3	3	3

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

M.Sc. CHEMISTRY SEMESTER IV
CODE: CH-403B
SUBJECT NAME: Inorganic Special-IV
NO. OF CREDITS: 4

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: Suggest better composite materials on the basis of their properties and structure.
CO2: Synthesize and characterize nanoparticles.
CO3: Design and control coordination reactions in non aqueous solvents
CO4: Explain various characteristics of cement and can propose some further research in this area.

UNIT-I: Composite Materials

Definition, General characteristics and classification, Matrix, Fillers, Types of matrix and fillers, Division of composites based on filler reinforcement pattern, Dispersion strengthened composites, Al-based (SAP) and Mg, Ti, Ni-based fibrous composites, Critical length of fibers, Applications of Composites.

UNIT-II: Nano materials Technology:

Nano materials and their historical perspective. Applications of nanoscience and nanotechnology in various fields. Unique properties of nanomaterials due to their nanosize, Quantum dots, Nanotubes, Fullerenes;

Techniques for their synthesis: Hydrothermal, Solvothermal, Microwave irradiation, sol-gel, Precipitation, Reverse Micelle Synthesis, Physical Vapour deposition (PVD), Chemical Vapour Deposition (CVD), Electro deposition,

Thin Films and Langmuir-Blodgett films: Preparation, properties and applications.

Properties of nanostructured materials: optical, magnetic, chemical and photo catalytic properties.

UNIT-III: Crystal Structures

Structures of some binary and ternary compounds such as fluorite, antifluorite, rutile, antirutile, crystobalite, layer lattices- CdI_2, BiI_3; ReO3, Mn_2O_3, corundum, pervoskite, Ilmenite and Calcite, band theory of solids.

Non-aqueous Solvents: Reaction in non-aqueous media with respect to H_2SO_4, BrF_3, N_2O_4 and phosphoryl chloride; Kinetics and mechanism of coordination reactions in non-aqueous media.

UNIT-IV: Cement Chemistry: Indian Cement Industry, Cement Manufacturing Process, Cement Raw Materials, Corrective Materials/ Additives. Raw Mix Proportioning, Raw Mix Design,

Modulii Values and their effects. Burnability, Absorption and effect of Coal Ash. Chemical and Phase Composition of Clinker, Bogue Calculation, Clinker Reaction during Clinkerization, Fuels, Mineralisers and Fluxes. Hydration of Cement, Setting, Hardening and Strength gain, Role of various Clinker Phases. Use of Waste Materials – Fly ash and Slag etc., Pozzolanic Reaction, Hydration of Slag. Types of Cement, BIS specifications of various types of Cement. Quality Control in Cement Manufacture. Physical and Chemical Testing of Cement.

REFERENCE BOOKS:

1. Materials Science by Azimasov (Mir Publications)
2. Introduction to nanotechnology : Charles P. Poole, Jr. Frank, J. Owens : Wiley India
3. Basics of nanochemistry., Sachdeva, Mamta V
4. Nanochemistry, Sergeev, G. B. and K. L. Klabunde, Elsevier, 2013.
5. Concise Inorganic Chemistry – J.D. Lee
6. Inorganic Chemistry – T. Moeller.
7. Modern Aspects of Inorganic Chemistry – H.J. Emeleus & A.G. Sharpe.
8. The Chemistry of Cement and Concrete, F. M. Lea
9. Cement Chemistry, H.F.W. Taylor

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-403B

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	2	3	3	2	3	3	3	3
CO2	3	3	3	3	2	3	3	3	3	3	2	3	3	3	3
CO3	3	3	3	3	2	3	3	3	3	3	2	3	3	3	3
CO4	3	3	3	3	2	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 IV
CODE: CH-411B
SUBJECT NAME: ORGANIC CHEMISTRY SPECIAL-II
NO. OF CREDITS: 4

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: Get to know mechanistic details of various name reaction in organic chemistry.

CO2: To understand the principle of oxidation and reduction reactions related various important organic functional groups.

CO3: To understand the principle of Organometallic Reagents and their applications in organic synthesis.

CO4: Have an idea of supramolecular chemistry, Phase Transfer Catalysis, Crown ethers, cryptates, cyclodextrins, calixarenes, and micelles.

UNIT I: Name Reactions & Rearrangements

A detailed study including mechanism of Beckmann, Hofmann, Curtius, Lossen, Schmidt, Favorskii, Neber, Fritsch-Butenberg-Wiechell, Baeyer-Villiger, Benzil benzillic acid rearrangements, Arndt-Eistert synthesis, Darzens synthesis, stroke enamine synthesis, Shapiro reaction, Sharplcss asymmetric epoxidation.

UNIT II: Redox Reactions

Oxidation - Introduction, Different oxidative processes for the followings: Hydrocarbons- alkenes, aromatic rings, saturated C-H groups (activated and unactivated). Alcohols, diols, aldehydes, ketones, and carboxylic acids.

Reduction – Introduction, Different reductive processes for followings: Hydrocarbons – alkanes, alkenes, alkynes and aromatic rings. Carbonyl compounds – aldehydes, ketones, acids and their derivatives. Nitro compounds. Hydrogenolysis.

UNIT III: Organometallic Reagents-I

Principle, preparations, properties and applications of the reagents of the following metals/non-metals (Main group elements) in organic synthesis with mechanistic details;

Li, Mg, Cd, Zn, Cu, S, Si, B and I.

UNIT IV: Organometallic Reagents-II

Principle, preparations, properties and applications of the reagents of the following metals (transition metal reagents) in organic synthesis with mechanistic details Pd, Fe, Co, Rh, Cr and Ti compounds.

Supramolecular chemistry: An idea of supramolecular chemistry, Phase Transfer Catalysis, Crown ethers, cryptates, cyclodextrins, calixarenes and micelles.

REFERENCE BOOKS:

1. Modern Synthetic Reactions, H.O. House, W.A. Benzamin.
2. Some Modern Method of Organic Synthesis, W. Carruther, Cambridge Univ. Press.
3. Advanced Organic Chemistry, Reactions Mechanism and Structure, J. March, John Wiley.
4. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional
5. Handbook of Green Chemistry- Gre en Catalysis- Paul T. Ana sta s, Robert H. Crabtree, Wiley-VCH
6. Methods and Reagents for green synthesis: An introduct ion, Pietro Tundo, Alvis e Perosa, F. Zecchin, 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-411B

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

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

M.Sc. CHEMISTRY SEMESTER IV
CODE: CH-412B
SUBJECT NAME: ORGANIC CHEMISTRY SPECIAL-III
NO. OF CREDITS: 4

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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: be familiar with basic concepts of disconnection approach, one- & two-group C-X and C-C disconnections, chemoselectivity, reversal of polarity, amine synthesis, stereoselectivity, stereospecificity, regioselectivity and regiospecificity.

CO2: apprise of protection of important functional groups namely alcoholic, amino, carbonyl and carboxylic groups and to apply the concept of disconnection approach for the synthesis of drug molecules.

CO3: be acquainted with mechanistic details of the methods of preparation and reactions of heterocyclic compounds.

CO4: understand the general aspects of natural products including structures, stereochemistry and synthesis.

UNIT I: Disconnection Approach-I

An introduction of synthons and synthetic equivalents, general principles of the disconnection approach, functional group interconversions, the importance of order of events in organic synthesis, one group C-X and two group C-X disconnections, one group C-C disconnection, chemoselectivity, regioselectivity, regiospecificity, stereoselectivity and stereospecificity, reversal of polarity.

UNIT II: Disconnection Approach-II

Principle of protection of alcoholic, amino, carbonyl and carboxylic groups. Two group C-C disconnection- Diels Alder reactions, 1,3-difunctionalized compounds and α,β unsaturated carbonyl compounds, control in carbonyl condensations, 1,5-difunctionalized compounds-Michael addition and Robinson Annelation.
Disconnection approach towards the synthesis of juvabione and cortinsone.

UNIT III: Heterocyclic compounds

Systematic (Hantzsch-Widman) nomenclature for monocylic and fused ring systems. General synthesis and reactions (including mechanism) of the followings: Three-membered heterocycles: oxirane, azirane, Four-memebered heterocycles:

Oxetane and azetidine, Five-membered heterocycles: pyrazole, imidazole, oxazole, thiazole; Comparison of their basic character.

UNIT IV: Natural products

Terpenoids: General aspects of structure determination of terpenoids. Structure elucidation and synthesis of Geraniol, α-pinene. Biogenetic isoprene rule and biogenesis of terpenoids.

Steroids: Structure and biological role of Cholestrole with absolute configuration (synthesis and structural elucidation excluded).

Methods for the following conversions.

i) Cholesterol → Testosterone
ii) Cholesterol → Progesterone
iii) Cholesterol → 5-α and 5-β cholanic acids.

Alkaloids: Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring.
Structure, stereochemistry, synthesis and biosynthesis of the followings: Ephedrine, Nicotine.

REFERENCE BOOKS:

1. Designing Organic Synthesis, S.Warren, Wiley.
2. Organic Chemistry, Vol. 2, I.L. Finar, ELBS.
3. Heterocylic Chemistry, T.L. Gilchrist, Longman Scientific Technical.
4. Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, eds. Pergaman Press.
5. Natural Products: Chemistry and Biology Significance, J.Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Essex.

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-412B

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**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**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 IV
CODE: CH-413B
SUBJECT NAME: ORGANIC CHEMISTRY SPECIAL-IV
NO. OF CREDITS: 4

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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 basics of enzymes (classification and nomenclature) and their role in biological systems.

CO2: Know basics of conenzyme chemistry and mechanism of the bio-chemical reactions catalyzed by them.

CO3: Know the basics of antibiotics mainly focusing to the penicillin.

CO4: Understand mode of drug action, drug development basics and synthesis of important drugs.

UNIT I

Enzymes: Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labeling. Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition.

Mechanism of Enzyme Action: Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion, Mechanism of action of chymotrypsin.

UNIT II

Co-Enzyme Chemistry: Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate (TPP), pyridoxal phosphate (PLP), NAD^+, $NADP^+$, FMN, FAD. Mechanisms of reactions catalyzed by the above cofactors

Antibiotics: Cell wall biosysnthesis and protein synthesis inhibitors: Penicillins and semi-synthetic penicillins. Medicinal uses of penicillin G, problems of sensitivity to acids, β-lactamases and narrow spectrum of activity, solving these problems leading to the development of penicillin V. Introduction and discovery of cephalosporins (structure elucidation and synthesis excluded).

UNIT III

Drug Design: Classification and discovery of new drugs, history and development of chemotherapeutic agents, therapeutic index, LD50 and ED50, naming of (new) drugs.

Elementary idea about drug action: the receptor role, neurotransmitters and receptors, ion channels and their control. Membrane bound enzymes-activation/deactivation. Chemical basis of messenger induced change of shape by the receptor. Design of agonists, antagonists and partial agonists

Drug development: Screening of natural products, isolation and purification, structure determination, structure-activity relationships (SAR), synthetic analogues, isosteres and bioisosteres, concept of lead compounds.

Brief overview of pharmacokinetics and pharmacodynamics, concept of prodrug and synergism.

UNIT IV

Synthesis, General Mode of Action and Medicinal Uses of Important Drugs in the Following Categories.

Antineoplastic Agents: Mechlorethamine, Chlorambucil, cyclophosphamide, aminopterin, 6-mercaptopurine, paclitaxel (synthesis of paclitaxel excluded)

Antimalarials:Chloroquine, primaquine, chloroguanide, pyrimethamine

Analgesics, Antipyrics and Antiinflammatory agents: Morphine and related compounds (codeine and heroin), meperidine, methadone, aspirin, acetaminophen, indomethacin, phenylbutazone, mefenamic acid, ibuprofen, diclofenac, celecoxib.

Antifertility agents: Ovulation inhibitors and related hormonal contraceptives - norethindrone, norethynodrel, estradiol, mestranol, non-hormonal contraceptive-centchroman (synthesis of all the drugs excluded).

Cardiovascular Drugs: Calcium channel blockers and β-blockers: sorbitrate, diltiazem, atenolol and verapamil.

AIDS and drugs against HIV: HIV infection to the system, structure and mode of action of important drugs against HIV (nucleoside reverse transcriptase inhibitors) - AZT, ddI, ddC, d4T and 3TC (synthesis only of AZT).

REFERENCE BOOKS:

1. Organic Chemistry, Vol 2, I. L. Finar, ELBS.
2. Natural Products: Chemistry and Biology Significance, J.Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Essex.
3. Biochemistry, A.L. Lehninger.
4. Outlines of Biochemistry, Cohn & Stumpf.
5. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, Ed. Robert F. Dorge.
6. Burger's Medicinal Chemistry and Drug Discovery Vol-I Ed. M.E. Wolf, John Wiley.
7. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.

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-413B

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

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

M.Sc. Chemistry SEMESTER IV
CODE: CH-421B
SUBJECT NAME: Physical Chemistry Special-II
NO. OF CREDITS: 04

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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 various applications of emulsions, reverse micelles.
CO2: Determine molecular weight of polymers.
CO3: Apply fluorescence spectroscopy for various chemical problems.
CO4: Understand various solvent effects on probe behavior.

UNIT-I: Physical Polymer Science

Polymers Hyperbranched–star, Plasticizers, composites. Classification of Polymers, tacticity, Polymer entanglement theory and relationship with physical properties, Average end-to-end distance, average radius of gyration (Rg) of polymer chains, statistical distribution of end-to-end distance (Re-e) and segment density. Glass transition temperature (Tg) and factors influencing the measurement and its dependence on molecular weight, chemical structure and composition. Thermodynamics of polymer solutions: Entropy of mixing – Flory-Huggins Theory. Molecular Weight and Number-, Weight-, z-Average, Polydispersity index and standard deviation. Determination of Molecular Weight of Polymers: Osmotic pressure method, sedimentation-velocity & equilibrium method. Light scattering by polymer solutions, Form factor and the Zimm Model, Viscoelasticity. Conducting Polymers and Polymer electrolytes.

UNIT-II: Micelles and Emulsion

Surface active agents, classification of surface-active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, determination of CMC, counter-ion binding to micelles, thermodynamics of micellization-phase separation and mass action models, solubilization, emulsions, micro emulsion: Mechanism of formation and their stability, Application of emulsions, reverse micelles. Micellar catalysis. Colloids: Theory, application, and interfaces.

UNIT-III: Photochemistry – I

Revision of basic concepts of photochemistry, Lifetimes of excited electronic states of atoms and molecules. Charge transfer transitions, The Frank-Condon principle, emission spectra, environment effect on absorption and emission spectra, Wigner's spin conservation rule. Modes of decay of

excited states, quenching of fluorescence, delayed fluorescence, collisional quenching, Stern–Volmer equation. Excimer and exciplex formation and decay. Techniques for the study of transient species in photochemical reactions. Fluorescence up conversion, TCSPC, Applications of Lasers in photochemical kinetics.

UNIT-IV: Photochemistry – II

Fluorescence Quenching and Solvent Effects: Overview of Solvent Polarity, Effects of Solvent Polarity, Polarity Surrounding a Membrane-Bound Fluorophore, Other Mechanisms for Spectral Shifts, General Solvent Effects: The Lippert-Mataga Equation, Derivation of the Lippert Equation, Application of the Lippert Equation, Specific Solvent Effects, Specific Solvent Effects and Lippert Plots, Temperature Effects, Additional Factors that Affect Emission Spectra, Locally Excited and Internal Charge-Transfer. States, Excited-State Intramolecular Proton Transfer (ESIPT), Changes in the Non-Radiative Decay Rates, Changes in the Rate of Radiative Decay, Effects of Viscosity, Probe–Probe Interactions, Advanced Solvent-Sensitive Probes, Effects of Solvent Mixtures.

REFERENCE BOOKS:

1. L. H. Sperling, “Introduction to Physical Polymer Science” 4th Ed., John Wiley & Sons, Inc. Publication, 2006.
2. Paul A. Hiemenz and Timothy P. Lodge, “Polymer Chemistry” 2nd Ed. Taylor & Francis Group CRC Press, 2007.
3. Fred W. Billmeyer, “Textbook of Polymer Science” Wiley India Pvt. Limited, 2007.
4. M. Rubinstein and Ralph H. Colby, Polymer Physics (Chemistry), Oxford University Press, 2003.
5. Y. Moroi, Micelles: Theoretical and Applied Aspects, Springer, 1992.
6. Engel, T. & Reid, P. “Physical Chemistry” 3rd Ed. Pearson (2013).
7. Joseph R. Lakowicz, “Principles of Fluorescence Spectroscopy” 3rd Ed., Springer US, 2006.
8. Brian Wardle, “Principles and Applications of Photochemistry” John Wiley & Sons Ltd., 2009.
9. K. K. Rohatgi and K. K. Mukherjee; Fundamentals of Photochemistry, 3rd ed. New Age International (P) Ltd., 2014.
10. N. J. Turro, V. Ramamurthy and J. C. Scaiano, Modern Molecular Photochemistry of Organic Molecules, 1st ed. University Science, Books, CA, 2010

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-421B**

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 IV
CODE: CH-422B
SUBJECT NAME: Physical Chemistry Special-III
NO. OF CREDITS: 4

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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 modern techniques for rate determination.
CO2: Apply transition state theory to various chemical systems.
CO3: Determine and calculate thermodynamic properties using non equilibrium thermodynamics.
CO4: Apply bio physical methods to predict protein Structure.

UNIT-I: Transition State Theory

Molecular beams, principle of crossed-molecular beams. Molecular encounters and principal parameters, e.g. Impact parameter, Collision cross-section, Reaction cross-section and relation between reaction cross-section and reaction rate (single velocity). Dependence of collisional cross-section on translational energy. A brief aspect of statistical mechanics and transition state theory, application on calculation of second order rate constant for reactions with collision for (atom + atom), (atom + molecule), and (molecule + molecule) reactions.

UNIT-II: Chemical Dynamics

Solution Kinetics - Kinetic salt-effect. Modern techniques in gas phase and in solution, flash photolysis, flow methods, relaxation techniques (temperature jump, pressure jump) and shock tube technique. Metal-ion catalyzed reactions and reaction mechanism, induced reactions and their characteristics, applications, kinetics and mechanism of induced reaction in metal complexes, kinetics of hydroformylation reactions. Enzyme catalyzed models of 1:2 type enzyme substrate systems, kinetics of one-enzyme two-substrate systems: Bi-Bi Mechanism, Sequential and Ping-Pong Mechanism.

UNIT-III: Non-equilibrium Thermodynamics

Non-equilibrium Thermodynamics: General theory of non-equilibrium thermodynamics, entropy production in heat flow, matter flow and electric current, the Onsager's reciprocal relations, their proof, transport parameters, thermoelectric effects, thermomechanical phenomena and thermocells. Determination and calculation of thermodynamic properties i.e. internal energy, entropy, Helmholtz and Gibbs free energy, ortho and para hydrogen states, free energy functions. Partition function and

equilibrium constant, effect of nuclear spin, isomolecular reaction, isotopic exchange reactions. Einstein theory and Debye theory of heat capacities of monatomic solids.

UNIT-IV: Bio-Physical Chemistry

Chemical bonds in biological systems; Properties and role of water biological systems. Thermodynamic principles in biological systems – entropy behavior in biology system. Cell Membrane and Transport of Ions: Structure and functions of cell membrane. Active transport across cell membrane, irreversible thermodynamics treatment of membrane transport. Na^{+}-K^{+} pump. Osmotic pressure, membrane equilibrium. Introduction to Protein Folding: Protein-Protein interaction, Protein-Ligand interaction, Protein-Folding dynamics, Protein Folding: Theory and Experiment, Folding Accessory Proteins, Protein Structure Prediction and Design, Protein Dynamics, DNA-Drug Intercalation. Optical methods and applications: Optical techniques in biological systems: Linear and Circular Dichroism.

REFERENCE BOOKS:

1. C. Raymond, "Physical Chemistry for the Biosciences", University Science Books, California 2005.
2. R. I. Masel, Chemical Kinetics and Catalysis, Wiley Interscience, New York, 2001.
3. Fred Basolo and Ralph G. Pearson, "Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution, 1967.
4. K. J. Laidler and J. H. Meiser, "Physical Chemistry" 3rd Ed. Houghton Mifflin Company, Boston 1999.
5. K. J. Laidler, "Chemical Kinetics" Pearson Education India; 3rd Ed., 2003.
6. Houston, P. Chemical Kinetics and Reaction Dynamics. New York, NY: McGraw-Hill, 2001.
7. Donald Voet and Judith G. Voet, "Biochemistry", 4th Ed., John Wiley & Sons, Inc., 2010.
8. D. A. McQuarrie, "Statistical Mechanics" Viva Books Pvt. Ltd.: New Delhi, 2003.
9. Terrell L. Hill, "An introduction to Statistical Thermodynamics" Dover Publications, 2008.
10. R.K. Pathria and P.D. Beale, "Statistical Mechanics", 3rd Edn., Elsevier Ltd., 2011.
11. Lecture Notes: http://umich.edu/~elements/03chap/html/transition/index.htm#IIA

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-422B**

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 IV
CODE: CH-423B
SUBJECT NAME: Physical Chemistry Special-IV
NO. OF CREDITS: 4

			SESSIONAL	: 25
L	T	P	FINAL EXAM	: 75
4	0	0	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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 photovoltaics and design of solar cells.
CO2: Learn and apply various electroanalytical techniques.
CO3: Basics of molecular modelling of materials.
CO4: Design and understand working of fuel cells and battries.

UNIT-I: Band theory of Solids and Solar Cells

Free electron theory of metals, Quantum mechanical treatment explaining the origin of band gaps, density of states, Band theory, Bloch theorem, Brillouin zones, effective mass of charge carriers, Semiconductors: Direct and indirect band gap semiconductors, hole-concept, temperature dependence of mobility and electrical conductivity, free carrier concentration in intrinsic and extrinsic semiconductors, mass active law, Generation of carriers and their recombination in semiconductors. Types of junctions, Analysis of p-n junction including I-V characteristics. Introduction to Photovoltaics. Basic PV system design. Design and materials of solar cells. Thermodynamics of light conversion. Solar radiation and conversion efficiency. Factors influencing solar cell efficiency. Recent advancement and future challenges in solar cells.

UNIT-II: Advanced Electrochemistry

Advanced Electrochemistry concepts: Overpotential concept, Exchange current density, Butler-Volmer equation, Polarizable and non-polarizable interfaces. Tafel equations. Electrochemical Processes: Difference between kinetically and mass transport controlled electrochemical processes. Potential Sweep Method: Linear-Sweep voltammetry, Cyclic voltammetry. Controlled current techniques- chronopotentiometry: theory and applications. Coulometry and hydrodynamic methods. Polarography, Dropping Mercury Electrode (DME) and DME applications. Electrocatalysis: Introduction, Homogeneous and heterogeneous electrocatalysis

UNIT-III: Fuel Cells and Batteries

Electrochemical storage, theoretical consideration of Fuel Cells, Types of Fuel Cells, maximum intrinsic efficiency, Hydrogen–Oxygen Fuel Cells, Alkaline Fuel Cells, Phosphoric Acid Fuel Cell, Direct-Methanol Fuel Cells. Current Density and Fuel Cells over-potentials characteristics.

Battery characteristics specification, components, battery systems, Lead storage battery. Li-ion Batteries – Advantages, materials, recent advancements and future challenges. Supercapacitors-Fundamentals and Impedance analysis. Nanostructured and surface modified electrodes: Introduction and their applications. Electrochemistry of water splitting, electrolysis of sea water, electrochemical reduction of CO2. Corrosion: Forms of corrosion, Corrosion monitoring and prevention methods.

UNIT-IV: Molecular Modelling of Materials

Phase Space, Z-matrix, Molecular representations, Potentials and Force-Fields, Types of Force-field, and their relevance. Type of dihedrals and dihedral potentials. Periodic Boundary Conditions, Minimum Image convention. Cut-off potentials. Propagation of Newton's Equation – Leap-Frog algorithm. Time-Step and Energy Minimization. Fluctuations - Time Correlation Function, Radial Distribution Function and Mean Square Displacement. Simulated Annealing – Advantages and applications.

REFERENCE BOOKS:

1. Alan L. Fahrenbruch and Richard Bube, “Fundamentals of solar cells: Photovoltaic Solar Energy Conversion”, Academic Press, 2012.
A. R. West, “Solid State Chemistry and its Applications”, 2nd Ed., John Wiley & Sons, 2014.
2. E. Moore and L. Smart “Solid state chemistry: An introduction”, Chapman Hall, 1996.
3. Charles Kittel, “Kittel's Introduction to Solid State Physics”, Wiley India Edition, 2019.
4. L. V. Azaroff, “Introduction to Solids”, Tata McGraw-Hill, New Delhi, 1977.
5. John O'M. Bockris and Amulya K.N. Reddy, “Volume 1: Modern Electrochemistry: Ionics” Springer, 2nd Ed., 1998.
6. John O'M. Bockris and Amulya K.N. Reddy, “Modern Electrochemistry 2B: Electrodics in Chemistry, Engineering, Biology and Environmental Science” Springer, 2nd Ed., 2000.
A. J. Bard and L.R. Faulkner, “Electrochemical Methods Fundamentals and Applications”, Wiley, 2nd Ed. 2000.
7. S. Srinivasan, “Fuel cells from fundamentals to applications”, Springer, New York, 2006.
8. M. P. Allen and D. J. Tildesley, “Computer Simulations of Liquids” Oxford Science Publications, 1989.
9. Mark Tuckerman, “Statistical Mechanics: Theory and Molecular Simulation” by Oxford Graduate Texts, 2010.
10. Andrew R. Leach, “Molecular Modeling: Principles and Applications” Addison Wesley Publishing Company, 1997.
11. Daan Frenkel, “Understanding Molecular Simulation: From Algorithms to Applications” Computational Science Series, Vol 1, 2001.
12. Frank Jensen, “Introduction to Computational Chemistry” 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-423B

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 IV
CODE: CH-404B
SUBJECT NAME: Inorganic Chemistry Lab -Special-II
NO. OF CREDITS: 3

L	T	P		
0	0	6	SESSIONAL	: 30
			FINAL EXAM	: 70
			TOTAL	: 100

COURSE OUTCOMES:

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

CO1: perform spectrophotometric analysis of compounds.
CO2: do analysis based on conductometric titrations
CO3: do pH-metry based analysis of compounds and solutions
CO4: handle different instruments for analytical studies

Instrumentation Techniques:

I	Spectrophotometric Determinations
II	Conductometric Titrations
III	Flame Photometry
IV	Potentiometric/pH-analysis
V	Electrogravimetric analysis
VI	Polarographic analysis
VII	Any other techniques introduced

Note: Instrumentation techniques may be worked out as per resource availability

Experiment: 45 marks
Lab Record: 15 marks
Viva-voce: 10 marks

REFERENCE BOOKS:

1. Synthesis and Characterization of Inorganic compounds. W. L. Jolly, Prentice Hall, Englowood.
2. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London.
3. 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-404B

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 IV
CODE: CH-405B
SUBJECT NAME: Inorganic Chemistry Lab -Special-III
NO. OF CREDITS: 3

			SESSIONAL	: 30
L	T	P	FINAL EXAM	: 70
0	0	6	TOTAL	: 100

COURSE OUTCOMES:

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

CO1: Perform elemental analysis by volumetric and gravimetric methods
CO2: Undertake instrumental techniques for analysis of inorganic compounds and solutions
CO3: Understand the concept and application of complexometric titrations
CO4: Handle different instruments for analytical studies

Quantitative analysis:

1. Determination of triple elements in the mixtures, ores, alloys etc. by available analytical techniques.
   - **I** Volumetrically
   - **II** Gravimetrically
   - **III** Instrumentation methods

2. Complex Ion Composition determination by Job's method

   (a) Determination of composition of complex ion nickel(II) ethylene-diamine, $Ni(NH_2CH_2CH_2NH_2)_x$, $Zn(NH_2CH_2CH_2NH_2)_x$ by Job's method
   (b) Determination of composition of 8-hydroxy quinoline-Ca^{2+} complex by Job's method.

Experiment: 45 marks
Lab Record: 15 marks
Viva-voce: 10 marks

REFERENCE BOOKS:

1. Synthesis and Characterization of Inorganic compounds. W. L. Jolly, Prentice Hall, Englowood.
2. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London.
3. 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-405B

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 IV
CODE: CH-414B
SUBJECT NAME: ORGANIC CHEMISTRY LAB –SPECIAL-II
NO. OF CREDITS: 3

			SESSIONAL	: 30
L	T	P	FINAL EXAM	: 70
0	0	6	TOTAL	: 100

COURSE OUTCOMES:

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

CO1: To understand the methods of separations of binary (liquid-liquid, liquid-solid or solid-solid) organic mixtures.

CO2: To prepare derivatives of different organic functionalities.

CO3: To characterize given organic compounds by interpreting their ^{1}H NMR and FT-IR spectra.

CO4: To develop the ability to compile information in the form of lab records.

1. **Qualitative Analysis**: Separation of components of a binary (liquid-liquid, liquid-solid or solid-solid) organic mixture using physical and chemical methods and characterization of the components with the help of chemical analysis
2. Spectroscopic confirmation of the binary mixtures using IR and NMR (IR & NMR spectra will be provided).

3. **Extraction of organic compound from natural products:** Any two of the followings:–
   - Caffeine from tea leaves.
   - Isolation of β-carotene from carrot.
   - Isolation of limonene from citrus rind.
   - Isolation of nicotine from tobacco.
   - Isolation of lactose from milk.
   - Isolation of Casein from milk.

Experiment: 45 marks
Lab Record: 15 marks
Viva-voce: 10 marks

REFERENCE BOOKS:

1. "Elementary Practical Organic Chemistry by Arthur I.Vogel Longmans, Green and Co. 1958.
2. "An Introduction to Practical Biochemistry", by David T. Plummr, Tata McGraw Hill Publishing Company, Ltd., N. Delhi, 1988.

3. Practical Organic Chemistry' by Mann and Saunders.
4. Text Book of Vogel's Practical Organic Chemistry by Longman Group, B.S. Furness et al., Ltd.
5. "Experiments in Organic Chemistry" Louis F. Fieser O.C. Heath and Company Boston, 1955.
6. "Organic Synthesis" Collective Vol. I.
7. Laboratory Manual in Organic Chemistry' by R.K. Bansal, Wiley Eastern Ltd., New Delhi-1980.
8. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975).
9. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.
10. "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966.
11. "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors.
12. "A Guide to spectroscopy in Organic Chemistry' by PAVY
13. "Spectrometric Identification of Organic Compounds", Fifth Ed., R.M. Silverstein, G.S. Bassler and T.C.Morrile, John Wiley and Sons, New York.
14. "Organic Spectroscopy', 3rd Ed., by William Kamp. John Wiley & Sons.
15. "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming.
16. Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975).
17. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.

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-414B

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

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

M.Sc. CHEMISTRY SEMESTER IV
CODE: CH-415B
SUBJECT NAME: ORGANIC CHEMISTRY LAB-SPECIAL-III
NO. OF CREDITS: 3

			SESSIONAL	: 30
L	T	P	FINAL EXAM	: 70
0	0	6	TOTAL	: 100

NOTE: Question paper will have two parts. Part-1 will be compulsory and have 10 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 concept of estimation in organic chemistry.
CO2: Do the estimation of amino acids, hydroxyl group, acetoxy group, carbonyl group, unsaturation, reducing and non-reducing sugars.
CO3: Determine the saponification value and iodine value of fats and oils, formalin and glycine.
CO4: Determination of the molecular weight of an acid by titration and by the silver salt method.

1. **Quantitative estimation of the followings:** Amino group, hydroxyl group, acetoxy group, carbonyl group, unsaturation, reducing and non-reducing sugars,

2. Saponification value and iodine value of fats and oils, formalin and glycine, Determination of the molecular weight of an acid by titration and by the silver salt method.

3. **Colorimetric determination of the following:** Carbohydrates, ascorbic acid, amino acids, proteins, cholesterol, urea.

Experiment: 45 marks
Lab Record: 15 marks
Viva-voce: 10 marks

REFERENCE BOOKS:

1 "Elementary Practical Organic Chemistry by Arthur I.Vogel Longmans, Green and Co. 1958.

2 "An Introduction to Practical Biochemistry", by David T. Plummr, Tata McGraw Hill Publishing Company, Ltd., N. Delhi, 1988.
3 Practical Organic Chemistry' by Mann and Saunders.
4 Text Book of Vogel's Practical Organic Chemistry by Longman Group, B.S. Furness et al., Ltd.
5 "Experiments in Organic Chemistry" Louis F. Fieser O.C. Heath and Company Boston, 1955.
6 "Organic Synthesis" Collective Vol. I.
7 Laboratory Manual in Organic Chemistry' by R.K. Bansal, Wiley Eastern Ltd., New Delhi-1980.
8 "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975).
9 "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.
10 "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966.
11 "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors.
12 "A Guide to spectroscopy in Organic Chemistry' by PAVY
13 "Spectrometric Identification of Organic Compounds", Fifth Ed., R.M. Silverstein, G.S. Bassler and T.C.Morrile, John Wiley and Sons, New York.
14 "Organic Spectroscopy', 3rd Ed., by William Kamp. John Wiley & Sons.
15 "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming.
16 Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975).
17 "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.

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-415B

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

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

M.Sc. CHEMISTRY SEMESTER IV
CODE: CH-424B
SUBJECT NAME: PHYSICAL CHEMISTRY LAB SPECIAL-II
NO. OF CREDITS: 3

			SESSIONAL	: 30
L	T	P	FINAL EXAM	: 70
0	0	6	TOTAL	: 100

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:
CO1: Handle the UV/Visible spectrophotometer and able to find out the various parameters associated with UV/Visible spectrophotometer.
CO2: Determine the kinetic parameter of reactions and metal ion half-wave potential.
CO3: Determine fluorescence quantum yield using Fluorescence Spectroscopy.
CO4: Determine the acid dissociation constant (pKa and Pka*).

Colorimetry/ Spectrophotometry

i. Verification of the Lambert-Beer's law using solutions such as K2Cr2O7, CuSO4, KMnO4 in water and I2 in CCl4.
ii. Study of iron-iron and iron-salicylic acid complexes.
iii. Determination of the composition of various mixtures spectrophotometrically: Potassium dichromate and potassium permanganate
iv. Determine the dissociation constant of an indicator spectrophotometrically.

Fluorescence Spectroscopy:

i. Determining the Acid Dissociation Constant of 2-Naphthol in the Ground and Excited State by Application of the Förster cycle.
ii. Determination of relative fluorescence quantum yield for a fluorophore.

Chemical Kinetics

i. Determination of the velocity constant and energy of activation of the reactions between H2O2 and HI.
ii. Investigation of the reaction between acetone and iodine (with respect to H^+, I_2 and acetone).
iii. Determination of the order and velocity of the reaction between potassium persulphate and potassium iodide.
iv. Study the rate of reaction between ethyl bromoacetate and sodium thiosulphate kinetically.

Polarography

i. Determination of half-wave potentials of some cations in aqueous and in non-aqueous solutions.
ii. Determination of half-wave potentials of ions in mixtures.

iii. Amperometry titrations involving: (i) $Pb(NO_3)_2$ vs. $K_2Cr_2O_7$ and (ii) $Pb(NO_3)_2$ vs. K_2SO_4.

Experiment: 45 marks
Lab Record: 15 marks
Viva-voce: 10 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-424B

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 IV
CODE: CH-425B
SUBJECT NAME: PHYSICAL CHEMISTRY LAB-SPECIAL-III
NO. OF CREDITS: 3

			SESSIONAL	: 30
L	T	P	FINAL EXAM	: 70
0	0	6	TOTAL	: 100

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:
CO1: Determine speed of sound.
CO2: Determine dipole moments.
CO3: Handle data analysis by origin-Lab draw.
CO4: Determine dielectric constants of some organic liquids.

Interferrometry

i. Determination of speed of sound of pure liquids/mixtures using interferrometer.
ii. Flame Photometry
iii. Determination of Na^+, K^+ , Ca^{2+} and Mg^{2+} in tap water, juice, electrical etc.

Dielectric Constant and Dipole Moment

i. Determination of dielectric constants of some organic liquids and composition of unknown mixtures.
ii. Determination of dipole moments of some organic liquids.

Data- Handling/Representation

i. Using origin-Lab draw data in different styles of graphs.
ii. Linear-Curve fitting and calculation of regression coefficient using EXCEL worksheet.
iii. Calculate activation energy using thermal analysis data by single/ multiple heating rate methods using EXCEL worksheet.

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-425B

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 IV
CODE: CH-431B
SUBJECT NAME: DISSERTATION
NO. OF CREDITS: 8

L	T	P		
0	0		SESSIONAL	: 50
			FINAL EXAM	: 150
			TOTAL	: 200

COURSE OUTCOMES:

The student will be able to
CO1: Learn to review and correlate the literature reports related to a particular topic.
CO2: Acquire knowledge about the research ethics.
CO3: gain knowledge and will develop the skill of research report writing.
CO4: Develop the ability to present and defend their dissertation work to the expert.

COURSE DESCRIPTION:

This course may consists of the review of some research papers, development of the laboratory experiment, fabrication of a device, working out some problem related to subject, participation in some ongoing research activity, analysis of the data. The work can be carried out in any thrust area of subject (Experimental or theoretical) under the guidance of allotted supervisor of the department.

Mapping of CO and PO for CH-431B

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**	**2**	**3**	**3**	**3**	**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-I	CH-101B	√		√
ORGANIC CHEMISTRY (GENERAL-I)	CH-102B	√		√
PHYSICAL CHEMISTRY-I	CH-103B	√		√
MATHEMATICS FOR CHEMISTS	CH-104X-B			√
CHEMISTRY OF LIFE PROCESSES	CH-104Y-B			√
INORGANIC CHEMISTRY LAB-I	CH-105B	√	√	√
ORGANIC CHEMISTRY LAB-I	CH-106B	√	√	√
PHYSICAL CHEMISTRY LAB-I	CH-107B	√	√	√
INORGANIC CHEMISTRY (GENERAL-II)	CH-201B	√		√
ORGANIC CHEMISTRY (GENERAL-II)	CH-202B	√		√
PHYSICAL CHEMISTRY (GENERAL-II)	CH-203B	√		√
COMPUTATIONAL TECHNIQUES	CH-204X-B	√	√	√
CHEMISTRY OF SUPRAMOLECULES	**CH-204Y-B**	√		√
INORGANIC CHEMISTRY LAB-II	CH-205B	√	√	√
ORGANIC CHEMISTRY LAB-II	CH-206B	√	√	√
PHYSICAL CHEMISTRY LAB-II	CH-207B	√	√	√

SPECTROSCOPIC METHODS IN CHEMISTRY	CH-301B	√		√
ADVANCE SPECTROSCOPY	CH-302B	√		√
INSTRUMENTAL METHODS OF ANALYSIS	CH-303B	√		√
INSTRUMENTAL ANALYSIS LAB	CH-304B	√	√	√
INORGANIC CHEMISTRY SPECIAL-I	CH-305B	√		√
INORGANIC CHEMISTRY LAB SPECIAL-I	CH-306B	√	√	√
ORGANIC CHEMISTRY SPECIAL-I	CH-315B	√		√
ORGANIC CHEMISTRY LAB-SPECIAL-I	CH-316B	√	√	√
PHYSICAL CHEMISTRY SPECIAL-I	CH-325B	√		√
PHYSICAL CHEMISTRY LAB SPECIAL-I	CH-326B	√	√	√
INORGANIC CHEMISTRY SPECIAL-II	CH-401B	√		√
INORGANIC CHEMISTRY SPECIAL-III	CH-402B	√		√
INORGANIC CHEMISTRY SPECIAL-IV	CH-403B	√		√
INORGANIC CHEMISTRY LAB-SPECIAL-II	CH-404B	√	√	√
INORGANIC CHEMISTRY LAB-SPECIAL-III	CH-405B	√	√	√
ORGANIC CHEMISTRY SPECIAL-II	CH-411B	√		√
ORGANIC CHEMISTRY SPECIAL-III	CH-412B	√		√
ORGANIC CHEMISTRY SPECIAL-IV	CH-413B	√		√

ORGANIC CHEMISTRY LAB-SPECIAL-II	CH-414B	√	√	√
ORGANIC CHEMISTRY LAB-SPECIAL-III	CH-415B	√	√	√
PHYSICAL CHEMISTRY SPECIAL-II	CH-421B	√		√
PHYSICAL CHEMISTRY SPECIAL-III	CH-422B	√		√
PHYSICAL CHEMISTRY SPECIAL-IV	CH-423B	√		√
PHYSICAL CHEMISTRY LAB-SPECIAL-II	CH-424B	√	√	√
PHYSICAL CHEMISTRY LAB-SPECIAL-III	CH-425B	√	√	√