SCHEME & SYLLABUS

M.Sc (Hons.) Chemistry

(As per NEP 2020)

Department of Physical Sciences

University Institute of Sciences (UIS)

Sant Baba Bhag Singh University

2023

ABOUT THE DEPARTMENT

The Physical Sciences expands our knowledge of the universe and underlines new technologies, which benefit our society. In keeping with the heritage of imparting quality education, teaching and research are the prime motive of the Department of Physical Sciences.

Department of Physical Sciences is dynamic and progressive in its development of new course initiatives and to contribute substantially to the goal of SBBSU and becoming a research oriented organization. The teaching is by way of interactive sessions between students and teachers. Our courses ensure a coherent degree structure while encouraging interdisciplinary approach.

Student centric, ICT enabled and interactive teaching, outcome based teaching model comprising of theoretical work, regular academic activities such as research projects, seminars, resource learning and hands-on laboratory work.

The Department wishes to focus on providing a comprehensive curriculum at undergraduate and postgraduate levels with teaching- learning adjunct to cater the need of industry, relevant research and career opportunities, meritorious careers in academia and proficient industries. Our research oriented teaching paves the way for entry into different careers since it equips students with advanced transferable skills in information gathering, analysis and presentation, which are vital tools in the field of science.

SALIENT FEATURES OF THE DEPARTMENT

- The department is blessed to have specialized faculty in various fields of Physical Sciences *viz.* Chemistry, Physics, Mathematics.
- The Department keeps its students abreast of latest advancements in technology through ultra-modern computer facilities, e-learning, virtual labs, SWAYAM Courses as per UGC guidelines.
- The department updates curricula on a regular basis to ensure that students keep up with the changing trends of education and research globally. The syllabi of courses are designed to equip students to qualify exams such as GATE, UGC- NET / SLET, TIFR etc.
- The Department has well equipped laboratories with a number of instruments and facilities like, UV- Visible Spectrophotometer, High Speed Centrifuge, Muffle furnance, Digital water bath, Polarimeter, Ultrasonic interferometer, Ballistic Galvanometer **,** Deflection and vibration Magnetometer **,** Electron spin resonance, Turbiditimeter, Abbs Refractrometer, Digital weighing balance/ Spring balance, Magnetic plate with stirrer, pH meter, Conductometer, Flame Photometer, colorimeter and a double distillation plant etc.
- Students and teachers participation in International, National, State and Regional seminars and conferences. Along with Industry aligned academia, expert interaction, is the key features of the department.
- Curricular and the co-curricular activities are well balanced in the Teaching Learning environment to provide holistic education to the students.
- The outcome based teaching model of faculty comprising of theoretical work, regular academic activities such as research projects, seminars, resource learning and hands-on laboratory work.
- Along with Industry aligned academia, expert interaction, is the key features of the department.

M. Sc. (Hons.) Chemistry :

M. Sc. (Hons.) Chemistry is a route for the science students who have completed their bachelor degree taking chemistry as one subjects. The program is designed to develop the knowledge of students about the field of chemical sciences and to served the society. They can also pursue Ph. D program in Chemistry after master degree.

Vision

To aspire, achieve and sustain for excellence in academics and research through scientific knowledge so as to provide solutions to global environmental issues and transform graduates into responsible citizens and competent professionals.

Mission:

- Holistic development of learner through academic excellence, employability, acquisition of analytical skills and higher research.
- To explore and advance new frontiers in physical sciences and integration with interdisciplinary sciences through visionary research for the benefit of society
- To develop graduates for lifelong learning and professional growth.

ELIGIBILITY CRITERIA : B.Sc. (Pass) with **Chemistry** as one of the Core subjects /**B.Sc**. (Hons.) **Chemistry** with 50% marks (45% marks in case of **SC**/ST candidates) in aggregate or equivalent grade from any university recognized by **UGC**.

DURATION: 2 Years

CAREER PATHWAYS

The program is designed to meet the growing requirement of qualified professionals in field of chemical and pharmaceuticals industry and education. Master degree holders are hired both by Government and private organizations. They can join Ph.D programmes in different academic / research organizations.

• Government Jobs

Prepare students for various government jobs such as education sector, Chemical industry, Pharmaceuticals sector, R&D and civil services etc..

• Corporate Jobs

Multiple pathways designed according to the level of the students to prepare them for different job profiles as per needs of industrial sector.

• Higher Studies

This pathway prepares students for Higher Studies and helps in their research also.

• **Entrepreneurship :** To set up new ventures as analytical & Testing labs

Programme Educational Objective (PEO)

PEO1. To impart quality education in chemical sciences to achieve excellence in teaching-learning and research.
PEO2. To provide hand on training and execution of the chemical experiments and safe handling of chemistry laboratory and chemical waste.
PEO3. To construct a bridge between the theoretical and practical aspects of chemistry and inculcate research aptitude.
PEO4. To equip the learners to apply knowledge of chemistry and to analyze the local and global impact of chemistry on individuals, organizations, and society.
PEO5. To develop talented and committed human resource which act as catalyst to support interdisciplinary research and become fit for industry and entrepreneur.
PEO6. To develop employable skills and life time leaning.

PROGRAMME OUTCOMES (PO)	
PO1	**Disciplinary Knowledge**: The student will acquire in-depth knowledge of various concepts and practical principles of Chemistry. A graduate in Chemistry is expected to be thoroughly conversant with all fundamental laws and principle in variety of areas of Chemistry along with their applications and laboratory techniques
PO2	**Critical Thinking:** Critical thinking as an attribute enables a student to identify, formulate and analyse a complex variety of problems in Chemistry. A graduate in Chemistry is expected to assess, reconstruct and solve chemistry problems critically.
PO3	**Problem Solving**: The student will be well-equipped to solve complex problems of chemistry through critical thinking.
PO4	**Scientific /Analytical Reasoning**: Students learn to investigate, experiments/ theoretical methods, relate information and interpret data based on scientific reasoning. The student will be able to draw logical conclusions based on a group of observations, analytical techniques and measurements.
PO5	**Modern Tool Usage:** Graduates will be able to use appropriate analytical and instrumental techniques for material characterization. A student with degree in Chemistry is able to employ knowledge and skill in computers in a variety of situations- data analysis, coding of complex Chemistry problems as well as information retrieval and library use
PO6	**Multicultural Competence**: Graduates will learn multicultural sensitivity about societal, health, safety, legal and cultural issues through various activities and able to integrate multicultural awareness regarding race, gender, physical ability, age, income and other social variables and create an environment that is, " welcoming for all students"
PO7	**Environment & Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
PO8	**Research related skills & Ethics:** Develop skills for critically review scientific information and become able to comprehend and write effective reports and design documentation. Able to create a sense of ethical responsibilities among students. The student is aware of what constitutes unethical behaviour- plagiarism, fabrication and misrepresentation or manipulation of data

PO9	**Self-directed Learning**: Students are encouraged to accept challenges/latest advancements encountered in Chemical Sciences from various resources. Various activities/advanced ideas equip the students to find relevant information and educate themselves
PO10	**Individual and Team Work**: Acquire the ability to function effectively as a teams to accomplish a common goals in classroom, laboratory or any other team of members from diverse fields. The student will be capable of contributing meaningfully to team ethos and goals.
PO11	**Communication Skills:** Students will be able to communicate effectively about scientific and technical information of chemical sciences from various sources and convey it to intended audience, both orally and in writing in an intelligible manner.
PO12	**Life long Learning:** With strong conceptual framework in the subject along with the skills of teamwork, analytical reasoning, problem solving, critical thinking etc. make the students lifelong learners.

	PROGRAMME SPECIFIC OUTCOMES (PSO)
PSO1.	Able to provide chemical nomenclature, classification, structure, reactivity and stereochemistry of organic and inorganic matter.
PSO2.	Proficient in organic and inorganic reaction mechanisms and chemical analysis through quantitative/qualitative mode.
PSO3	Apply modern spectroscopic methods of analysis for chemical characterization of any form of matter.
PSO4	Employ core analytical and practical experiences of Chemical Sciences for the Societal expectations and solutions for environmental problems.
PSO5	Proficient in theoretical as well as practical aspects of Electrochemistry, chemical themodynamics, kinetics, quantum chemistry.
PSO6	Acquire ability to explain applications of Chemistry relates to the real world in term of advanced synthetic methods, advanced materials and analytical tools.

1. Curriculum Structure: *M.Sc (Hons) Chemistry* programme will have a curriculum with Syllabi consisting of following type of courses:

I. **Major Courses:** A course, which should compulsorily by studied by a candidate as a core requirement is termed as a major course. These courses are employability enhancement courses relevant to the chosen program of study. Program core comprises of Theory, Practical, Project, Seminar etc. Project work is considered as a special course involving application of knowledge in solving/ analyzing/exploring a real life situation/ difficult problem.

II. **Minor Courses:** A course, which should compulsorily by studied by a candidate as a minor from specific discipline only with relevant competencies to the discipline is termed as a major course.

III. **Elective Courses:** Elective course is generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or with provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill. Accordingly, elective course may be categorizes as:

A. Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective.

B. Project (I): An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

IV. Value added Courses & Ability Enhancement Courses (VAC/AEC): The Ability Enhancement Courses (AEC) may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC). AECC courses are the courses based upon the content that leads to Knowledge enhancement. SEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, values etc.

A. Value added Courses/Ability Enhancement Compulsory Courses: Environmental Science, English Communication/MIL Communication, technical writing skills, research based skills.

B. Skill Enhancement Courses (SEC): These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge.

2. NOMENCLATURE USED:

Major Courses: Core Course
Minor Courses:
AEC: Ability Enhancement Course
SEC: Skill Enhancement Core Course
EC: Elective Course

Course Scheme (M. Sc. (Hons.) Chemistry) 2023

Semester-I

I. Theory Subjects

Sr. No.	Type of course	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	Major	CHM551	Chemistry I: Main Group Chemistry	4:0:0	4:0:0	4	4
2	Major	CHM 553	Chemistry II: Electrochemistry & Surface Chemistry	4:0:0	4:0:0	4	4
3	Major	CHM555	Chemistry III: Thermodynamics	4:0:0	4:0:0	4	4
4	Minor	CHM557	Pericyclic reactions & Photochemistry	4:0:0	4:0:0	4	4
5	Major (DSE)	CHM 559 CHM561 CHM563	**ELECTIVE I: (Choose any one)** Analytical Chemistry Chemical Kinetics & Chemical Equilibrium Symmetry & Group Theory)	4:0:0	4:0:0	4	4
6	VAC		**Value Added Course**	3:0:0	3:0:0	3	3
		EVS003	Natural Hazards and Disaster Management				
		II. Practical Subjects					
7	Major	CHM565	Inorganic Chemistry Practical-I	0:0:4	0:0:4	4	2
8	Major	CHM567	Organic Chemistry Practical-I	0:0:4	0:0:4	4	2
	Total					31	27

Major: Major Course
Minor : Minor Course
VAC: Value added Course
DSE: Discipline specific Elective Course

Total Credit Hours-27
Total Contact Hours- 31

Course Scheme (M. Sc. (Hons.) Chemistry) 2023

Semester-II

I. Theory Subjects

Sr. No.	Type of course	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	Major	CHM552	Organic Reaction Mechanism	4:0:0	4:0:0	4	4
2	Major	CHM554	Quantum Chemistry	4:0:0	4:0:0	4	4
3	Major	CHM556	Spectroscopy (Techniques for Structural elucidation of Organic & Inorganic Compounds)	4:0:0	4:0:0	4	4
4	Minor	CHM558	Coordination Chemistry	4:0:0	4:0:0	4	4
5	Major (DSE)	CHM560 CHM562 CHM564	**ELECTIVE II** (Choose any one) Organometallics Chemistry and Metal Clusters Environmental Chemistry Bioinorganic Chemistry	4:0:0	4:0:0	4	4
6	MDC	MAT 528/ MMB542	Mathematics for Chemists(for B.Sc. Medical students)/ Chemistry of Biological Macromolecules (for B.Sc. NonMedical students)	3:0:0	3:0:0	3	3
		II. Practical Subjects					
7	Major	CHM566	Organic Chemistry Practical-II	0:0:4	0:0:2	4	2
8	Major	CHM568	Physical Chemistry Practical-I	0:0:4	0:0:2	4	2
		Total				31	27

Total Credit Hours-27
Total; Contact Hours- 31

Major: Major Course
Minor: Minor Course
MDC: Multidisciplinary Course
DSE: Discipline specific Elective Course

***Students have to apply for summer or Industrial training/Internship after completion of their 2nd sem End Semester Exam.**

Course Scheme (M. Sc. (Hons.) Chemistry) 2023

Semester-III

I. Theory Subjects

Sr. No.	Type of course	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	Major (DSE)	CHM 651 CHM 653 CHM 655	**ELECTIVE-III** Choose any one) Chemistry of Natural Products & Heterocyclic Chemistry Organic reaction & Reagents Recent Trends in Inorganic Chemistry	4:0:0	4:0:0	4	4
2	Major (DSE)	CHM 657 CHM659 CHM661	**ELECTIVE IV** (Choose any one) Polymer Science Biofuel Bioorganic Chemistry	4:0:0	4:0:0	4	4
3	Major	RM 651	Basics of Research Methodology in Biological & Chemical Sciences	4:1:0	4:1:0	5	5
4	Minor	CHM663	Instrumental Methods of Analysis	2:0:0	2:0:0	2	2
5	Minor	RM 655	Publication & Research Ethics	2:0:0	2:0:0	2	2
		II. Practical Subjects					
1	Major	CHM665	Physical Chemistry Practical-II	0:0:4	0:0:2	4	2
2	Minor (SEC)	CHM667	Seminar & Summer training	0:0:4	0:0:2	4	2
3	Major (SEC)	CHM669	Dissertation -I (Synopsis& Elucidation of Research Objectives)	0:0:8	0:0:4	8	4
		Total				**33**	**25**

Total Credit Hours-25
Total; Contact Hours- 33

Major: Major Course
SEC: Skill Enhancement Course
DSE : Discipline specific Elective Course

***Evaluation of dissertation-I will be based on submission of synopsis and approved research objectives through DRC committee of the department.**

Course Scheme (M. Sc. (Hons.) Chemistry) 2023

Semester-IV

I. Theory Subjects

Sr. No.	Type of course	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	Major (DSE)	CHM652 CHM654 CHM656	**ELECTIVE V** (Choose any one) Nano-Science& Nano Chemistry Green Chemistry Chemistry of Materials	4:0:0	4:0:0	4	4
2	Major (DSE)	CHM658 CHM660 CHM662	**ELECTIVE-VI** Choose any one) Pharmaceutical Chemistry & Drug Design Industrial Chemical analysis & Quality Control Physico-chemical studies and Biomolecules	4:0:0	4:0:0	4	4
3	Major	RM652	Advances in Research Methodology in Biological and Chemical Sciences	4:1:0	4:1:0	5	5
4	Minor	RM654	Scientific &Technical Writing	2:0:0	2:0:0	2	2

II. Practical Subjects

1	Major	CHM664	Inorganic Chemistry Practical-II	0:0:4	0:0:2	4	2
2	Major	CHM666	Dissertation -II	0:0:16	0:0:8	16	8
		Total				**35**	**25**

Total Credit Hours-25
Total Contact Hours- 35

Major: Major Course
SEC: Skill Enhancement Course
DSE: Discipline specific Elective Course
AEC: Ability Enhancement Course

***Evaluation of dissertation-II will be based on submission of complete dissertation and evaluation through institutional RDC.**

Summary of Scheme of M. Sc. (Hons.) Chemistry (P G 0 4 7)
2023 batch onward

Sem	L	T	P	Total Contact hrs/wk	Total Credits hrs/wk	Major (Credit/wk)	Minor (Credit/wk)	Major (DSE) (Credit/wk)	VAC (Credit/wk)	MDC (Credit/wk)
I	23	0	8	31	27	16	4	4	3	0
II	23	0	8	31	27	16	4	4	0	3
III	16	1	16	33	25	11	6	8	-	-
IV	14	1	20	35	25	15	2	8	-	-
Total	76	2	52	130	104	58	16	24	3	3


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SEMESTER I

Semester	**I**
Course Code	**CHM551**
Course Title	**Chemistry I: Main Group Chemistry**
Type of course	Major
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To introduce the importance of H-bonding, reactivity of metals and inert pair effect , formation of coordination complexes, tendency of lighter elements to form electron deficient compounds, structural features of silicates and organosilcon , Chemistry of inter- halogens, compounds of xenon and krypton and to recognize the importance of group 12 elements
Course Outcomes	The students will be able to: 1. Importance of H-bonding in natural processes is appreciable 2. Recognition of capability of s-block elements and group 12 elements to form coordination complexes as the latter are having many similarities with the former. 3. Realization of importance of silicon as it is the second most abundant element onearth's crust after oxygen and it occurs as SiO2 and silicate materials.

Syllabus

Unit-I

Chemistry of hydrogen: History of discovery of hydrogen atom, Isotopes and ionized forms of hydrogen, Protonic acids and bases, hydrides, The Hydrogen Bond, its influence on Properties and influence on structure, Strength of hydrogen bonds and theoretical description, some natural elegant examples of H-bonding, Information about H-bonding from various techniques like IR, NMR and X-ray.

Noble gases: introduction and oxidation state survey, noble gas clathrates ,haides, oxidesand other compounds : synthesis, reactivity and stereochemistry.

Unit-II

Chemistry of S-block metals: Introduction and oxidation state survey, standard redox potentials of alkali and alkaline earth metals, lattice energy and hydration energy and diagonal relationship. Structure and synthesis of Hydrides, Halides, Oxides, Peroxides, Superoxides, Suboxides,

elements. Coordination Complexes of Crowns and Crypts of Alkali and Alkaline EarthMetals ions.

Chemistry of group 12 elements: Introduction, Similarities and differences between these elements and traditional elements, oxidation state, Chemistry of the elements : reactivity ,standard redox potentials, their combination with halides. Chalcogenides and their related compounds, oxygen, sulphur and halogen compounds, Formation of coordination complexes, Low valent compounds. (5 lectures)

Unit-III

Chemistry of Boron, Aluminum and Silicon: Borides, Boranes, Bonding in boranes, topology of boranes, synthesis and reactivity. Wade's rules,Carboranes and metallocarboranes,Borazine and boron nitride. Chemistry of boron and Aluminum Halides, Amphoteric nature of Aluminium oxides. Potash alum and Aluminum Alkyls. Low oxidation state Alcompounds.Organosilicon Compoundslike carbosilanes, stability of disilenesand silicones.

Unit-IV

Chemistry of halogens: Interhalogens: Introduction, Diatomic, Tetraatomic, hexaatomic and octa-atomic interhalogens: Synthesis, physical properties, chemical reactions, fluorinating agent, as ionizing solvent and electrical conductivity, Lewis acid behavior. Polyhalide and polyhalonium ions of diatomic interhalogens, Reactivity sequence of various interhalogens. Structures and bonding in some polyiodide anions, Pseudohalogens, Cholorofluorocarbons.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Main Group Chemistry	W. Henderson	Royal Society of Chemistry(2000)
2	Chemistry of Elements	N. N. Greenwood	Pergamon Press(2000)
3	Inorganic Chemistry, Principles of structureand reactivity	J. E. Huheey, Fourthedition	Pearson(2005)
4	Inorganic Chemistry 4th edition	D. F. Shriver and P. W. Atkins,	Oxford University, Oxford(2006)
5	Advanced Inorganic Chemistry	F. A. Cotton and G. Wilkinson , Sixth edition	John Wiley & Sons (2003)
6	Concepts & Model of Inorganic Chemistry	B. Douglas , third edition	John Wiley & Sons(2001)

Semester	**I**
Course Code	**CHM553**
Course Title	**Chemistry II: Electrochemistry & Surface Chemistry**
Type of course	Major
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as one of the main Subject
Course Objective	This study Deals with the properties of surfaces or phase boundaries and with the chemical changes occurring at a surface or interface.
Course Outcomes	The students will be able to: 1. Acquire basic knowledge of Electrochemistry of electrode electrolyte interface and properties of surfaces or phase boundaries. 2. Understading basic concepts of electro chemistry, redox processes in electrochemical systems, EMF, pH and their applications 3. Activity and activity coefficient ad Application of homogeneous and heterogeneous catalysis in chemical synthesis

Unit-I

Adsorption: Surface tension, capillary action, pressure difference across curved surface (Laplace equations), vapor pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (Electro-kinetic phenomena), catalytic activity at surfaces.

Adsorption and Catalysis: Colloids and their stability, Adsorption of solids, Gibbs adsorption isotherm, BET adsorption isotherm, Langmuir and Fredulich Isotherms. Homogeneous catalysis and heterogeneous catalysis, enzyme catalysis. Michealis-Menten mechanism, Lineweaver-Burk Plot, competitive, non-competitive and uncompetitive bindings, kinetics of catalytic reactions.

Unit-II

Electrochemistry: Oxidation numbers. Redox potential. Electrochemical series. Redox indicators. Electrochemical cell reactions, Nernst equation, Electrode Kinetics, electrical double layer, electode/electrolyte interface, Batteries, primary & secondary Fuel Cells, Introduction to corrosion, homogeneous theory, forms of corrosion, corrosion monitoring and Prevention corrosion.

Electrochemical Cells: Concentration cells with and without liquid junction, thermodynamics of reversible electrodes and reversible cells, potentiometric titration, conductometric titrations

Unit-III

Colloidal State: Classification of colloids, charge and stability of colloidal dispersions, Hardy-Schulze Law, gold number, electrical properties of colloids, electrical double layer and its structure, Stern's theory of double layer, zeta-potential, electrophoresis and electro-osmosis, emulsions and their classification, emulsifiers, gels and their classification, thixotropy. Association colloids; miceller formation, cmc, soap action, Application of colloids.

Micelles: Surface active agents, classification of surface active agents, micellization, Hydrophobic interactions, critical micellar concentration (CMC), factors affecting CMC of surfactants, counter ion binding to micelles, solubilization, micro emulsion, reverse micelles.

Unit-IV

Voltmametry and Polarography: Polarography, polarographic cells, polarogram, interpretation of polarographic waves, equation for the polarographic waves, effect of complex formation on polarographic wave, polarograms for irreversible reactions, dropping mercury electrode, current variations during life time of a drop, merits and demerits of dme, polarographic diffusioncurrents, Ilkovic equation, capillary characteristics, temperature, polarograms for mixture of reactants, anodic and cathodic waves, factors affecting polarographic currents, applications of polarography, treatment of data, organic and inorganic polarographic analysis, voltammetry at solid electrodes, cyclic voltammetry and interpretation of data.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Surface Chemistry	E.M. Mc Cash	Oxford University Press, Oxford (2001).
2	An Introduction to Liquid State	P.A. Eglestaff	Academic Press.
3	Electrochemical methods, Fundamentals and Methods	A.J. Bard, L.R. Faulkner,	Wiley, 1980.
4	Physical Electrochemistry- Fundamentals, Techniques and Applications	EliezerGileadi,	Wiley-VCH 2011.

Semester	**I**
Course Code	**CHM 555**
Course Title	**Chemistry III: Thermodynamics**
Type of course	**Major**
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To impart knowledge of advanced classical and statistical thermodynamics. To understand behavior of activity coefficient, ionic strength, distribution Law, electro kinetic phenomena, diffusion, electric conduction, irreversible thermodynamics for biological systems
Course Outcomes	The students will be able to: 1. Understand Coherent Knowledge of different thermodynamic parameters for chemical reactions. 2. Analyze advanced classical and statistical thermodynamics. 3. Interpret irreversible thermodynamics for biological systems.

Syllabus

Unit-I

Thermodynamics: First law of thermodynamics, relation between C_p and C_v; enthalpies of physical and chemical changes; temperature dependence of enthalpies. Second law of thermodynamics, entropy, Gibbs-Helmoholtz equation. Third law of thermodynamics and calculation of entropy.

Classical Thermodynamics: Brief concepts of free energy, chemical potential and entropy. Partial molar properties, partial molar free energy, partial molar volume and partial molar heat content and their significances. Determination of these quantities.

.**Unit-II**

Concept of fugacity and determination of fugacity. Non-ideal systems: Excess functions for non-ideal solutions. Activity, activity coefficients, Debye-Huckel theory for activity coefficient of electrolytic solutions, determination of activity and activity coefficients, ionic strength. Application of phase rule to three component system, second order phase transitions

Unit-III

Calculation of thermodynamic properties in terms of partition functions. Application of partition functions. Heat capacity behavior of solids-chemical equilibria and equilibrium constants in terms of partition functions, Fermi-Dirac statistics, distribution laws, and application to metals. Bose-Einstein statistics-distribution law and application to helium.

Unit-IV

Non Equilibrium Thermodynamics: Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, entropy balance equations for different irreversible processes (e.g., heat flow, chemical reaction etc.) transformations of generalized fluxes and forces, non-equilibrium stationery states, phenomenological equations, microscopic reversibility and Onsager's reciprocity relations, electro kinetic phenomena, diffusion, electric conduction, irreversible thermodynamics for biological systems, coupled reactions.

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Thermodynamics for Chemists	S. Glasstone	East West Press, New

			Delhi (1950).
2	Thermodynamics for Students of Chemistry	J. Rajaram and J.C. Kuriacose	Lal Nagin Chand, New Delhi (1986).
3	Elements of Chemical Thermodynamics	L.K. Nash	Addision Wesley (1962).
4	Introduction to statistical thermodynamics	T. L. Hill	Addison-Wesley *Publishing*

Semester	**I**
Course Code	**CHM559**
Course Title	**Analytical Chemistry**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To aware students about Qualitative and quantitative aspects of analysis, Optical, thermal ,electrical methods of analysis, different separation tecniques
Course Outcomes	The students will be able to: 1. Acquire knowledge of environmental analytical method. 2. Apply semi-micro qualitative analysis of soil, water air and food ingredients 3. Apply different techniques of industrial analysis

Unit I

Qualitative and quantitative aspects of analysis: Qualitative and quantitative. Classification of analytical methods- classical and instrumental, basis of their classification with examples. Classification - systematic or Determinate errors – additive, proportional; instrumental, operative, Random errors – Gaussian distribution; Accuracy-absolute error and relative error; Precision – uncertainty; Propagation of systematic and random errors.

Sampling and methods of sampling. Mean, median, average deviation, standard deviation, relative standard deviation. Significant figures and rules to determine significant figures. Calculations involving significant figures; Rounding off. Confidence limit, correlation coefficient and regression analysis. Comparison of methods: F-test and T-test. Rejection of data based on Q-test. Least squares method for deriving calibration graph. Standard reference materials, criteria for selection of analytical method. Concepts important to quantitative analysis, classification of methods for quantitative analysis, choice of method for analysis, Theory of volumetric and gravimetric methods of analysis.

Unit II

Optical methods of analysis: Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs). Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal, Techniques for the quantitative estimation of trace level of metal ions from water samples.

Thermal methods of analysis: Theory of thermogravimetric analysis (TGA) – Factors influencing TGA – Instrumentation of TGA - Applications of TGA for analysis of inorganic compounds and polymers. Theory, instrumentation and applications of DTA and DSC.

Electroanalytical methods: Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations.Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

Unit III

Separation techniques: Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation, Technique of extraction: batch, continuous and counter current extractions, Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non aqueous media.

Chromatography: Definition and Classification; principle and efficiency of the technique, Mechanism of separation: Basic concepts of Paper, Thin Layer and Column, adsorption, partition & ion-exchange, chromatography; Development of chromatograms: frontal, elution and displacement methods. Introduction to HPLC-Applications in qualitative and quantitative analysis.

Unit IV

Analysis of soil: Trace element analysis in soil - B, Cd, Cu, Fe, Mn, Mo, Zn, Pb., Determination of pH of soil. Total soluble salt Estimation of calcium and magnesium, Qualitative detection of nitrate and phosphate.

Air Analysis: sampling of aerosols, sampling of gaseous pollutants, analysis of SO2, NO2, CO-CO2, hydrocarbons, particulates

Water Analysis : Determination of pH, EC,TDS, DO, colour, turbidity, total solids, conductivity, acidity, alkalinity hardness, chloride, fluoride, sulphate, nitrite, nitrate, phosphorous (total inorganic and organic), BOD, COD, TOC, pesticides.

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.

b. Analysis of preservatives and colouring matter. Pesticide analysis in food products.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Experimental Physical Chemistry	Arthur M. Halpern, George C. McBane	Freeman,2006.
2	Experiments in Physical Chemistry, 5th ed.,	Schoemaker et al.	MGH, 1989
3	Chemistry Experiments for Instrumental Methods	Sawyer, Heineman, Beebe	Wiley, 1984 .
4	Standard Method of Chemical Analysis	F.J. Welcher	Vol. III, Van Nostrand Reinhold Co
5	Elemental Analysis of Airborne Particles	Ed. S. Landsberger and M. Creatchman	Gordon and Breach Science Publication
6	Advanced Practical Physical Chemistry.	Yadav, J. B.	Krishna Prakashan Media. (2006).

Semester	**I**
Course Code	**CHM561**
Course Title	**Chemical Kinetics & Chemical Equilibrium**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as one of the main Subject
Course Objective	This study Deals with the properties of kinetics and equilibrium of a chemical reaction and the chemical changes occurring in the reaction medium with time.
Course Outcomes	The students will be able to: 1. Acquire basic knowledge of Kinetics of a chemical reaction and relation between reactant concentration and time in a reaction 2. Understading basic concepts of Chemical Kinetics, order, molecularity, rate laws of a reaction, Temperature dependence of reaction rates and their applications 3. Apply law of chemical equilibrium, van't hoff reaction isotherm and Le Chatelier's principle in a chemical reaction.

UnitI:

The rate of a reaction : Reaction rates and stoichiometry, elementary and multistep reaction, relation between reactant concentration and time: order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential rate laws for first order, differential rate laws for second order, differential rate laws for zero order reaction, integrated rate laws for first orderreaction, integrated rate laws for second order reaction and integrated rate laws for zero orderreaction, pseudo unimolecular reactions, determination of the order, kinetics of complex reactions (limited to first order).

UnitII:

Temperature dependence of reaction rates: Arrhenius equation, derivation of Arrhenius equation, calculation of activation energy graphically, calculation of activation energy by two different temperature, collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates. (i) opposing reactions (ii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iii) chain reactions.

Catalysis, heterogeneous catalysis, the haber synthesis of ammonia, homogeneous catalysis, enzyme catalysis

UnitIII:

Spontaneous reactions , free energy of spontaneous reaction, role of temperature, standard free energy change, standard free energy of formulation of compounds, the concept of chemical

equilibrium, Law of mass action, thermodynamic derivation of law of chemical equilibrium,van't hoff reaction isotherm, distinction between ΔG and ΔG^0, relation between Kp, Kc, Kx ,relation between Kp and Kc for ideal gas mixture, relation between Kp andKc for liquid state, calculations of Kp and Kc for different reaction,

Unit IV:

De Donder's treatment of chemical equilibria, degree of advancement of chemical reaction, thermodynamic relation for chemical affinity, enthalpy and affinity, internal energy and affinity. Homogeneous equilibrium, Intregrated form of Vant's equation, pressure dependence of equilibrium constant Kp, pressure dependence of equilibrium constant Kc, pressure dependence of equilibrium constant Kx, heterogeneous equilibrium, dissociation of calcium carbonates, LeChatelier's principle: effect of change of temperature, effect of change of pressure, Le Chatelier's principle in physical equilibrium: Vapour pressure of liquid, effect of pressure on the boiling point of the liquid, effect of pressure on the frizzing point of the liquid, effect of temperature on solubility.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Principles of Physical Chemistry	B. R. Puri , Madan S. Pathania L.R. Sharma	Vishal Publishing Company (2020)
2	Atkins' Physical Chemistry, thermodynamics and kinetics	Peter Atkins, Julio de Paula	Oxford University press,(2014)
3	A Textbook of Physical Chemistry, Thermodynamics and Chemical Equilibrium(volume Two)	K. L. Kapoor	McGraw Hill Education(2019)
4	A Textbook of Physical Chemistry (Vol. Five)	K. L. Kapoor	Macmillan Indian press.2009
5	An introduction to Chemical Kinetics	Claire Vallance	Morgan & claypool publishers, US, 7017

Semester	**I**
Course Code	**CHM563**
Course Title	**Symmetry & Group Theory**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To introduce the concepts and importance of symmetry and group theory in solving chemical problems and transition metal complexes, orgnaometallics, inorganic chains, rings and cages.
Course Outcomes	The students will be able to: 1. Understand Coherent Knowledge of concepts and importance of symmetry 2. group theory to recognize and assign symmetry characteristics to molecules and objects 3. Solve chemical problems and transition metal complexes.

Unit-I

Fundamentals of Group Theory: Symmetry elements, symmetry operations, symmetry elements commonly occurring molecules like NH3, CH4, SF6, PF5, SF4, Ni(CO)4, Fe(CO)5, group multiplication table-subgroups, similarity transformations and classes- identifications of symmetry operations and determination of point groups determination of reducible and irreducible representations, reduction formula for converting reducible representations into irreducible ones, Mulliken symbols

Unit-II

Groups and their basic properties: definition of a group - basic properties of a group-definition of abelian - cyclic- isomorphic, finite, infinite groups and subgroup. Symmetry classification of molecules into point groups-Schoenflies symbol (only-difference between point group and space group).

Matrices- Definition of matrix, square matrix, diagonal matrix, null matrix, unit matrix, row matrix, column matrix, symmetric matrix, skew symmetric matrix and conjugate matrix. Multiplication, commutative and non commutative-determination of inverse of a matrix, block multiplication of matrices-addition and subtraction of matrices.

Unit III

Applications of Group Theory-I : Determination of representations of vibrational modes in linear and non-linear molecules.

Character tables, Orthogonality theorem and its consequences - construction of character table for linear and non-linear molecules. construction of character tables for C2v, C3v (non-abelian group), use of symmetry in obtaining symmetry of orbitals in molecules, qualitative splitting of s, p, and d orbitals in octahedral, tetrahedral and square planar fields using character tables and without the use of character tables. Symmetry adapted linear combinations, symmetry aspects of MO theory, Group theory and Vibrational spectroscopy - vibrational modes as basis for group representation - symmetry selection rules for IR and Raman spectra, Mutual exclusion principle - classification of vibrational modes. Application of group theory for the electronic spectra of molecules of interest.

Unit-IV

Applications of Group Theory-II : Derivation of spectroscopic terms for d1 to d9 electronic configurations, correlation diagram for d2 ion in octahedral field, Splitting of d1 to d9 terms in an octahedral and tetrahedral field. Selection rules of d-d transitions. Spin-spin, orbital-orbital and spin-orbital coupling, LS and jj coupling . Comparison of CFSE values of d1 to d9 ions in terms of orbit splitting and R-S term splitting. Effect of CFSE on thermodynamic properties, lattice energy, heat of hydration heat of ligation and spinal structure. Strong field configurations, transition from weak to strong crystal fields, evaluation of strong crystal field terms of d2 configuration in octahedral and tetrahedral crystal fields (using group theory).

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Chemical Application of Group Theory	F.A. Cotton	Wiley Eastern
2	Inorganic Chemistry, 3rd edition	G. L. Miessler, D. A. Tarr	Pearson Education
3	Introduction to Ligand Field	B.N. Figgis	Wiley Eastern
4	Inorganic Electronic Spectroscopy	A.B.P. Lever	Elsevier.
5	Introduction to Magnetochemistry	A. Earnshaw	Academic Press.
6	Advanced Inorganic Chemistry	F.A. Cotton and G. Wilkinson	Wiley Inter-science

Semester	**I**
Course Code	**CHM 557**
Course Title	**Pericyclic reactions & Photochemistry**
Type of course	Minor
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To give the knowledge of Pericyclic reactions, & photochemical reactions.
Course Outcomes	The students will be able to: 1. Understand the Basic principles of photochemical reactions, photochemistry of carbonyl compounds at different conditions. . 2. Analyze correlation diagrams method and Perturbation of molecular orbital (PMO) approach. 3. Apply Mechanistic and stereochemical aspects of thermally or photochemically driven pericyclic reactions.

Syllabus

Unit-I

Pericyclic Reactions: Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene, allyl system, classification of pericyclic reactions FMO approach. Woodward-Hoffmann correlation diagrams method and Perturbation of molecular orbital (PMO) approach for the explanation of pericyclic reactions under thermal and photo-chemical conditions.

Electrocyclic reactions – controtatory and disrotatory motions, 4n, 4n+2, allyl systems secondary effects. Electrocyclic reactions of 4n , 4n+2 systems thermally and photochemically, Stereochemistry of electrocyclic reactions with examples

Cycloadditions reactions – antrafacial and suprafacial additions, notation of cylcoadditions (4n) and (4n+2) systems with a greater emphasis on (2+2) and (4+2) cycloaddition-stereochemical effects and effects of substituents on the rates of cycloadditions, 1,3-dipolar cyclo-additions and cheleotropic reactions.

Unit-II

Sigmatropic Rearrangements: suprafacial and antrafacial shifts [1,2]- sigmatropic shifts involving carbon moieties retention and invertion of configuration, (3,3) and (5,5) sigma-tropic rearrangements, Claisen and Cope rearrangements, fluxional tautomerism, aza-cope rearrangements, introductions to Ene reactions, simple problems on Pericyclic reactions. Elecrocyclic rearrangement of cyclobutenes and 1,3 cyclohexadienes.

Unit-III

Photochemistry: Basic Principles of Photochemical Reactions: Photochemical laws – Franck-Condon principle, Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, transfer of excitation energy, radiative lifetimes, quantum yields, quenching rates and mechanisms, actinometry.

Determination of Reaction Mechanism: Classification, rate constants and life times of reactive energy states –determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions – photodissociation, gas-phase photolysis.

Photochemistry of Alkenes: Intramolecular reactions of the olefinic bond – geometrical isomerism, cyclization reactions, rearrangement of 1,4- and 1, - dinenes.

Photochemistry of Aromatic Compounds: Isomerisations, additions and substitutions.

Unit-IV

Photochemistry of Carbonyl Compounds: Intramolecular reactions of carbonyl compounds – saturated, cyclic and acyclic, β, γ- unsaturated and α,β-unsaturated compounds, Cyclohexadienones. Intermolecular cycloaddition reactions – dimerisations and oxetane formation.

Miscellaneous Photochemical Reactions: Photo-Fries reactions of anilides. Photo-Fries rearrangement. Barton reaction. Photochemical formation of smog. Photodegradation of polymers. Photochemistry of vision.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Molecular reactions and	Chapman and Depuy	Pearson Education,
2	Molecular Reactions and Photochemistry	C. H. *DePuy* and O. L. *Chapman*	Prentice-Hall
3	Organic reaction mechanism, 3rd ed.	V. K. Ahluwalia	Narosa publishing house, New Dehli
4	Photochemistry & Pericyclic Reactions, 3rd Edition	Jagdamba Singh & Jaya Singh	New Academic Science Ltd

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Course Code	**EVS003**
Course Title	**Natural Hazards and Disaster Management**
Type of course	VAC
L T P	3 0 0
Credits	3
Course prerequisite	Graduation
Course Objective	To learn about natural hazards, risk assessment and disaster management
Course Outcomes	The students will be able to: 1. know the current overview of natural hazard materials 2. discuss the physical aspects of vulnerability and elements of risk mapping, assessment 3. know the development planning, sustainable development in the context of Climate Change

Unit I

Overview of natural hazards; Introduction to natural hazards, impact and mitigation in Global and Indian context; causes and consequences of geological hazards, flood, drought and climate change issues, forest hazard, tsunami and coastal hazards, cyclone hazards, snow avalanche, GLOF and glacier related hazards, extreme weather events, urban and industrial hazards.

Unit II

Introduction: to vulnerability and risk assessment, socio-economic and physical aspects of vulnerability and elements of risk mapping, assessment, and reduction strategies.

Unit III

Earth observation: Data availability and key operational issues for DM: EO systems for natural hazards study: present (operational) and future systems; multi-temporal data sources, multi-temporal database organisation: Key operational issues, utilisation of geo-information products for disaster management (available through International cooperation e.g. International Charter etc.)

Unit IV

Disaster management framework of India and recent initiatives by Govt. of India with special emphasis on DRR HFA 2005-2015, MDG and SAARC comprehensive framework for DRR Disaster Management Support (DMS): Status in India for use of space inputs Mainstreaming DRR in Development Planning Sustainable development in the context of Climate Change Disaster Recovery-Strategy and case examples.

Text and Reference books:

S. No.	Name/Title	Author	Publisher
1	Environmental Hazards : Assessing Risk and Reducing Disaster	Keith Smith and Petley David, 2008.	Routledge
2	Geo-information for Disaster Management	van Oosterom Peter, Zlatanova Siyka and Fendel Elfriede, 2005	Springer-Verlag
3	Geospatial Techniques in Urban Hazards and Disaster Analysis	Showalter, Pamela S. and Lu, Yongmei, 2010.	John Wiley and Sons.
4	An International Perspective on Natural Disaster: Occurrence, Mitigation and Consequences	Stoltman JP, Lidstone J and Dechano LM., 2004.	Kluwer Academic Publishers

Semester	**I**
Course Code	**CHM565**
Course Title	**Inorganic Chemistry Practical-1**
Type of course	Practical (Major)
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To synthesize the coordination complexes and to impart knowledge of various techniques for analysis of inorganic compounds.
Course Outcomes	The students will be able to: 1. Acquire Coherent Knowledge of analytical data forTitrimetric and gravimetric analysis of different cations and anions. 2. Understand the principles, and methodology involved in precipitations and its titrations for assaying different ions. 3. Discuss and apply the principles involved in the redox titrations and Prepare different types of inorganic compounds.

List of Experiments ***Note: Perform at least any two three experiments from each section.***

A.Inorganic Preparations & Estimation

Preparation of Reinecke salt,Trinitrotriamine cobalt (III),
Preparation of Potassium trioxalatomangnate(III), Ferrous ammonium sulphate,
Preparation of Potassium trioxalatechromate(III).
Estimation of metal in complexes by Electronic Spectroscopy
Determine the total hardness of water.

B.Oxidation-Reduction Titrations

Standardization with sodium oxalate of KMnO4 and determination of Ca^{2+} ion.
Standardization of ceric sulphate with Mohr's salt and determination of $Cu^{2+,}$ NO3 -1 and C2O4 ions.
Standardization of K2Cr2O7 with Fe^{2+} and determination of Fe^{3+} (Ferric alum)
Standardization of hypo solution with potassium iodate / K2Cr2O7 and determination of availableCl2 in bleaching powder, Sb^{3+} and Cu^{2+}.
Determination of hydrazine with KIO3 titration.

C. Precipitation Titrations

AgNO3 standardization by Mohr's method by using adsorption indicator.
Volhard's method for Cl^- determination.
Determination of ammonium / potassium thiocyanate.

D. Complexometric Titrations

Analysis of two cation-system using EDTA
Determination of Cu^{2+} and Ni^{2+} by using masking reagent by EDTA titration.
Determination of Ni^{2+} (back titration).
Determination of Ca^{2+} (by substitution method).

E. Gravimetric Analysis

Determination of Ba^{2+} as its chromate.
Estimation of lead as its lead molybdate.
Estimation of chromium (III) as its lead chromate.
Estimation of Cu^{2+} using Ammonium/ Sodium thiocyanate.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Vogel's quantitative analysis 6 Edn	Mendham, Denny	Pearson Education 2002
2	Synthesis and Technique in Inorganic chemistry	G. S.Girlomi; R.J. Angleci	3rd edn.; University Science Books.
3	Advanced Practical Inorganic Chemistry	Ayodha Singh	Campus Books 2002

Semester	**I**
Course Code	**CHM567**
Course Title	**Organic Chemistry Practical-1**
Type of course	Practical (Major)
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To learn the basic organic preparations and organic reagents like reducing agents and oxidizing agents.
Course Outcomes	The students will be able to: 1. Adopt safe laboratory practices by handling laboratory glassware, equipment and chemicals. 2. Understand the basic nature of reagents like reducing agents and oxidizing agents. 3. Apply & propose starting materials, functional groups, mechanism, and typical reaction conditions.

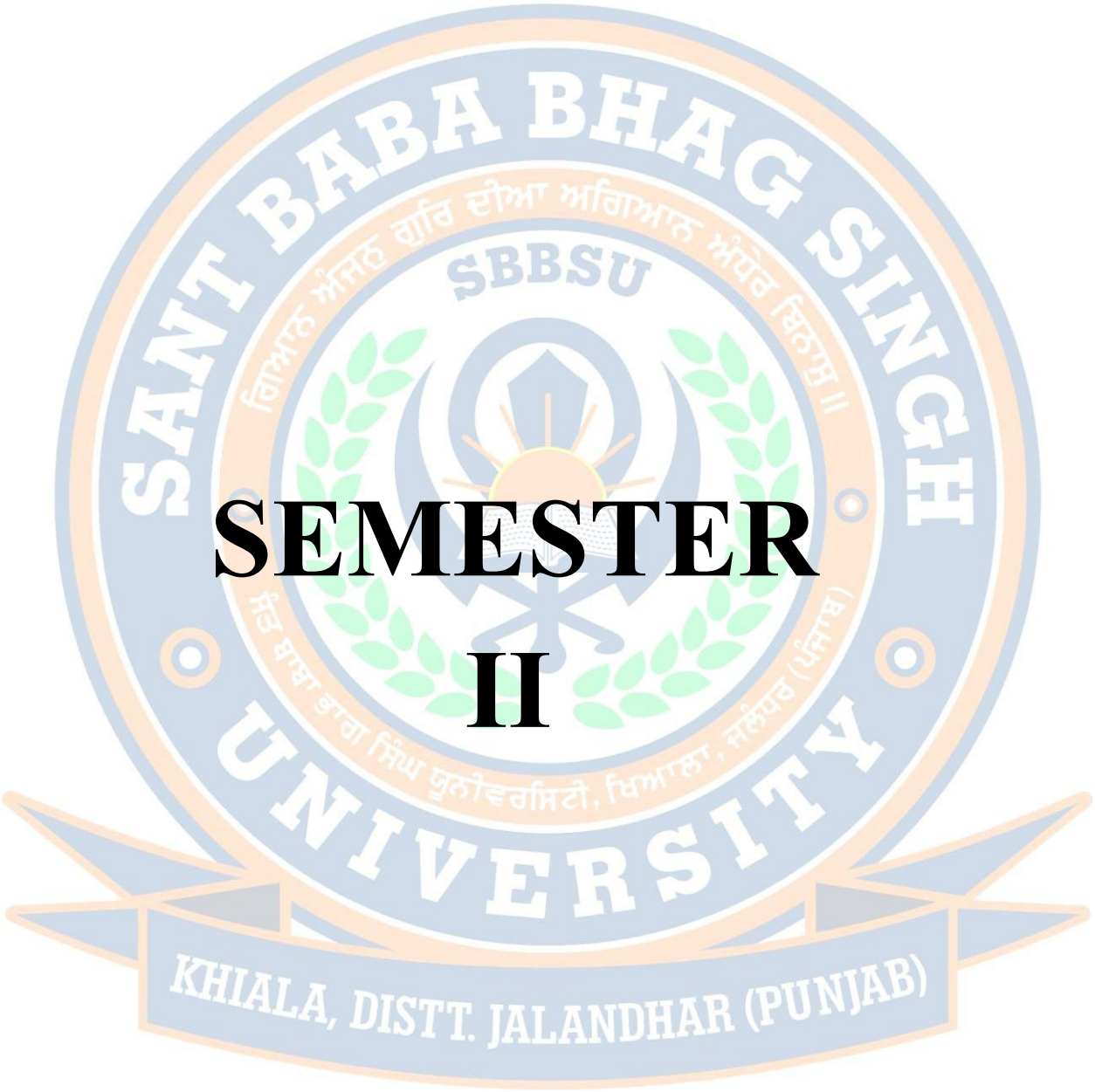
List of Experiments

Synthesis: Synthesis, purification and identification of organic compounds by recrystallization/functional group identification:

i. Oxidation: Adipic acid from cyclohexanol
ii. Aldol condensation: Dibenzal acetone from benzaldehyde
iii. Sandmeyer reaction: p-Chlorotoluene from p-toluidine
iv. Cannizzaro reaction: Benzyl alcohol and benzoic acid from benzaldehyde
v. Aromatic electrophilic substitutions: p-nitroaniline from aniline
vi. Aromatic electrophilic substitutions: Picric acid from phenol
vii. Beckmann Rearrangement: Benzanilide Benzophenone oxime Benzaldehyde
viii. Reduction: Benzhydrol from benzophenone [NaBH4 reduction]
ix. Esterification: Methyl benzoate from benzoic acid
x. Carbohydrate Modification: Osazone derivative from carbohydrates
xi. Haloform reaction: Iodoform synthesis from acetone / ethyl alcohol
xii. Sublimation: Synthesis/purification of Phthalic anhydride from Phthalic acid
xiii. Preparation of p- Iodonitrobenzene from p-nitroaniline.
xiv. Preparation of benzyl alcohol and benzoic acid (Cannizzaro's reaction).
xv. Preparation of Dibenzal acetone from benzaldehyde (Claisen-Schmidt reaction).
xvi. Preparation of Acetanilide, bromoacetanilide, bromoaniline.

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Experimental Organic Chemistry,	Harwood, L.M., Moody, C.J.	1st edition, Blackwell Scientific Publishers, 1989.
2	Text Book of Practical Organic Chemistry	Vogel, A.I.	ELBS, IVth edition, Longman Group Ltd., 1978.
3	Practical Organic Chemistry	. Mann, F.G.; Saunders, B.C.	4th edition, New Impression, Orient Longman Pvt. Ltd., 1975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SBBSU
UNIVERSITY
KHIALA, DISTT. JALANDHAR (PUNJAB)

SEMESTER II

Semester	**II**
Course Code	**CHM552**
Course Title	**Organic Reaction Mechanism**
Type of course	Major
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To impart knowledge of stereochemical aspects of organic compounds reactive intermediates and mechanism of general organic reactions including substitution, elimination and addition.
Course Outcomes	The students will be able to: 1. Understand Coherent Knowledge of mechanistic aspects in nucleophilic ,electrophilic substitution, addition and elimination reactions. 2. Analyze reaction conditions, products formation and mechanisms of some named reactions. 3. Apply various reaction pathways to develop new and notable organic compounds.

Syllabus

Unit-I

Stereochemistry: Elements of symmetry, chirality, projection formulae,configurational and conformational isomerism in acyclic and cyclic compounds, molecules with more than one chiral center. Threo and erythro isomers, methods of resolution, optical purity. stereogenicity, stereoselectivity, diastereoselectivity, D/L, R/S, *E*/*Z* and *cis*/*trans* configurational notations Prochirality – enantiotopic and diastereotopic atoms, groups. Stereospecific and stereoselective synthesis. Asymmetric synthesis.Optical activity in absence of chiral carbon (Biphenyls, Allenes, Spiranes). conformational analysis of cyclic compounds such as cyclopentane, cyclohexane, cyclohexanone derivatives, decalins, 1,2, 1,3-, 1,4-disubstituted cyclohexane derivatives and D-Glucose, effect of conformation on reactivity.

Unit-II

Nature of Bonding in Organic Reactions: Aromaticity in Benzenoid and non-benzenoid compounds. Huckel Rule, Alternant and non alternant hydrocarbons. Energy levels of Π(pi) molecular orbitals in simple systems. Annulenes, Antiaromaticity, Homoaromaticity, PMO approach.

Reaction Mechanism, Structure and Reactivity: Types of mechanisms in different reactions, thermodynamic and kinetic requirements, Kinetic and thermodynamic control in product formation. Transition states and reaction intermediates, Isotope effects, Hard and Soft Acid Base concept, Study of reactive intermediates – Types of intermediates, isolation and detection of intermediates, trapping of intermediates.

Unit-III

Aliphatic Nucleophilic Substitution: The SN2, SN1 and SNi mechanisms, mixed SN1 & SN2mechanism, SET mechanism. The neighbouring group mechanism (anchimeric assistance).

Neighbouring group participation by pi and sigma bonds, Classical non-classical & phenonium cations, Rearrangements in carbocations (general survey). Ester hydrolysis. Nucleophilic substitution at allylic, aliphatic trigonal and vinylic carbon.

Aromatic Electrophilic Substitution: The arenium ion mechanism, orientation and reactivity in mono substituted and di substituted aromatics. Energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Gatterman-Koch reaction, Pechmann reaction, Houben – Hoesch reaction, Fries rearrangement.

Aromatic Nucleophilic Substitution: ArSN1, ArSN2 and ArSN via benzyne (Arynes) mechanisms. Reactivity effect of substrate structure, leaving group and nucleophile. The von Richter, Sommelet-Hauser and Smiles rearrangements.

Unit-IV

Free Radical Reactions: Type of free radical reactions, free radical substitution mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity.Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation. Coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Free Radical Rearrangement. Hunsdiecker reaction, Kolbe reaction, Hydroxylation of aromatics by Fenton's reagent.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Highlights of Organic Chemistry	W.J. L. Nobel	An Advanced Text Book
2	Advanced organic chemistry part-A. 5th Ed	F. A. Carey and R. J. Sundberg	Springer (2007)
3	A guidebook to mechanism in organic chemistry, 6th Ed	Peter Sykes	Orient Longman
4	Stereochemistry conformation and Mechanism	P. S. Kalsi	New Age International
5	Stereochemistry of carbon compounds	Ernest Eliel	McGraw Hill, New York (1962).

Semester	**II**
Course Code	**CHM554**
Course Title	**Quantum Chemistry**
Type of course	Major
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as one of the main Subject
Course Objective	To acquire knowledge of the Quantum theory & quantum chemical description of chemical bonding, reactivity and their applications in molecular spectroscopy and inorganic chemistry.
Course Outcomes	The students will be able to: 1. Acquire Knowledge about Electronic energy states and different operators for molecules. 2. Understand Quantum chemical description of angular momentum. 3. Use Quantum chemical description of chemical bonding, reactivity and their applications in molecular spectroscopy in organic chemistry.

Syllabus

Unit-I

Quantum Theory: Introduction and Principles: Particle Nature of Radiation: The Origin of Quantum Theory, Black body radiations, Planck's Quantum Hypothesis, Planck's radiation law, photoelectric effect: Failure of Classical Physics, Einstein's Theory—Photons Stopping Potential, Compton Effect: Compton's Explantation, Experimental Arrangement ,Failure of Classical Physics, Bohr's Theory and its limitation: Energy of the Electron in the *n*th Bohr Orbit, Frequency and Wavelength of the Radiation in the Transition *n*2 to *n*1, Explanation of the Hydrogen Spectrum, Rydberg relation for explaining atomic spectrum of hydrogen. Hydrogenic Ions, Correction for Finite Nuclear Mass, Limitations of the Bohr Model,
De- Broglie hypothesis, Other Useful Expressions for the De Broglie Wavelength, The Need for a Wave Function, Born's Interpretation of the Wave Function
.

Unit-II

Heisenberg's uncertainty principle, Representation of a Particle by a Wave Packet, Wave Packets in Three Dimensions, Heisenberg's Uncertainty Principle, Energy-Time Uncertainty Relation,General Statement of the Uncertainty Principle, The Ground State Energy and the Radius of the Hydrogen Atom, Nonexistence of Electrons Inside the Nucleus solution of classical wave equation by separation of variables method

Operators and observations, normal and orthogonal functions, Hermitian and unitary operators, introduction to differentiation and integration, Eigen value equation. Hamiltonian operator, interpretation of wave function, postulates of quantum mechanics.

Unit-III

Angular Momentum: Commutative laws, need of polar coordinates, transformation of Cartesian coordinate into polar coordinate, angular momentum of one particle system, orbital angular momentum, the ladder operator method for angular momentum, spin angular momentum and their relations

Applications of Quantum Postulates: Solution of particle in one and three dimensional box, degeneracy, the linear harmonic oscillator, rigid rotators, quantization of vibrational and rotational energy levels, hydrogen and hydrogen like atoms.

The Approximate Methods: Need for approximation methods, Perturbation and Variation methods and their application to Helium atom.

Unit-IV

General Orbital Theory of Conjugated Systems: Chemical bonding: Molecular orbital theory, term symbol of molecular orbital theory, valance bond theory, hybridization, calculation of coefficient of AO'S used in hybridization, linear combination of atomic orbital, overlap integral, coulomb's integral, bond order, charge density calculations for ethylene, allyl system, butadiene system, cyclo butadiene cyclo propenyl system. Huckel's rule for molecular orbital theory of conjugated system.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Physical Chemistry, A Molecular Approach	MacQuarrie and Simon	University Science Books, 1997
2	Quantum Chemistry	Ira N. Levine	Prentice Hall
3	Physical Chemistry	P. W. Atkins	ELBS, Oxford, 1997.
4	Quantum Chemistry	H. Eyring, Kimball and Walter	Nabu Press (September 12, 2011)

Semester	**II**
Course Code	**CHM556**
Course Title	**Spectroscopy (Techniques for Structural elucidation of Organic & Inorganic Compounds)**
Type of course	Major
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To get familiarized with various spectroscopic techniques such as UV, IR, NMR and Mass spectroscopy and illustrate their application for structural elucidation of organic molecules.
Course Outcomes	The students will be able to: 1. Acquire Coherent and advanced knowledge of the principles and techniques in spectroscopy. 2. Understand electronic,Vibrational, proton NMR & 13C NMR and mass spectrometry methods of analysis. 3. Apply spectroscopic methods (UV,IR,1H-NMR,13C-NMR& mass spectrometry) in organic structure elucidation.

Syllabus

UNIT-I

General Introduction to spectroscopy: Nature of radiation, energies corresponding to various kind of radiation, energies for atomic and molecular transitions, Experimental techniques, intensities of spectral lines, Selection rules and transition moments, Linewidths, Broadening.

Electronic Spectroscopy/ Ultraviolet and Visible Spectroscopy: Electronic transition, energy of electronic transition, selection rules, the Franck-Condon principle. Beer- Lambert law, Factors affecting electronic transitions: effect of solvent, Steric effect in biphenyls.**U**ltraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Woodward- Fieser-rules for conjugated dienes and carbonyl compounds & Benzanoid systems, Ultraviolet spectra of aromatic and heterocyclic compounds.

Microwave Spectroscopy: Classification of molecules, rigid rotor model, effect of isotopic substitution on the transition frequencies, intensities of spectral lines, non-rigid rotor, Stark effect, applications.

UNIT-II

Infrared Spectroscopy: Introduction, Theory of IR absorption, types of vibrations, observed number of modes of vibrations, Intensity of absorption bands, theoretical group frequencies Dispersion IR spectrometer and FT IR spectrometer: Instrumentation and sample handling. Characteristic vibrational frequencies of organic compounds: Alkanes, alkenes, alkynes, aromatic compounds, mononuclear and polynuclear aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds.

IR spectroscopy of inorganic compounds:. Review of harmonic oscillator, Selection rules, vibrational energies of diatomic molecules, zero point energy, anharmonicity, vibration-rotation

spectroscopy, Morse potential energy diagram, P, Q, R branches, vibrations of polyatomic molecules. Factor affecting vibrational frequency: Effect of hydrogen bonding and solvent effect, electrical effects, resonance, Inductive effects, Ring strain), overtones, combination bands and Fermi resonance. Application of IR to the following: Distinction between: Ionic and coordinate anions such as NO_3, SO_4 and SCN b) Distinction between : Lattice and coordinated water. Mode of bonding of ligands such as urea, dimethylsulphoxide.

Raman Spectroscopy - Classical and quantum theories of Raman Effect, selection rules, mutual exclusion principle, resonance Raman Spectroscopy, surface enhanced Raman spectroscopy, coherent anti stokes Raman spectroscopy.

UNIT-III

Nuclear Magnetic Resonance Spectroscopy, ^{1}H proton: Historical introduction to magnetic resonances, chemical shift, mechanism of electron shielding and factors contributing to the magnitude of chemical shift, measurement techniques (CW and FT methods). Solvent used, reference standards. Simple applications ofchemical shift, ring currents and aromaticity, anisotropy shifts, factors affecting chemical shifts. Spin-spin coupling, coupling constants, Karplus relationship, interpretation of spectra. Chemical shift values and correlation for protons bonded to carbon and other nuclei of various organic compounds. First andsecond order spectra A_2, AB, AX, AB_2, AX_2,A_2B_2, A_2X_2, ABX and ABC spin systems. Long range coupling, Decoupling Techniques, double resonance, Effect of deuteration, Effects of chemical exchange, fluxional molecules,Hindered rotation on NMR spectrum. Nuclear overhausser effect, Lanthanide shift reagents

^{13}C NMR & 2D NMR : Introduction, , Correlationspectroscopy (COSY), Homo COSY (^{1}H-^{1}H COSY), Hetro COSY (1H-13C COSY, HMQC), Long range ^{1}H-^{13}C COSY (HMBC), NOESY, DEPT techniques, ^{13}C NMR spectra, their interpretation and applications

Basic concepts of NMR of inorganic spin active nuclei: ^{31}P, ^{19}F, ^{29}Si, ^{11}B, ^{10}B, ^{57}Se & ^{195}Pt, ^{119} Sn and NMR spectra of paramagnetic complexes. NMR study in Fluxional organometallic compounds**: T**rigonal bipyramidal molecules, Systems with coordination number six or more and organometallic molecules (PF_5, $Ti(acac)_2Cl_2$, $Ti(acac)_2Br_2$, $Ta_2(OMe)_{10}$,).

UNIT-IV

ESR: Hyperfine coupling, spin polarization for atoms and transition metal ions, spin orbit coupling and significance of *g*-tensors, application of transition metal complexes (having one unpaired electron) including biological systems.

Mass Spectrometry: Introduction, ion production - EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance, molecular ion peak, metastable peak, McLafferty rearrangement. Nitrogen rule. Mass spectral fragmentation of organic compounds, common functional groups, High resolution mass spectrometery. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination

The combined application of UV, IR, Raman, NMR and mass spectra in solving advanced spectroscopicproblems.

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Instrumental Methods of Chemical Analysis	G.W.Ewing,	McGraw Hill Pub, 1975.

2	Spectrometric Identification of Organic Compounds	Robert M. Silverstein	7th edition John Wiley
3	Organic Spectroscopy.	W. Kemp	Macmillan; 2nd edition (1987);
4	Organic Spectroscopy: Principles and Applications	Jag Mohan	Himalaya ***Publishing*** House, Bombay, 1 992.
5	Applications of absorption spectroscopy of organic compounds. (1965).	Dyer, J. R.	Phi Learning.
6	Spectroscopy of organic compounds. (2007).	Kalsi, P. S.	New Age International.
7	Introduction to solid NMR Spectroscopy. (2010)	Melinda, J.D.	Wiley India Pvt Ltd

Semester	**II**
Course Code	**CHM558**
Course Title	**Coordination Chemistry**
Type of course	Minor
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	The main goal of this subject is to study the coordination complexes, reactions and their applications.
Course Outcomes	The students will be able to: 4. Understand Formation, reaction mechanism of coordination complexes, their Kinetic and thermal stability, and determinations. 5. stability of coordination complexes. 6. Able to interpret the electronic and magnetic properties of coordination compounds.

Syllabus

UNIT - I Coordination Chemistry and bonding

Nomenclature, isomerism and methods of preparation of coordination complexes- types of ligands. Bonding: Valence bond theory- Crystal field theory – Crystal field effects in tetrahedral, octahedral and square planar symmetries. Crystal field stabilization energy - weak and strong fields- spectrochemical series. Molecular orbital theory: based on group theoretical approach. M.O. diagram of Oh. Td & square planar symmetries involving pi bonding- experimental evidence for the presence of pi bonding. Magnetic behaviour of the transition metal ions in crystal field and molecular orbital theories.

Unit-II

Electronic Spectra and Magnetic Properties of Transition Metal Complexes-I

Term symbols for d configuration. calculations of Dq, B and β parameters, Characteristics of d-d transition -- selection rules rules for electronic spectra. Weak and strong field limits. Spectroscopic ground states, correlation ,Orgel diagram and Tanabe – Sugano energy level diagrams. Spectrochemical series, Jahn-Teller tetrahedral distortion and spin orbit couplings. Nephelauxetic effect -charge transfer spectra. Luminescence spectra.

Magnetic moments based on crystal field ground term, Perturbation Theory and its application, Spin orbit coupling operator for magnetic susceptibility and magnetic moment of T terms and A, E terms, Anomalous magnetic moments, magnetic exchange coupling and spin crossover

UNIT – III

Reaction Mechanisms of Transition Metal Complexes

Introduction, potential energy diagram and reactivity of metal complexes, ligand substitution reactions, labile and inert metal complexes, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, anation reaction, ligand displacement reactions in octahedral and square planar complexes, Trans effect, mechanism of the substitution reaction reactions without metal ligand bond cleavage, Electron transfer reactions: sphere process.

Stepwise and overall formation constant and their interaction, trends in stepwise constants, Factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin.

Unit-IV

Metal II–Complexes: Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structure elucidation, important reaction of metal carbonyls. Preparation, bonding structure and important reactions of transition metal nitrosyl, Complexes of unsaturated hydrocarbons- alkenes, allyl and pentadienyl complexes.

Arene complexes-complexes of biochemical importance: Cytochromes, Haemoglobin, Myoglobin, Cyanocobalamine, Chlorophyll- structure and functions.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	*Inorganic Chemistry- Principles of Structure and Reactivity* (IV Edition).	Huheey, J. E., Keitler, E. A., & Keitler, R. L.(2012).	Singapore: PearsonEducation.
2	Basic Inorganic Chemistry (III Edition).	Cotton, F. A., Wilkinson, G., & Paul.L. (2007).	New York: John Wiley& Sons.
3	Inorganic Chemistry	D.F.Shriver, P.W.Atkins and C.H.Langford,	Oxford, 2nd. edn. 1994.
4	Magnetism and Transition Metal Complexes	F. E. Mabbs and D. J. Machin	(Chapman and Hall) London (1973).
5	Introduction to Magnetochemistry	A. Earnshaw	Academic Press, (1968)
6	*Co-ordination Chemistry*.(Ist Edition)	Sarn, K. (2005).	New Delhi: Rajat Publications.
7	An Introduction to Inorganic Chemistry	K.F.Purcell and J.C.Kotz	Saunders 1990, Chapter 14.
8	Organotransition Metal Chemistry	Anthony F.Hill	Royal Society of Chemistry, Tutorial Chemistry Text, 2002. Chapters 1 to 7.
9	Comprehensive Coordination Chemistry	Vol.1. G Wilkinson (Ed)	Wiley, New York, 1967
10	Inorganic Chemistry,	Gary L. Miessler, Paul J. Fischer and DonaldA. Tarr, (2013).	Pearson

Semester	**II**
Course Code	**CHM560**
Course Title	**Organometallics Chemistry and Metal Clusters**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as one of the main Subject.
Course Objective	The main goal of this branch is to study the organometallics, π-acid ligands, Inorganic Rings, Chains and Metal Cluster which containing at least one bond between a metal and carbon
Course Outcomes	The students will be able to: 1. Explain basic properties, formation, reaction mechanism of organometallic compound. 2. Understand synthesis, properties, bonding and structures of organometallic compound. 3. Understand the principles behind the formation of metal cluster compounds, stability and application of Inorganic Rings, Chains and cages.

Syllabus

Unit -I

Basic Organometallic Chemistry: Common notation used in organometallic chemistry- Metal-ligand interactions; The basis of 18e- Rule, 16-electron rules , Exceptions to eighteen electron rule, isolobal analogy. Basic principles of ligand-field theory; molecular orbital theory

Organic-transition metal chemistry: complexes with π-acceptor and σ-donor ligands, π-acid ligands: π-acceptor character of CO, O2, N2, NO, PH3 molecules in terms of MOEL diagram,

Unit-II

Organometallics: Methods of preparation in perspective-organo lithium compounds: structure and bonding & reaction of carbolithiatic organometallics, Preparation and structure of organoaluminium compounds, Technical applications of tris (alkyl) aluminium compounds.

Molecular orbital description of ligands to transition metals.

Description of bonding of two electron ligands to Transition Metals. Preparation of olefin Transition Metal Complexes, olefenic and acetylenic complexes, 2π – ligands: Allylic and 4π – complexes of cyclopentadiene. Synthesis and structure. 4π–ligands: Butadiene, cyclobutadiene, 2π–complexes of cyclopentadiene, pentadiene, cyclic dienes, cyclopentadienyls, Molecular orbital picture of bonding in ferrocene.

Unit-III

Organometallic compounds in Homogeneous hydrogenation of unsaturated compounds, dihydrocatalysis, monohydrido compounds, selected application of dihydride oliphinic hydrogenation catalyst, Wilkinsons catalyst. water gas shift reaction, acetic acid synthesis by carbonyls, coordinative unsaturation, acid-base behavior reaction, migration of atoms or groups

from metal to ligand, Insertion reaction, reactions of coordinated ligands, catalytic reactions of alkenes– Isomerisation of alkenes, hydroformylation and Hydrosilation of unsaturated compounds, aldehydes and ketones, Ziegler-Natta polymerization of ethylene and propylene
Synthetic application of transition metal carbonyl compound: Synthesis and important reaction of metal carbonyls, coupling reaction, carbonylation by neutral metal carbonyls, carbonylation by anionic metal complexes, carbonylation by metal acyl complexes, decarbonylation of aldehydes and acid chlorides.

Unit-IV
Inorganic Rings, Cages and Metal Cluster: Inorganic cages

Rings: Synthesis and application of Borazines, Phosphazenes and other heterocyclic inorganic ring, homocyclic inorganic systems.
Cage : cages of P and S, oxides & sulphides, metal carbonyl and halide clusters, compounds with metal-metal multiple bonds, boron cage compounds, boranes, carboranes and metallocene carboranes,– synthesis and structure, .
Metal cluster: metal-metal bond, binuclear compounds, trinuclear clusture, fluxional molecules.

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Organometallics: A Concise Introduction	C. Elschenbroich and A. Salzer,	2nd Ed., VCH1992.
2	Inorganic Chemistry Principles of Structure and Reactivity	J.E. Huheey	Harper Interscience
3	Wilkinson, Advanced Inorganic Chemistry	F.A. Cotton and G. Wilkinson	Ed. V & VI.Wiley Inter-science.
4	Inorganic Chemistry	G. L. Miessler, D. A. Tarr	3rd edition, Pearson Education

Semester	**II**
Course Code	**CHM562**
Course Title	**Environmental Chemistry**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To acquire the knowledge of different chemical phenomena as applied to environmental interfaces, policies as guidelines emanating from these phenomena and water/wastewater treatment techniques.
Course Outcomes	The students will be able to: 1. Comprehend Basic chemical processes in the air water and soil environment 2. Understand & Propose policies as guidelines regarding different environmental interfaces. 3. Apply different chemical phenomena as applied to environmental interfaces.

Unit-I

Environment: Introduction. Composition of atmosphere, Biogeochemical cycles of C, N, P, S and O. Bio-distribution of elements.

Water pollution: Aquatic pollution - inorganic, organic, pesticide, agricultural, industrial and sewage, detergents, oil spills and oil pollutants. Water quality parameters , Chemical composition of water bodies-lakes, streams, rivers and wet lands, Types, sources and classification of water pollutants, Industrial water pollution, constituents of aquatic Environment, oxygen contents of water and aquatic life, oxygen electrode, and its use. Water quality standards, Analysis of water pollutants: Water analysis: Color, odour, conductivity, TDS, pH, acidity, alkalinity, chloride, residual chlorine, hardness, trace metal analysis, elemental analysis, ammonia, nitrite, nitrate, fluoride, sulphide, phosphate, phenols, surfactants, BOD, COD, DO, TOC, Purification and treatment of water. non-dispersive IR spectroscopy, anode stripping, ICP, AES, Chromatography, ion-selective electrodes, neutron activation analysis.

Unit-II

Water treatment Technologies: Chemical and Physical Methods of wastewater treatment with emphasis on sedimentation, coagulation, adsorption, water softening, defluoridation and ion exchange process, Activated sludge process, trickling filter and Membrane bioreactorprocess description, design and application.

Chemistry of Soil: Physio-chemical composition of soil, humus, inorganic and organic components of soil, micro and macro nutrients, acid-base and ion exchange reactions in soils, cation exchange capacity (CEC), ion exchange (physiosorption), ligand exchange (chemisorption), complexations, chelation; precipitation / dissolution reactions in soil solution, Wastes and pollutants in soil, treatment and recycling soil analysis, Pesticide, residue analysis soil pollution, Sources of pesticides residue in the Environment, pesticides degradation by

natural forces, effect of pesticide residue on life, Analytical techniques (HPLC, GC-MS) for pesticides residue analysis

Unit-III

Air Pollution: Chemical composition of atmosphere- particles, ions and radicals and their formation, Sources and sinks of gases pollutants, classification & effects of air pollutants, Air pollution problems in India, pollution problems in industrial area, Global air pollution problems, smog, green house effect, global warming, acid rain, ozone depletion, Photochemical reactions in the atmosphere Photochemical smog and their consequences on Environment. Major air pollution disasters.

Analytical methods for measuring air pollutants. Continuous monitoring . Ozone Chemistry and Montreal Protocol, Kyoto Protocol, Persistant Organic Pollutants (POP) and Stockholm Convention.

Unit-IV

Sources of Natural and Artificial Radiations: Radioactive pollution, disposal of radioactive waste. Dosimetry, types of dosimeters, radioactive substances, applications and handling of isotopes and other radionuclides in environment.

Biochemical and Toxicological aspects of arsenic, cadmium, lead, mercury, estimation of organomercurials, carbon monoxide, O3, PAN, MIC and other carcinogens. Effects on life and Environment.

Environmental Toxicology: Chemical solutions to environmental problems, biodegradability, principles of decomposition, better industrial processes,

Water Conservation and management techniques; Rain water harvesting; Watershed management; Eutrophication; Restoration of Lakes, transboundary river water sharing

Waste Management: Biomass waste management, biomedical waste management and chemical waste management, design and construction of waste management site. Regulations for waste management.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Environmental Chemistry	S. E. Manahan	Lewis Publishers
2	Environmental Chemistry	Sharma & Kaur	Krishna Publishers
3	Environmental Chemistry	A. K. De	Wiley Eastern
4	Environmental Pollution Analysis	S.M. Khopkar	Wiley Eastern
5	Standard Method of Chemical Analysis	F.J. Welcher	Vol. III, Van Nostrand Reinhold Co
6	Environmental Toxicology	Ed. J. Rose	Gordon and Breach Science Publication
7	Elemental Analysis of Airborne Particles	Ed. S. Landsberger and M. Creatchman	Gordon and Breach Science Publication
8	Environmental Chemistry	C. Baird, W. H. Freema	Wiley Eastern

Semester	**II**
Course Code	**CHM564**
Course Title	**Bio-Inorganic Chemistry**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	Main aim to Study the role of metals, enzymes, photosystems in biology. To provide knowledge of structure, function, and physicochemical properties of biomolecules.
Course Outcomes	The students will be able to: 1. Gain Coherent and advanced knowledge of various types of metals, enzymes, photosystems in biology. 2. Acquaint knowledge about the role of electron Transfer in Biology. 3. Analyse structure, function, and physicochemical properties of biomolecules.

Unit-I

Role of Metal ions in Biological Systems: Functions of metal ions in biological systems. Transport of ions through cell membrane - Na+/K+ Pump.

Natural oxygen carriers: Structure and function of Hemoglobin, Myoglobin, Hemerythrin & Hemocyanin. Mechanism of dioxygen binding with heme proteins. oxygen Transport in human body (-perutz mechanism), Nature of Iron-dioxygen linkage in Hemoglobin, Model system - Model Synthetic complexes of Iron and Cobalt as Oxygen carrier, Non-heme proteins (Hemerythrin & Hemocyanin).

Synthetic oxygen carriers: Oxygen molecule and its reduction products, model compounds for oxygen carrier (Vaska's Iridium cjomplex, cobalt complexes with dimethyl glyoxime and Schiff base ligands).

Unit-II

Metalloporphyrin: Porphyrins and their salient features, characteristic absorption spectrum of porphyrins, chlorophyll (structure and its role in photosynthesis). Other iron-porphyrin biomolecules, peroxidases and catalases, cytochromes, cytochrome P450 enzymes

Metallothionein: Ferredoxins, carboxypeptidase, carbonic anhydrase, blue copper proteins, superoxide dismutase,
Structure and function, inhibition and poisoning vitamin B12 and B12 coenzymes metallothionein , Cyanide poisoning and its remedy.

Unit-III

Photosynthetic Pigments: Complexes of Porphyrin. Redox mechanism in Photosystems (PS-I and PS-II), Cleavage of Water in PS-II.

Biological Nitrogen Fixation: Enzymatic reduction of Nitrogen to Ammonia - Nitrogenase Structure and mechanism. Molybdenum Nitrogenase - Spectroscopic and other studies. Model Systems for Nitrogenase.

Electron Transfer in Biology: Structure and Function of Metallic Proteins in Electron Transport Process,

Metal Storage, Transport and Biomineralisation : Metal Storage and Transport Structure and Function of Ferritin, Trans ferritin and Siderophores. Biomineralisation.

Unit-IV

Calcium in Biology: Biochemistry of calcium as hormonal messenger, muscle contraction blood clotting, neurotransmitter, metals in the regulation of biochemical events. Role of Calcium in living systems. Transport and regulation of Calcium - pathways and mechanism, Calcium Channels and pumps. Calcium binding proteins - Intracellular, Mediated membrane and Extracellular.

Metal - Nuclic Acid Interactions: Metal ions and Nucleic Acids Interactions (binding) - Types & suitable examples. Metal complexes for therapeutic uses (cisplatin, carboplatin, non platinum metal complexes). Metal Deficiency and disease. Toxic effects of Metals. Metals used for diagnosis. Metals used in Chemotherapy with particular reference to Anticancer drugs.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Principles of Bioinorganic Chemistry,	S. J. Lippard and J. M. Berg,	University Science Books (1994)
2	Bioinorganic Chemistry	Bertini, H. B. Grey, S. J. Lippard and J. S. Valentine	Viva Books Pvt. Ltd., New Delhi (1998
3	Biological Inorganic Chemistry: Structure and Reactivity	Harry B. Gray, Edward I. Stiefel et al.,	University Science Books.
4	Biological Inorganic Chemistry: An Introduction	Robert Crichton	.Elsevier Science (2008)
5	Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life, An Introduction and Guide	W. Kaim and B. Schwederski	Wiley, New York (1995)
6	Inorganic Chemistry of Biological Processes, 2nd Ed.	M. N. Hughes	JohnWiley & Sons, New York (1981),

Multidisciplinary Course

Semester	**II**
Course Code	**MAT 528**
Course Title	**Mathematics for Chemists(for B.Sc. Medical students)**
Type of course	MDC
L T P	3 0 0
Credits	3
Course prerequisite	B.Sc. with Chemistry as one of the main Subject
Course Objective	To learn basic concept of chemistry numerical like order of reaction, method of partial fractions, area under a curve etc.
Course Outcomes	The students will be able to: 1. Understand basic numerical methods like order of reaction, method of partial fractions 2. Analyze & interpret the area under a curve using Integral Calculus. 3. Apply solution of linear equations by using Determinants and Matrices.

Unit-I

Trigonometry: Definition of sin, cos, tan, cot, sec, cosec functions with the help of unit circle, values of sin x cos x cos x for x = 0, n/6, n/3, n/2. Meaning of a trignometrical identity. The following identities (no need of derivation and proof. However, application has to be emphasized).

Cos2 x+sin2 x = 1,Sin (x=2)-Sin2 x/½ sin x, Cos (x-2)Cos x, Cos(-x = cos x; sin(-x) = sin x Sin(-x) = sin x ; cos (-x) = --cos x, Sin(+x)= ---xin x; (+x) = --co x, Sin 2x = 2 sin x cos x Cos 2x = 2 sin x cos x, Cos 2x = 2lcosx-1, Tan (x) = -- sin x; cos x,Tan (x) = -- tan x; tan(x/2 – x = cot x), Tan (-x) = -tan x, Tan 2x = 2 tan x/(1-tan2 x)

Unit-II

Determinants and Matrices: Definition and expansion properties of determinants, product of two determinants of 3rd order. Introduction to various terms Matrix, row, column, diagonal unit. Sub, square, equal matrices, null, symmetricular, order of, character of, transpose of, adjoint of, inverse of matrices. Addition multiplication, Multiplication of matrices.

Unit -III

Differential Calculus : Differentiation of standard functions, theorems relating to the derivative of the sum, difference, product and quotient of functions, derivative of trigonometric functions, inverse trigonometric functions, logarithmic functions and exponential functions, differentiation of implicit functions, logarithmic differentiation.

Unit-IV

Integral Calculus : Integration as an inverse of differentiation summation, area under a curve, indefinite integrals of standard forms, method of substitution, method of partial fractions, integration by parts, definite integrals.

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	Differential Calculus	Santi Narayan	S. Chand And Company
2	Integral Calculus.	Santi Narayan	S. Chand And Company
3	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers
4	Mathematical Techniques in Chemistry	Joseph B. Dence	Wiley; 1St Edition edition (1975)
5	Mathematics of Physics and Chemistry	Margenau and Murphy	Van Nostrand
6	A Text Book of Engineering Mathematics	B.L. Moncha and H.R. Choudhary	Young Press; 2 edition

Multidisciplinary Course

Semester	**II**
Course Code	**MMB 542**
Course Title	**Chemistry of Biological Macromolecules (for B.Sc. Non Medical students)**
Type of course	MDC
L T P	2 0 0
Credits	2
Course prerequisite	B.Sc. with Chemistry as one of the main Subject
Course Objective	To impart knowledge of molecular structure and interactions present in various bio-molecules that assist in functioning and organization of biological cell.
Course Outcomes	The students will be able to: 1. Acquire basic knowledge about organization and working principles of various components of living cell. 2. Understand basic principles of structure, function, and folding of biomolecules 3. Acquire knowledge of molecular structure and interactions of proteins, carbohydrates, lipids and nucleic acids.

Unit 1

Introduction: Cell structure and functions, general characteristics of cells, difference between prokaryotic and eukaryotic cells, difference between plant and animal cells, cell organelles. Tissues, organs and organ systems.

Water: Water – physical properties and structure of water molecules, Role of water in life, water as reactant; and role of water in maintaining the native structure of biopolymers. pH, Acidic and basic buffers, Biological buffers, buffering against pH changes in biological systems Henderson-Hasselbalch equation, Hofmeister series, Chaotropic and kosmotropic ions/co-solvents.

Unit 2

Amino Acids and Peptides: Classification and properties of amino acids, Isoelectric point, Separation of amino acids, peptide and polypeptides, primary structures, structure of peptide bond, synthesis of peptides, N-terminal, C-terminal and sequence determination.

Proteins: Secondary structure of proteins with emphasize on supramoelcular --sheets, supersecondary structure and triple helix structure of collagen, tertiary structure of protein-folding, quaternary structure of protein, Automated Peptide synthesis, in-vivo and in-vitro protein folding, protein misfolding and conformational diseases.

Unit 3

Carbohydrates: Biologically important monosaccharides, disaccharides and polysaccharides, glycoproteins, role of sugars in biological recognition. An overview of Metabolism: citric acid cycle, glycolysis.

Lipids: Lipid classification, lipid bilayers, liproproteins-composition. high density (HDL) and low-density (LDL) lipoproteins and function, Phospholipids, membrane proteins - integral membrane proteins, .

Unit 4

Nucleic Acids: Purine and pyrimidine bases, Nucleotides, Nucleosides, base pairing via H-bonding, DNA, RNA structure and conformation, double helix model of DNA, different types of RNA and their functions, the chemical basis for heredity, overview of replication of DNA, transcription, translation and genetic code, ATP.

Text and Reference Books:

S. No.	Name/Title	Author	Publisher
1	Cord Biology		South Western Educational Publications, Texas, 2000.
2	Contemporary Enzyme kinetics and Mechanisms	D. L. Purich	Academic Press, 1983.
3	Bio-organic Chemistry, A chemical approach to enzyme action	Dugas H	Springer 2003.
4	Text book of Organic Medical and Pharmaceutical Chemistry,10th Ed	Wilson, Gisvold & Dorque	Lippincoh pover publishers, 1998.
5	Organic Chemistry, Third Edition,	Paula Yurkanis Bruice	Pearson Education

Semester	**II**
Course Code	**CHM566**
Course Title	**Organic Chemistry Practical- II**
Type of course	Practical (Major)
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. with Chemistry as one of the main Subject
Course Objective	Organic synthesis and quantitative analysis of organic compounds.
Course Outcomes	The students will be able to: 1. Acquire basic knowledge of organic synthesis of organic compounds. 2. Analyze & Interpret the quantitative analysis of organic compounds. 3. Propose methodologies for the extraction of Organic Compounds from Natural Sources.

1. Preparation, separation and purification of organic compounds, and their characterization by spectral techniques (UV, IR, PMR, CMR and MS)

1. Synthesis of 2-chloro-4-bromoaniline from aniline (Bromination and chlorination)
2. Synthesis of methyl orange from aniline. (Aromatic electrophilic substitution and diazocoupling).
3. Synthesis of benzpinacol and its pinacol rearrangement.
4. Synthesis of o-chlorobenzoic acid from phthalimide. Synthesis of acridone from o-chlorobenzoic acid. (Hofmann bromamide and Sandmeyer's reaction).
5. Synthesis of 2, 4-dinitrophenyl hydrazine from chloro benzene. (Electrophilic and nucleophilic substitution reactions on aromatic ring).
6. Synthesis of triphenylcarbinol from bromobenzene. (Grignard reaction)

2. Quantitative Analysis of Organic Compounds:

1. Estimation of phenol/aniline using bromate-bromide solution. (The application to find the purity of the sample and to determine the amount in given solution).
2. Determine the number of hydroxyl and amino groups in the given sample by the acetylation method.
3. Determine the mol. wt. of the given ketone by using 2,4-DNP method.
4. Estimation of reducing sugar by Fehling solution method.
5. To determine the sponification value of the given fat or oil sample.
6. To determine the iodine number of the given fat or oil sample.
7. Estimation of glycin

3. Chromatography:

Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of Rf values

4. Synthesis using Ionic liquids

Preparation of ionic liquid.

Synthesis of chiral compounds using ionic liquids and determination of optical activity of the product by polarimeter

5. Extraction of Organic Compounds from Natural Sources

(i) Isolation of caffeine from tea leaves.
(ii) Isolation of casein/lactose from milk
(iii) Isolation of piperine from black pepper
(iv) Isolation of Lcycopene from tomatoes
(v) Isolation of Hippuric acid from urine
(vi) Isolation and purification of lecithin from Soyabean seeds

6. Synthesis using Microwave/Sonicator

(i) Alkylation of diethyl malonate with benzyl chloride.
(ii) Synthesis of Heterocyclic compounds using multi component reactions

Note: Perform at least any two from each section.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Laboratory Experiments in Organic Chemistry	R. Adams, J. R. Johnson and C. F. Wilcox.	The Macmillan Limited, London.
2	An Introduction to Modern Experimental Organic Chemistry	R. M. Roberts, J. C. Gilbert, L.B.Rodewald and A. S. Wingrove Holt	Ranehart and Winston Inc. New York.
3	Introduction to Organic Laboratory Techniques – A Contemporary Approach	D. L. Pavia, G. M. Lampmana and G. S. Kriz	W. B. Saunders Company, 1976.

Semester	**II**
Course Code	**CHM568**
Course Title	**Physical Chemistry Practical- I**
Type of course	Practical (Major)
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. with Chemistry as one of the main Subject
Course Objective	To impart knowledge and hand-on experiences of different analytical and thermodynamic techniques (conductometry, pHmetry and other viscosity and surface tension measurements) for chemical and biomolecular analysis
Course Outcomes	The students will be able to: 1. Acquire basic knowledge about analytical techniques such as conductometric, pH metric and potentiometry techniques. 2. Understand and apply different thermodynamic techniques like viscosity and surface tension measurements for solutions. 3. Analyze determination of solubility of different inorganic and organic salt.

1. Viscosity:

(i) To determine the coefficient of viscosity of given liquid by Ostwald's viscometer.

(ii) Determination of relative and absolute viscosity of a given liquid.

(iii) Determination of percentage composition of a liquid mixture by viscosity measurement.

(iv) Determination of molecular weight of a high polymer (say polystyrene) by viscosity measurement.

2. Surface Tension:

(i) Determination of surface tension of given liquid by drop no. method by stalgmometer.

(ii) To determine the C.M.C. of a soap (sodium or potassium lauryl sulphate by surface tension measurements and to compare cleansing power of two detergents.

(iii) Determination of surface tension of alcohols & Determination of Parachor value of >CH2 group.

(iv) To measure interfacial tension and to test the validity of Antonoff's rule.

3. Solubility:

(i) Determination of solubility of inorganic salt in water at different temperatures and hence to draw the solubility curve.

(ii) Determination of heat of solution of a substance by solubility method

(iii) To study the effect of addition of an electrolyte on the solubility of an organic acid.

(iv) To study the variation of solubility of Ca (OH)2 in NaOH solution and hence determine thesolubility product.

(v) Determine the solubility (g/litre) of sparingly soluble lead sulphate from conductance measurements.

(vi) To obtain the mutual solubility curve of phenol + H2O, and hence the Upper Consolute point,

4. Colloidal State:

(i) To compare the precipitation power of Na^{+}, Ba^{+2} & $A1^{+3}$ ions for As2S3 sol.

(ii) To study interaction between arsenious sulphide and ferric hydroxide sol.

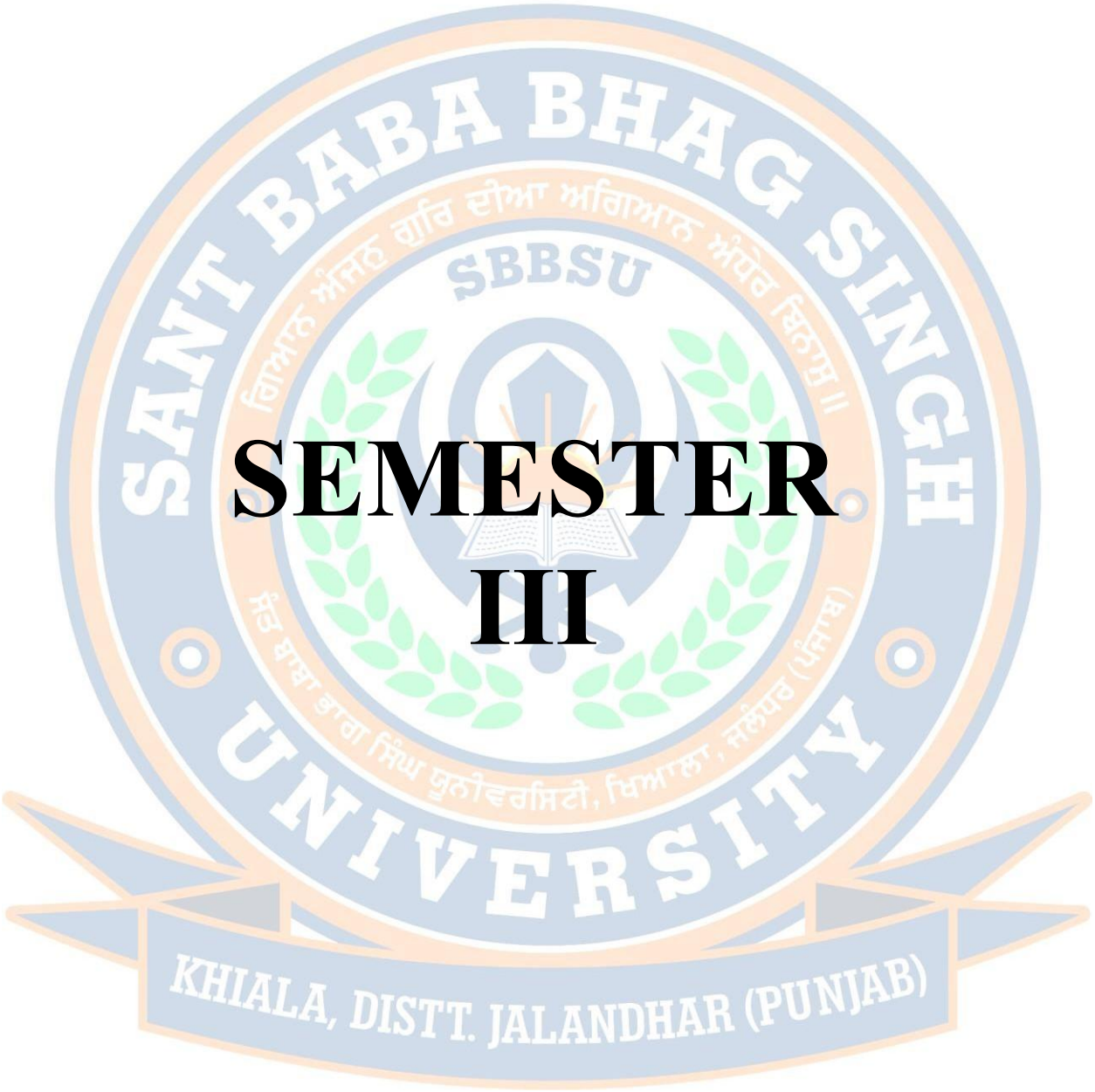
5. Potentiometric/ conductometric titrations:

(i) Preparation of buffers and measurement of their pH.
(ii) To determine the strength, dissociation constant of given acid pH metrically.
(iii)Titration of weak acid /Weak base conductometrically.
(iv) Titration of strong acid /strong base conductometrically.
(v) To determine dissociation constant of given acid conductometrically.
(vi) Compare the relative strength of CH3COOH and CICH2COOH from conductance measurements.
(vii) Titrate a given mixture of HCl and CH3COOH against NaOH solution conductometrically
(viii)Determine the dissociation constant of acetic acid in DMSO, DMF and dioxane by titrating it with KOH.
(ix)Determine the activity coefficient of an electrolyte at different molalities by e.m.f. measurements.

Note: Perform at least any three from each section.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Experimental Physical Chemistry	Arthur M. Halpern, George C. McBane	Freeman,2006.
2	Experiments in Physical Chemistry, 5th ed.,	Schoemaker et al.	MGH, 1989
3	Chemistry Experiments for Instrumental Methods	Sawyer, Heineman, Beebe	Wiley, 1984 .
4	Physical Chemistry Practical.	Maity S., and Ghosh, N.(	New Central Book Agency (P) Ltd. 2012).
5	Senior Practical Physical Chemistry.	Khosla, B.D., Garg, V.C., and Gulati A.R.	S. Chand and Sons. (2007).
6	Advanced Practical Physical Chemistry.	Yadav, J. B.	Krishna Prakashan Media. (2006).
7	Experiments in Physical Chemistry,	Ghosh, J.C.	Bharati Bhavan. (1990).



SEMESTER III

Semester	**III**
Course Code	**CHM651**
Course Title	**Chemistry of Natural Products & Heterocyclic Chemistry**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To impart knowledge about classification, occurrence and biosynthesis of various natural products and synthesis of organic compounds containing N, O, and S like compounds.
Course Outcomes	The students will be able to: 1. Gain Coherent and advanced knowledge of various types of natural products, their biosynthesis 2. Analyse structure, identify complex structure of natural products 3. Acquaint knowledge about heterocyclic compounds, their structure, synthetic routes

Unit-I

Terpenoids and Carotenoids: Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, stereochemistry, biosynthesis and synthesis of the following representative molecules: Citral, Geraniol, α-Terpeneol, Menthol, Farnesol, Zingiberene, Santonin, Phytol, Abietic acid and β-Carotene.

Alkaloids: Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants. Structure, stereochemistry, synthesis and biosynthesis of Ephedrine, (+)- Coniine, Nicotine, Atropine, Quinine and Morphine.

Unit-II

Steroids: Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation, structure determination and synthesis of Cholesterol, Bile acids, Androsterone, Testosterone, Estrone, Progestrone, Aldosterone. Biosynthesis of steroids

Plant Pigments: Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of Apigenin, Luteolin, Quercetin, Myrcetin, Quercetin-3-glucoside, Vitexin, Diadzein, Butein, Aureusin, Cyanidin-7-arabinoside, Cyanidin, Hirsutidin. Biosynthesis of flavonoids: Acetate pathway and Shikimic acid pathway.

Unit-III

Nomenclature of Heterocycles: Replacement and systematic nomenclature (Hantzsch-widman System) for monocyclic fused and bridged hetrocycles

Aromatic and Non aromatic Heterocycles: General chemical behaviour of aromatic heterocycles classification (structural type) criteria of aromaticity(bond length ring current and chemical shift in H NMR- Spectra empirical resonance energy delocalization energy and Dewar resonance energy)**,** Principles of heterocyclic synthesis involving cyclization reactions and

cycloaddition reaction.
Strain-bond angle and torsional strains and their conseqences in small ring heterocycles. Conformation of six-membered heterocycles with reference to molecular Geometry

Unit-IV

Small Ring Heterocycles: Three-membered and four-membered heterocyclic –synthesis and reactions of aziridines, oxiranes, thiiranes, azetidines, oxetanes and thietanes

Benzo-Fused Five-Memberd Heterocycles

Synthesis and reaction including medicinal applications of benzopyrroles, benzofurans and benzothiophenes

Reagents in Organic Synthesis: Use of the following reagents in organic synthesis and functional group transformations; Complex metal hydrides, Gilman's reagent, lithium dimethylcuprate, lithium disopropylamide (LDA) dicyclohexylcarbodimide. 1,3-Dithiane (reactivity umpolung), trimethylsilyl iodide, Woodward and prevost hydroxylation, osmium tetroxide, DDQ, selenium dioxide, phase transfer catalysts, crown ethers and Merrifield resin, Peterson's synthesis, Wilkinson's catalyst, Baker yeast.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Organic Chemistry, Vol. 2, 5th edition	Finar, I.L.	ELBS, 1975.
2	1. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas	Hostettmann, Kurt; Gupta, M.P.; Marston, A.	Harwood Academic Publishers.
3	Introduction to Flavonoids	Aggarwal, O.P.	2. Harwood Academic Publishers.
4	3. Natural Products: Chemistry and Biological Significance,	Mann, J.; Davidson, R.S.; Hobbs, J.B.; Banthrope, D.V.; Harborne, J.B.	. Longman, Esse
5	Organic Chemistry	Jerry March	Wiley & Sons
6	Heterocyclic Chemistry	Acheson.	Wiley-Interscience; 3rd edition (March 11, 1985)
7	Advanced Organic Chemistry	F.R.Carey, R.J. Sunberg.	Wiley Publishers
8	Highlights of Organic Chemistry	W.J.L. Nobel	An Advanced Text Book
9	Organic Chemistry	Jerry March	Wiley & Sons

Semester	**III**
Course Code	**CHM653**
Course Title	**Organic Reactions & Reagents**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To impart knowledge of named reactions & various reagents used in organic synthesis for various organic transformations and to get familiar with alternative methods of synthesis using PTC
Course Outcomes	The students will be able to: 1. Get familiar with various reactions, reagents mechanism along with application sof these reactions 2. Get familiar with alternative methods of synthesis 3. Critical study of reaction mechanism their investigation and applications

Syllabus

Unit-I

Energetic: Kinetics, and the Investigation of Mechanism: Energetic, rate and activation energy of reaction, kinetics and the rate limiting step, kinetic and thermodynamic control, investigation methods. Phase Transfer Catalysts: Introduction, mechanism, types and advantages, preparation of catalysts &application.

Unit-II

Crown Ethers: Introduction, nomenclature, special Features, nature of donor site and synthetic applications. Reagents in Organic Synthesis: Anhydrous aluminium chloride, aluminium isopropoxide, boron trifluride, N-Bromosuccinimide Diazomethane, Fenton's Reagent, Hydrogen peroxide, Lead tetra acetate, Lithium Aluminium Hydride, Osmium Tetroxide, Perbenzoic acid (Peroxybenzoic acid), periodic acid, Raney nickel, selenium dioxide, sodium amide (sodamide), sodium borohydride, NaBH4, Wilkinson's catalyst.

Unit-III

Name Reactions: Aldol condensation, Allyllic Rearrangement, Baeyer- Villiger Rearrangement, Beckmann Rearrangement , Brich Reduction, Cannizzaro Reaction, Claisen condensation and rearrangement, Curtius reaction, Diels Elders Reactions, Fries Rearrangement, Hofmann Rearrangement, Mannich Reaction, Oppenauer Oxidation, Pinacol-Pinacolone Rearrangement, Reformatsky Reaction, Reamer Tieman Reaction.

Unit-IV

Homogeneous hydrogenations: Mechanisms and applications using Rh, Ru and other metal complexes.
Oxidations: Scope of the following oxidizing reagents with relevant applications andmechanisms: DDQ, SeO2, Tl(NO3)3, Sharpless Asymmetric epoxidation, Asymmetric hydroxylation and aminohydroxylation.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Organic Synthesis - The Disconnection Approach	S. Warren	Willey Interscience,Ed.(1982)
2	Reactions Rearrangements and Reagents	S. N. Sanyal	Publisher Bharti Bhawan, 4th Ed(.2008)
3	Organic Synthesis-special Techniques	V. K. Ahluwaliaand R. Aggarwal,	Narosa Publishing House, Ed.(2005)
4	A Guidebook to Mechanism in Organic Chemistry	P. Sykes,	6th Ed.1981.
5	Phase Transfer Catalysis: Principles and Techniques	C. M. Starkesand C.Liotta	Acedemic Press, Ed. (1998)
6	Crown Compounds Their Characteristics andApplications	M. Iraoka	Amesterdam, Ed.(1982).

Semester	**III**
Course Code	**CHM655**
Course Title	**Recent Trends in Inorganic Chemistry**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To study recent advancements in Inorganic Chemistry with special emphasis to Inorganic Photochemistry, advanced catalysis.
Course Outcomes	The students will be able to: 1. Understand electronic structure of a variety of d orbital metal complexes 2. Get Knowledge about recent advancements in Inorganic Chemistry 3. Acquire knowledge of Inorganic Photochemistry, Oxidative-Addition and Migration reactions

Unit-I

Photo Inorganic Chemistry: Basics of photochemistry- Absorption, excitation, photochemical laws, quantum yield, electronically excited states, life times- measurements of the times Flash photolysis, energy adiddipation by radiative and non-radiative processes, absorption spectra, Franck-Condon principle, photochemical stages-primary and secondary processes, Kashia's rule, Thexi state. Applications of quenching and sensitization techniques in the identification of reactive state in coordination complexes

Unit-II

Photochemistry of Transition Metal Carbonyls: Photochemical substitution reactions of metal carbonyls with each other, n-donors, π-donors and ligands other than CO, Photochemical isomerization- positional isomerization, isomerization of ligands, Photochemical addition and elimination reactions – insertion into M-H, M-C and M-M bonds

Photo-reactions of complexes– photo-aquation, photo-substitution and photo-racemization; Photo-substitution and photo-redox reactions of Co(III) complexes; Adamson's rules, Photo substitution reactions of Cr(III)-Polypyridyls, Rh(III) Ammine Complexes, Ru-Polypyridyl complexes, Ru (II) polypyridyl and dinuclear Rh (I) isocyanide complexes as sensitizers; supra-molecular complexes as antenna. Ligand photo reactions, photoredox reactions, comparison of Fe(II) and Ru(II) complexes, Solar energy conversion – Photochemistry and photophysics of Ru(II)-polypyridine and related complexes, TiO_2 and related composites - Perovskite solar cells.

Photo synthesis in plants and Bacterio chlorophyll photosynthesis, photolysis of water using Inorganic precursors.

Oxidative-Addition and Migration (Insertion Reactions): Introduction: Acid base behaviour of metal atoms in complexes, Protonation and Lewis Base behaviour, acceptor properties of Lewis acidity of complexes, oxidative addition and reductive elimination, addition of specific

molecules, Hydrogen addition, HX additions, Organic halides addition of some other molecules productive elimination, migration (Insertion) reaction promotion of alkyl migration, insertion of CO into M-H bonds, other aspects of CO insertion reactions, transfer of other molecules, CO2, SO2 , NO2 , RCM, Insertion of alkenes and C-C unsaturated compounds, Cleavage of C-H bonds; alkane activation, Cyclometallation reactions. Reactions of free hydrocarbons.

Unit-III

Transition Metal hydride complexes: Characteristics, synthetic methods, chemical behaviour of hydride compounds, mononuclear polyhydrides, homoleptic polyhydride anions; carbonyl hydrides and onion. Molecular hydrogen compounds; metal hydrogen interaction with C-Hbonds; MH interactions; complexes of boron hydride and alumino hydrides, synthetic applications of metal hydrides.

Medical Photochemistry Introduction, Cells, Tissues and Light, Historical aspects, photophysics and photochemistry of PDT, Type I and Type II Mechanism, Singlet oxygen, Generations of PDT, Cancer photodetection, Porphyrin photosensitizers for PDT

Unit-IV

Transition Metal Complexes in Catalysis : Reductive Carbonylation Reaction: Methanol and methyl acetate, Adipic ester. decarbonylation reactions. Catalytic addition of molecules to C-C multiple bonds homogeneous hydrogenation, hydrocyanation of unsaturated compounds, hydrosilation of unsaturated compounds, hydrocyanation of alkenes, Cluster compounds in catalysis, supported homogeneous and phase transfer catalysis, Oxidation reaction: Oxidative carbonylations, Palladium catalysed oxidation of ethylene, Acrylonitrile synthesis, oxygen transfer from peroxo- and oxo- species, oxygen transfer from NO2 groups.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Concepts of Inorganic Photochemistry	A. W. Adamson and P. D. Fleischauer	Wiley.
2	Inorganic Chemistry	W.W. Porterfield	A Unified Approach
3	Advanced Inorganic Chemistry, 5th ed	F.A. Cotton and G. Willkinson	John Wiley & Sons, New York.
4	Organometalics: A Concise Introduction, 2nd Ed.	C. Elschenbroich and A. Salzer	VCH 1992.

Semester	**III**
Course Code	**CHM657**
Course Title	**Polymer Science**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	Main aim to Study the polymers, their processing, structure, properties and analysis of polymers by various methods
Course Outcomes	The students will be able to: 1. Acquire Coherent knowledge of different polymers, their processing, structure, properties and mechanisms of polymerization 2. Analyze number, weight and viscosity average molecular weights with various techniques 3. Apply & Design of methodologies for thermoplastic and thermosetting polymers

Syllabus

Unit-I

Basics: Importance of polymers. Basic concepts: Monomers, repeat, units, degree of polymerization. Linear, branched and network polymers. Classification of polymers. Polymerization: condensation, addition, radical chain-ionic and co-ordination and copolymerization. Polymerization conditions and polymer reactions. Polymerization in homogeneous and heterogeneous systems.

Unit-II

Polymer Characterization: Polydispersion-average molecular weight concept. Number, weight and viscocity average molecular weights. Polydispersity and. molecular weight distribution. The practical significance of molecular weight. Measurement of molecular weights. End-group, viscocity, light scattering, osmotic and ultracentrifugation methods. Analysis and testing of polymerschemical analysis of polymers, spectroscopic methods, X-ray diffraction study. Microscopy. Thermal analysis and physical testing-tensile strength. Fatigue, impact. Tear resistance. Hardness and abrasion resistance.

Unit-III

Structure and Properties: Morphology and order in crystalline polymers-configurations of polymer chains. Crystal structures of polymers. Morphology of crystalline polymers, strain-induced morphology, crystallization and melting. Polymer structure and physical properties - crystalline melting point Tm - melting points of homogeneous series, effect of chain flexibility and other steric factors; entropy and heat of fusion. The glass transition temperature, Tg-Relationship between Tm and Tg, effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking. Property requirements and polymer utilization.

Unit-IV

Polymer Processing: Plastics, elastomers and fibres. Compounding. Processing techniques: Calendering, die casting, rotational casting, film casting, injection moulding, blow moulding, extrusion moulding, thermoforming, foaming, reinforcing and fibre spinning.

Unit-V

Properties of Commerical Polymers: Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins and silicone polymers. Functional polymers - Fire retarding polymers and electrically conducting polymers. Biomedical polymers -contact lens, dental polymers, artificial heart, kidney, skin and blood cells.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Textbook of Polymer Science	F.W. Billmeyer Jr	Wiley
2	Polymer Science	V.A. Gowariker, N.V. Viswanathan and J. Sreedhar	Wiley-Eastern
3	Functional Monomers and Polymers	K. Takemoto, Y. Inaki and RM. Ottanbrite	
4	Contemporary Polymer Chemistry	H.R. Alcock and F.W. Lambe	Prentice Hall
5	Physics and Chemistry of Polymers	J.M.G. Cowie	J.M.G. Cowie

Semester	**III**
Course Code	**CHM659**
Course Title	**Biofuels**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To acquire knowledge of different methods of biofuel production, application,and their advantages.
Course Outcomes	The students will be able to: 1. Know current processes for biofuel production from biomass 2. Discuss the models of biomass concentration and utilization 3. Basic about Feedstock and Fermentation

Syllabus

Unit –I

Introduction: Drivers for alternative fuels, security, cost and environmental considerations, carbon sequestration and the impact of biofuels, review of current processes for biofuel production frombiomass

Unit –II

Economic Models: Costing of current and future processes for biofuel production from biomass, biomass availability, models of biomass concentration and utilization.

Unit –III

Feedstock Chemistry: Chemistry of triglycerides and carbohydrates, Improving biomass yield and properties for easier processing and conversion, Pretreatment of biomass, Enzymatic hydrolysis, Processes and alternatives, Enzymes immobilization techniques.

Unit –IV

Fermentation: Processes and alternatives, Aqueous processing of sugars.

Bio-Diesel and other alternative liquid fuels, Policy of biofuels, Biofuels around the world: Brazil, India and China

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Biofuels: Towards a greener and secure energy future,	*Bhojvaid, P.K.,*	TERI Press (2006).
2	Dadhich Production and Technology of Bio-diesel: Seeding a change,	Adholeya, A.,	TERI press (2008).
3	Biofuels: Production, Application andDevelopment	Scragg, A. H.,	CABI (2009).
4	Biofuels,	Olsson, L.,	Springer, (2007).
5	Biofuels: Illusion Or Reality?	Furfari, A.,	the European Experience, Editions TECHNIP (2008).

Semester	**III**
Course Code	**CHM661**
Course Title	**Bio-Organic Chemistry**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To provide knowledge of structure, function, and physicochemical properties of biomolecules. To aware students about the metalloenzymes, heme proteins, oxygen carriers, and non-heme proteins and therapatic Agents.
Course Outcomes	The students will be able to: 1. Understand structure, function and physicochemical properties of biomolecules 2. Interpret Structure & Properties of enzymes 3. Knowledge about Mechanism of enzyme action, metalloenzymes, heme proteins and oxygen carriers

Unit-I

Enzymes : Basic considerations. Proximity effects and molecular adaptation. Introduction and historical prospective, 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 labelling and enzyme modification by site-directed mutagenesis.

Co-Enzyme Chemistry: Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes.Structure and biological function of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FMN, FAD, LIPOIC ACID, vitamin B12. Mechanisms of reactions catalysed by the above cofactors.

Unit-II

Mechanism of Enzyme Action : Enzyme kinetics, Michaelis-menten and lineweaver-Burk plots, reversible andirreversible inhibition. Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonucleases, lysozyme and carboxypeptidase A
Metalloenzymes: Definitions: Apoenzyme, Coenzyme, Metalloenzyme, structure and functions of carbonic anhydrase A & B, carboxy peptidases.

Unit-III

Vitamins: Introduction of fat soluble and water soluble vitamins, sources, structure, requirements and functions of vitamin A,D,E and vitamin B1 and C.
Antibiotics: ß- Lactumrings, structure and synthesis of penicillin – G, penicillin-V, Amoxycillin, cholamphenicol, streptomycin.

Unit-IV

Transport and storage of metals: The transport mechanism, transport of alkali and alkaline earth metals, ionophores, transport by neutral macrocycles and anionic carriers, sodium/potassium pump, transport and storage of Iron (Transferrin & Ferritin). Transport of Iron in microorganisms (sidrophores), types of sidrophores (catecholate and Hydroxmato siderophores).

Inorganic compounds as therapatic Agents:- Introduction chelation therapy, synthetic metal chelates as antimicrobial agents, antiarthritis drugs, antitumor, anticancer drugs (Platinum complexes), Lithium and mental health.

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	The Inorganic Chemistry of Biological processes	M. N. Hughes	John Wiley & Sons Ltd
2	Medicinal Chemistry-the role of organic chemistry in drug research	C. R. Ganellin, and S. M. Roberts	Mount Kisko, NY 1973
3	Bio Inorganic Chemistry	Robert Wittay	
4	Advanced Inorganic Chemistry (4^{th} Edn)	Cotton and Wilkinson	
5	Topics in current chemistry (Inorganic Biochemistry) vol. 64 (1976)	Davison and Coworkers	
6	Inorganic chemistry	James E. Huheey.	

Semester	**III**
Course Code	**RM651**
Course Title	**Basics of Research Methodology in Biological & Chemical Sciences**
Type of course	Major
L T P	4 1 0
Credits	5
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To understand the philosophy of science and ethics, research integrity and publication ethics. To identify research misconduct and predatory publications. To understand indexing and citation databases, open access publications, research metrics (citations, h-index, impact Factor, etc.). To understand the usage of plagiarism tools
Course Outcomes	At the end of this course, the students should be able to: 1 understand some basic concepts of research and its methodologies 2 Identify appropriate research topics 3 Select and define appropriate research problem and parameters

Unit-1

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method. Understanding the language of research. Concept, Construct, Definition, Variable. Research Process. Problem Identification & Formulation. Research Question, Investigation Question.

Unit-2

Research design – concept, features and types; Identification, selection and formulation of research problem; Hypothesis – definition, types, qualities of a good hypothesis, null and alternative hypothesis, hypothesis testing – logic and importance.

Review of literature – purpose, sources, and methods. Sampling techniques – probability and non-probability sampling; Variables – types and control of variables in research.

Unit-3

Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size; Non-Response, Characteristics of a good sample. Probability Sample - Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining the size of the sample: Practical considerations in sampling and sample size. Data classification, tabulation and graphical representation.

Unit-4

Scientific writing – structure and components of a research paper, thesis and dissertation; Referencing styles and bibliography; Preparation of research proposals and project reports; Presentation of research work – oral and

PG

poster presentations; Publication process in scientific journals; Intellectual property rights – patents, copyrights, and trademarks; Research ethics – plagiarism, redundant publication, citation, acknowledgment; Ethical issues in research and methods for avoiding plagiarism.

Text & Reference Books:-

S.No.	Name/Title	Author	Publisher
1	Research Design: Qualitative, Quantitative, and Mixed Methods Approaches	John W. Creswell and . David Creswell	Sage Pubns; 5th edition (2 January 2018)
2	The Craft of Research	Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams	University of Chicago Press; 4th edition (28 October 2016)
3	Research Methodology: A Step-by-Step Guide for Beginners	Ranjit Kumar	Sage Publications
4	Research Methodology: methods and techniques	CR Kothari & Gaurav Garg	Age International Publishers; Fourth edition (1 September 2019)
5.	Research ethics.	Dooly, M., Moore, E., & Vallejo, C.	*Research-publishing. net*. (2017).

Semester	**III**
Course Code	**CHM 663**
Course Title	**Instrumental Methods of Analysis**
Type of course	Minor
L T P	2 0 0
Credits	2
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To impart knowledge of various analytical and instrumental methods for chemical characterization and analysis.
Course Outcomes	The students will be able to: 1. Understand Coherent knowledge of various analytical and methods for chemical characterization and analysis 2. Understand advanced knowledge of various instrumental methods for chemical characterization and analysis 3. Cognitive skills to analyse and apply analytical instrumental techniques for identification, characterization of compounds

Unit-I

Data Analysis: Evaluation of analytical data, criteria for selection of analytical method. Uncertainties, Errors, calibrations, Mean, Standard Deviation , Least square fit, Linear regression, covariance and correlation coefficient. Standard reference materials, ,

Atomic Absorption Spectroscopy: General principles, instrumental set up and analytical procedures and applications, fluorescence spectrometry, flame AAS, electrothermal AAS (ETAAS).

Chromatographic Methods: Classification of chromatographic techniques, Partition and distribution, principles of chromatography, Basic principle, instrumentation, methodology and applications of adsorption, partition and column chromatography, paper and thin layer chromatography, gas chromatography (GC) and high performance liquid chromatography (HPLC). LC-MS and LC-MS/MS. Ion exchange Chromatography, Affinity Chromatography.

Unit-II

Potentiometry – General principles, reference electrodes, ion selective electrodes, ion selective electrode construction, membrane electrode, glass electrodes, liquid membrane electrodes, biosensors ISFET and MOSFETS

Coulometry: Basic principles of electrogravimetry, ohmic potential, kinetic and concentration polarization, overpotential, constant current and constant potential coulometry. coulometric titrations and application.

Electrochemical Techniques & Voltammetry: Principles, dropping mercury electrode (DME), polarography, half-wave potential, cyclic voltammetry, voltammograms. Anion/cation striping voltammetry, Conductometry, pH metry, Karl Fischer titration and its applications.

UNIT III

Lasers and Laser Spectroscopy: Principles of laser action, pulsed lasers, examples of lasers: He-Ne, Nd-YAG, dye lasers. Applications of Laser spectroscopy.

Modern Methods of Surfaces and Crystal Analysis: SEM, TEM, STM, AFM, XRD: Instrumentation, basic principle, sample preparation, properties studied and practical applications of each technique for material characterization.

Unit-IV

Thermo-Analytical Method: Theory, instrumental requirements and methodology for thermo gravimetric analysis (TGA), differential thermal analysis (DTA) and differential scanning calorimetry (DSC), applications

Use of Photoelectron spectroscopy :UPES, X-ray photoelectron spectroscopy XPES for elemental analysis.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Instrumental Methods of Analysis,	Willard, Merritt, Dean and Settle	CBS Publisher and Distributors.,1986.
2	Thermal Analysis,	W. W. Wendlandt and L. W. Collins,	Dowden Hutechin and Ross
3	Basic Concepts of Analytical Chemistry	S. M. Khopkar ,	Wiley Eastern
4	Thermal Methods of Analysis, Principles, Application and Problems,	J. Haines,, R.S.; Hobbs, J.B.; Banthrope, D.V.; Harborne, J.B.	Blackie Academic and Professional, 1994. Longman, Esse
5	Chromatographic Methods	A. Braithwaite and F. J. Smith	5th edn. Blackie Academic and Professional, London, 1996
6	Principles of Instrumental Analysis	Skoog, Holder, Nieman	Fifth edition Thomson Books ,1998.

Semester	**III**
Course Code	**RM655**
Course Title	**Publication & Research Ethics**
Type of course	Minor
L T P	2 0 0
Credits	2
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To understand the philosophy of science and ethics, research integrity and publication ethics. To identify research misconduct and predatory publications. To understand indexing and citation databases, open access publications, research metrics (citations, h-index, impact Factor, etc.). To understand the usage of plagiarism tools.
Course Outcomes	At the end of the course the student will have awareness about the publication ethics and publication misconducts.

Unit I: Introduction to philosophy: definition, nature and scope, concept, branches - Ethics: definition, moral philosophy, nature of moral judgements and reactions.

Unit II: Ethics with respect to science and research: Intellectual honesty and research integrity - Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP) - Redundant Publications: duplicate and overlapping publications, salami slicing - Selective reporting and misrepresentation of data.

Unit III: Publication ethics: definition, introduction and importance - Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. - Conflicts of interest - Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types - Violation of publication ethics, authorship and contributor ship - Identification of publication misconduct, complaints and appeals - Predatory publisher and journals.

Unit IV: Indexing databases, Citation databases: Web of Science, Scopus, etc. Research Metrics (3 Hrs.): Impact Factor of journal as per Journal Citations Report, SNIP, SJR, IPP, Cite Score - Metrics: h-index, g index, i10 Index, altmetrics.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Thesis and assignment writing,	Anderson B.H., Dursaton, and Poole M.:	Wiley Eastern 1997
2	Research Design and Methods	Bordens K.S. and Abott B	Mc Graw Hill, 2008
3	The Student's Guide to Research Ethics	Paul Oliver	Open University Press, 2003

Semester	**III**
Course Code	**CHM665**
Course Title	**Physical Chemistry Practical-II**
Type of course	Practical (Major)
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To aware students about adsorption, chemical kinetics, solutions and phase equilibria and their applications.
Course Outcomes	The students will be able to: 1. Understand experimental techniques for controlling chemical reactions. 2. Apply and measure various physical and chemical properties of materials. 3. Design & carry out scientific experiments and result interpretation.

List of Experiments:

(Note: Perform at least any two/ three experiments from each section)

1. Adsorption

To study surface tension - concentration relationship for solutions (Gibbs equation).
To verify Freundlich and Langmuir adsorption isotherms for adsorption of acetic acid on activated charcoal.
To determine the freezing point depression constant of camphor using naphthalene as solute. Hence determine the molecular weight of acetanilide by Rast's micro method.

Determination of molecular weight of non-volatile and non-electrolyte/electrolyte by cryoscopic method and to determine the activity coefficient of an electrolyte

2. Phase Equilibria

Determination of partition coefficient of benzoic acid between organic solvent and water.
Determination of partition coefficient of iodine between water and octanol and determination of equilibrium constant of tri-iodide.
Determination of congruent composition and temperature of a binary system (e.g., diphenylamine benzophenone system)
To construct phase diagram of 3-component system ($CH_3COOH + CHCl_3 + H_2O$)

3. Chemical Kinetics

Determination of the effect of
(a) Change of temperature
(b) Change of concentration of reactants and catalyst and
(c) Ionic strength of the media on the velocity constant of hydrolysis ofan ester/ionic reactions.
Determination of the velocity constant of hydrolysis of an ester/ionic reaction in micellar media.
Determination of the rate constant for the oxidation of iodide ions by hydrogen peroxide studying the kinetics as an iodine clock reaction.
To study kinetics of inversion of cane sugar by optical rotation measurement.

Determination of energy of activation of $S_2O_8^{2-}$ +I $\rightarrow$ SO_4^{2-}+I_2 reaction

Studies on the effect of variation of ionic strength on the rate of $S_2O_8^{2-}$ +I SO_4^{2-}+I_2 reaction Curve fitting using linear and non-linear (Activation thermodynamic parameter, equilibrium thermodynamic parameter) regression analysis using software.

4. Refratrometry

(i) Determination of refractive indices (RI) of given liquids and determination of the concentration from RI.

(ii) Determine the specific refraction, molar refraction and atomic parachor with the help of Abbe's refractometer

(iii) Determination of specific and molar refraction of a liquid by Abbe refractometer.

(iv) To determine the molar refracitivity of water, DMF, Dioxane and mixtures of water, DFM, water-Dioxane and verify the refractivity rule.

(v) Predict about the interactions between components of mixture by plotting graph between refractive index and mole fraction.

(vi) Determine the refraction equivalents of C, H, and Cl atoms.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Experimental Physical Chemistry	Arthur M. Halpern, George C. McBane	Freeman,2006.
2	Experiments in Physical Chemistry, 5th ed.,	Schoemaker et al.	MGH, 1989
3	Chemistry Experiments for Instrumental Methods	Sawyer, Heineman, Beebe	Wiley, 1984 .
4	Physical Chemistry Practical.	Maity S., and Ghosh, N.(	New Central Book Agency (P) Ltd. 2012).
5	Senior Practical Physical Chemistry.	Khosla, B.D., Garg, V.C., and Gulati A.R.	S. Chand and Sons. (2007).
6	Advanced Practical Physical Chemistry.	Yadav, J. B.	Krishna Prakashan Media. (2006).
7	Experiments in Physical Chemistry,	Ghosh, J.C.	Bharati Bhavan. (1990).

Semester	**III**
Course Code	**CHM667**
Course Title	**Seminar & Summer Training**
Type of course	Minor (SEC)
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. with Chemistry as one of the main Subject
Course Objective	The course would develop soft skills of students, scientific aptitude, critical thinking, research writing and research presentation.
Course Outcomes	The students will be able to: 1. Investigate various aspects related to the chemistry. 2. Appreciate the literature and its relevance to his/her topic of interest how to write a report on a given topic. 3. Technical write and presentation on a given topic of research and commercial worth of chemistry.

1. The seminar must include discussion on topics such as awareness about, New advancements in Chemistry, Noble laureates in Chemistry. Peaceful uses of chemistry.

Student will contact the respective mentor/seminar coordinator at allocated schedule to:
l. Conduct the literature survey of the topic allotted.
2. In the next step the student will prepare a detail report in consultation with mentor.
3. The student will learn from the mentor how to prepare presentations.
4. The student will give presentations before the mentor at allotted time schedules regularly.
5. Final seminar of students will presented before the committee consisting of all faculty members of Chemistry and submit their reports duly signed by mentors on the dates notified to them.

2.Students should complete their Summer Training during their summer/winter vacations (minimum 30 days) in some other Institutions / Industries/ interdepartmental instrumentation lab like NITs, IITs , CSIR Labs , IOCL etc and the student will give final presentation of their training before the departmental committee.

Semester	**III**
Course Code	**CHM669**
Course Title	**Dissertation -I (Synopsis & Elucidation of Research Objectives)**
Type of course	Major
L T P	0 0 8
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	The project would develop scientific aptitude, reviewing of literature, critical thinking, hypothesis development, experiment planning, synopsis writing, problem presentation and way to solve the problem.
Course Outcomes	The students will be able to: 1. Analyze current literature research for research topic of his/her area of expertise. 2. Design a research problem. 3. Student will prepare synopsis. 4. Plan future experiments in the laboratory.

- Project supervisor would be allocated at the start of the semester and research project would be undertaken in discussion with the project supervisor.
- Extensive literature review will be done.
- At the end of the semester the student has to prepare Synopsis as per the university guidelines.
- Research Objectives & Synopsis to be evaluated and approved through departmental research committee meeting.
- Students have to submit the copy of Dissertation I/ synopsis duly approved by the supervisor.

SEMESTER IV

Semester	**IV**
Course Code	**CHM652**
Course Title	**Nano-Science & Nano-Chemistry**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To impart knowledge of nano chemistry and nanomaterials. carbon nanotubes and their applications
Course Outcomes	The students will be able to: 1. Acquire knowledge of Nanotechnology, properties and applications of nanomaterials. 2. Cognitive skills to analyse the methodology and fabrication and characterization of nanomaterials. 3. Apply use of carbon nanotubes based nanomaterials.

Unit-I

Nanochemistry Basics: Nanochemistry, self assembly, Self assembling materials, two dimensional assemblies, Mesoscale self assembly, coercing colloids.

Chemical Patterning, Lithography & Nanocontact Printing: Soft lithography, Dip pen nanolithography, Nanoplotters, Nanoblotters,

Unit-II

Nanomaterials: Nanoparticles: zero dimensional nanostructure, homogeneous and heterogeneous nucleation, metallic nanoparticles- synthesis and applications; nanowires and nanorods: one dimensional nanostructures, spontaneous growth, VLS, electro spinning, lithography; thin film: two dimensional nanostructure- preparation techniques; Langmuir-Blodgett (LB) film growth techniques, photolithography properties and applications.

Unit-III

Carbon nanostructures: Carbon molecules, clusters, carbon nanotubes and their applications. Nanorod, Nanotube, Nanowire Self- Assembly: Nanorod devices, Nanowire sensors, diodes & transistors. Instrumentation techniques SEM,TEM,AFM for characterization of nano meterials. **Scope and opportunities**: Nanoscale materials, Nanocrystals, nanotechnology enabled sensors, microelectronics, drug delivery, Bionanoinformation.

Unit-IV

Supramolecular chemistry: Definition and development of supramolecular chemistry, nature of binding interactions in supramolecular structures: ion-ion, ion-dipole, dipole-dipole, h-bonding,

cation---interactions, supramolecular chemistry in life, ionophores, porphyrin and other tetrapyrrollic macrocycles, coenzymes, neurotransmitters, DNA and biochemical self-assembly. Classification of supramolecular host-guest compounds, pre- organization and complementarily, receptors, nature of supramolecular interactions.

Supromolecular structures. Host-guest chemistry: synthesis and structure of crown ethers, lariat ether and podands, cryptands, spherands, calixarenes, cylcodextrins, cyclophanes, carcerands and hemicarcerands. Concepts of selectivity, macrocyclic, macrobicyclic synthesis and template effects.

Supramolcular chemistry of dendrimers and its assembly, dendritic nanodevices, Supramolecular polymers including amphiphilic block polymers and molecular imprinter polymers, biological self assembly in amyloids, actins and fibrin, COF and supramolecular gels.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Nanochemistry, A Chemical approach to Nanomaterials	G. A. Ozin & Andre, C. Arsenault	Royal society of Chemists, 2005.
2	Introduction to Nanotechnology	C. P. Poole, Jr., F. J. Owens	Wiley interscience
3	Real world cases in green chemistry	M.C. Cann and M. E. Connelly	ACS Publications.
4	Policies for cleaner Technologies	T. Clayton	Earthscan
5	New Trends in Green Chemistry	V. K. Ahluwalia and M. Kidwai	Anamaya Publishers, New Delhi.

Semester	**IV**
Course Code	**CHM654**
Course Title	**Green Chemistry**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To study about the greener methods which are eco friendly to environment like microwave induced greener synthesis, using ionic liquids or greener solvents, grinding conditions and ultrasound assisted green synthesis.
Course Outcomes	The students will be able to: 1. Acquire Coherent knowledge of concepts and tools of green chemistry and their importance in sustainable development. 2. Utilize abundantly available precursors for the production of value added chemicals. 3. Adopt and design solvent free synthesis strategies, Microwave assisted and sonicator in organic synthesis.

Unit-I

Designing a Green Synthesis: Choice of Starting Materials, Choice of Reagents, Choice of Catalysts, Choice of Solvents.

Basic Principles of Green Chemistry: Prevention of Waste/By-Products, Maximum Incorporation of the Reactants into the Final Product, Prevention or Minimization of Hazardous Products, Designing Safer Chemicals, Energy Requirements for Synthesis, Selection of Appropriate Solvent, Selection of Starting Materials, Use of Protecting Groups, Use of Catalyst, Products Designed Should be Biodegradable, Designing of Manufacturing Plants, Strengthening of Analytical Techniques.

Green Chemistry in Day-to-Day Life: Dry Cleaning of Clothes, Versatile Bleaching Agent.

Green Reagent: Dimethylcarbonate, Polymer Supported Reagents.

Unit-II

Green Catalysts: Acid Catalysts, Oxidation Catalysts, Basic Catalysts, Polymer Supported Catalysts.

Phase Transfer Catalysis in Green Synthesis: Introduction, Applications of PTC in Organic Synthesis, Oxidation Using Hydrogen Peroxide Under PTC Condition, Crown Ethers.

Microwave Induced Green Synthesis: Introduction, Applications - Microwave Assisted Reactions in Water, Microwave Assisted Reactions in Organic Solvents, Microwave Solvent Free Reactions (Solid State Reactions).

Ultrasound Assisted Green Synthesis: Introduction, Applications of Ultrasound.

Unit-III

Biocatalysts in Organic Synthesis: Introduction, Biochemical (Microbial) Oxidations, Biochemical (Microbial) Reductions, Enzymes Catalysed Hydrolytic Processes.

Organic Synthesis in Solid State: Introduction, Solid Phase Organic Synthesis Without Using Any Solvent, Solid Supported Organic Synthesis.

Versatile Ionic Liquids as Green Solvents: Green Solvents, Reactions in Acidic Ionic, Liquids, Reactions in Neutral Ionic Liquids.

Unit-IV

Aqueous Phase Reactions: Introduction, Diels-Alder Reaction, Claisen Rearrangement, Wittig-Homer Reaction, Michael Reaction, Aldol Condensation, Knoevenagel Reaction, Pinacol Coupling, Benzoin Condensation, Claisen-Schmidt Condensation, Heck Reaction, Strecker Synthesis, Wurtz Reaction, Oxidations, Reductions, Polymerization Reactions, Photochemical Reactions, Electrochemical Synthesis, Miscellaneous Reactions in Aqueous Phase.

Synthesis Involving Basic Principles of Green Chemistry: Some Examples; Introduction, Synthesis of Styrene, Synthesis of Adipic Acid, Catechol and 3-dehydroshikirnic Acid (a potential replacement for BHT), Synthesis of Methyl Methacrylate, Synthesis of Urethane, An Environmentally Benign Synthesis of Aromatic Amines, Selective Alkylation of Active Methylene Group, Free Radical bromination, Acetaldehyde, Furfural from Biomass, Synthesis of (S)-metolachlor, an Optically Active Herbicide, Synthesis of Ibuprofen, Synthesis of Paracetamol, Green Synthesis Qf3-phenyl Catechol, Synthesis of Epoxy styrene, Synthesis of Citral, Synthesis of Nicotinic Acid, Use of Molting Accelerators to Replace More, Toxic and Harmful Insecticides, An Environmentally Safe Marine Antifoulant.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Green chemistry frontiers in benign chemical synthesis and processes	P. Anastas and H. Williamson	Oxford University Press.
2	Chemical management: Reducing wast and cost through innovative supply strategies	Lerma and W. Straat	Willey Sons
3	Real world cases in green chemistry	M.C. Cann and M. E. Connelly	ACS Publications.
4	Policies for cleaner Technologies	T. Clayton	Earthscan
5	New Trends in Green Chemistry	V. K. Ahluwalia and M. Kidwai	Anamaya Publishers, New Delhi.

Semester	**IV**
Course Code	**CHM656**
Course Title	**Chemistry of Materials**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	Main aim to study the polymers, ceramics, solid state ceramics, Composites, nano meterials and meterials for solid state device
Course Outcomes	The students will be able to: 1. Attain basic knowledge of polymers, ceramics, solid state ceramics 2. Analyze the methodologies for fabrication. 3. Characterization ofnanomaterials, glasses and composites.

UNIT I:

Introduction : Materials and their classification, Role of Chemistry in Material design.

Synthesis and characterization of materials : Preparative techniques: Ceramic methods; chemical strategies, chemical vapour deposition; preparation of nanomaterials, Langmuir-Blodgett Films. Fabrication of ordered nanostructures . Composition and purity of materials.

Multiphase Materials: Ferrous alloys; Fe-C phase transformations in ferrous alloys; stainless steels, non-ferrous alloys, properties of ferrous and non-ferrous alloys and their applications.

UNIT II:

Organic Materials : Conducting organics - Metals from molecules, charge transfer materials and conducting polymers. Organic superconductors. Fullerenes. Molecular ferromagnets and ferroelectrics. Liquid crystals: mesomorphic behaviour, optical properties of liquid crystals, display devices.

Fullerenes, Carbon Nanotubes and Graphene: Types and Properties, methods of preparation and separation of carbon nanotubes, applications of fullerenes, CNTs and graphene.

UNIT III:

Polymeric Materials: Molecular shape, structure and configuration, crystallinity, stress-strain behaviour, thermal behaviour, polymer types and their applications, conducting and ferro-electric polymers.

Composites and Nanomaterials: Composite materials - metal matrix, ceramic -matrix, polymers matrix –microscopic composites; dispersion-strengthened and particle-reinforced, fibre-reinforced composites, macroscopic composites, nanocrystalline phase, preparation

procedures, properties and applications Microscopic composites; dispersion-strengthened, Nanocrystalline phase, preparation procedures, special properties, applications,

UNIT IV:

High T_c Materials: Defect perovskites, high Tc superconductivity in cuprates, preparation and. characterization of 1-2-3 and 2-1-4 materials, normal state properties; anisotropy; temperature dependence of electrical resistance; optical phonon modes, superconducting state; heat capacity; coherence length, elastic constants, position lifetimes, microwave absorption-pairing and multigap structure in high Tc materials, applications of high Tc materials.

Materials for Solid State Devices: Rectifiers, transistors, capacitors -IV-V compounds, low-dimensional quantum structures, optical properties. .

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Solid State Physics	N.W. Ashcroft and N.D. Mermin,	Saunders College
2	Material Science and Engineering	An Introduction, W.D. Callister,	Wiley
3	Principles of the Solid State	H.V. Keer,	Wiley Eastern
4	Materials Science	J.C. Anderson, K.D. Leaver, J.M. Alexander and A.D. Rawlings	ELBS
5	Thermotropic Liquid Crystals	Ed., G.W. Gray	John Wiley

Semester	**IV**
Course Code	**CHM658**
Course Title	**Pharmaceutical Chemistry & Drug Design**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To impart knowledge about process of drug discovery, drug design and drugdelivery
Course Outcomes	The students will be able to: 1. Acquire knowledge of Basic process of drug discovery & drug design. 2. Understanding of drug-receptor interactions and various drugmechanisms. 3. Prediction of pharmacokinetics, pharmacodynamics through SAR, QSAR in drug design and discovery. Predict and interpret mode of action of model representative drugs (antibiotics, psychoactive drugs.

Unit-1

Basics of Pharmaceutical Chemistry

Drug Discovery and Drug Development: Introduction, Present and Past, Classification of drugs, Drug targets specification, Choice of Bioassay, In Vivo and in Vitro tests, Pit falls.

Drug Action at Receptors: Receptor role, Change of shape by the receptors, Design of Agonists and Antagonists, Drug action on DNA and RNA.

Drug administration: Introduction, oral administration, sublingual administration, rectal administration, epithelial administration, inhalation, injection and implants.

Unit-II

Pharmacokinetics: Drug distribution and survival, Pharmacokinetic issues in drug design like Chemical and Metabolic stability, Hydrophilic / hydrophobic balance, Ionization, size and number of hydrogen bonding interactions, Drug dose levels, solubility and membrane permeability, variation of different groups to alter polarity.

Prodrugs: Introduction, Effect of prodrugs on: improved membrane permeability, prolonged drug activity, masking drug toxicity and side effects, increased chemical stability, targeting of drugs, prodrugs activation by external influence.

Unit-III

Drug Design, Drug-Target Interactions: Introduction, Variation of Substituent, Expansion of the Structure, Chain expansion/Contractions, Ring expansion/Contractions, Ring Variation, Ring Fusions, Isosteres. The influence of steric factors, optical, geometrical isomerism, conformational isomerism on pharmacological activity.

Drug Design, A Rational Approach: Introduction-analogues and prodrugs – concept of "lead". Quantum mechanical approach, Molecular orbital approach, Molecular connectivity approach, General considerations-Tailoring of drugs.

Structure-Activity Relationships (SAR): Basic concepts;

Quantitative Structure-Activity Relationships (QSAR): Introduction, Hydrophobicity, Electronic effects, Steric factors, physicochemical parameters

Unit-IV

Combinatorial Synthesis-The design of compound libraries and their application to drug discovery: application, combinatorial chemistry.

Antibiotics: Structure, SAR and biological action of antibiotics. Example- penicillin, penicillin-G, penicillin-V, Amoxycillin, chloramphenicol, tetracycline and streptomycin.

Sulphonamides: Structure, SAR and mode of action of sulphonamides,

Psychoactive drugs: Introduction neurotransmitters-receptor interaction, CNS depressant and stimulants SAR and mode of action.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Textbook of Pharmacology	W. C. Bowman, and M. J. Rand	Blackwell Scientific 1980
2	Medicinal Chemistry-the role of organic chemistry in drug research	C. R. Ganellin, and S. M. Roberts	Academic Press 1993.
3	Medicinal Chemistry-principles and practice	F. D. King	The Royal Society of Chemistry 1994.
4	Burger's Medicinal Chemistry and drug discovery	M. E. Wolff	5 th edition Volume 1-5. Wiley 1995
5	The Organic Chemistry of Drug Design and Drug Action,	R. B. Silverman	Academic Press Inc. London2nd Edition, 2004
6	An introduction to Medicinal Chemistry	Graham L. Patrik	Oxford University Press, 3rd edition, 2005
7	Pharmaceutical Process Validation	I. R. Berry & R. A. Nash	Academic Press, London, 3rd Edition, 2003

Semester	**IV**
Course Code	**CHM660**
Course Title	**Industrial Chemical analysis & Quality Control**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To impart basic knowledge of basic Industrial Chemical analysis & Quality Control processes.
Course Outcomes	The students will be able to: 1. Acquire Coherent and advanced knowledge of the basic of Industrial Chemical analysis & Quality Control processes. 2. Analyze Chemical, biological and radiation hazards in laboratory. 3. Safety followed during analysis of Special Industrial Material.

UNIT-I

Analytical Chemometrics : General introduction and its application in optimisation, Modelling and parameter estimation, Sampling, calibration, Factor analysis, Resolution, Signal processing, Structure-property relationship, Pattern recognition, Propagation of measurement uncertainties (inaccuracy and imprecision), Analytical validation techniques, Non-linear regression analysis, Good manufacturing practice (GMP), Good lab practice (GLP), lab and industrial safety.

UNIT-II

Analysis of Special Industrial Material (General Strategy for Analysis) : Analysis of dairy products, oils, soaps and synthetic detergents, food additives, petrochemicals (including liquid and gaseous fuels) pesticides, drugs and pharmaceuticals, fertilizers and paints.

UNIT-III

Clinical Analysis : Sampling and selective analysis of biological fluids (using routine and automatic instruments), glucose, bilirubins, total cholesterol, haemoglobin, creatinine, total proteins, albumin, urea-nitrogen, carticosteroids and barbiturates. Immunological methods of analysis: ELISA, RIA and Immunodiffusion.

UNIT-IV

Chemical Sensors : Principles, types of chemical sensors based on the modes of transductions, Types of chemical sensor based on the chemically sensitive materials (solid electrolyte, gas, semiconductor), Humidity sensors, Biosensors, Electrochemical sensors (Potentiometric sensors,

Ion-selective electrodes, Membrane electrodes, Amperometric sensors, Clark and Enzyme electrodes).

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Green chemistry frontiers in benign chemical synthesis and processes	P. Anastas and H. Williamson	Oxford University Press.
2	Chemical management: Reducing wast and cost through innovative supply strategies	Lerma and W. Straat	Willey Sons
3	Real world cases in green chemistry	M.C. Cann and M. E. Connelly	ACS Publications.
4	Policies for cleaner Technologies	T. Clayton	Earthscan
5	New Trends in Green Chemistry	V. K. Ahluwalia and M. Kidwai	Anamaya Publishers, New Delhi.

Semester	**IV**
Course Code	**CHM 662**
Course Title	**Physico-chemical studies and Biomolecules**
Type of course	Major (DSE)
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To introduce the concepts and importance of photochemistry and photophysical principles, their applications on simple and macromolecules.
Course Outcomes	The students will be able to explain 1. Basic concept about physicochemical properties. 2. Structure and properties of amino acids, peptides and carbohydrates. 3. Identify and characterize of transient intermediates by ultrafast Modern techniques.

Syllabus

Unit-I

Principles and Concepts: volatility/vapor pressure, molecular weight and size, solubility, boiling point, melting point, density/specific gravity, pH, apparent molar volumes, partial molar volumes, transfer volumes, partial molar expansibilities, relative deviation of apparent molar volume, molar conductivities, limiting molar conductivities.

Unit-II

Amino Acids, Peptides and Proteins: Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis Reactions of Amino acids: ester of –COOH group, acetylation of –NH2 group, complexation with Cu2+ ions, ninhydrin test. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins. Determinationof Primary structure of Peptides by degradation Edmann degradation (N-terminal) and C– terminal (thiohydantoin and with carboxypeptidase enzyme).

Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in mono-saccharides

Unit-III

Excimer and exciplex, Kinetics of luminescence quenching, Static and dynamic, Stern- Volmer analysis, Deviation from Stern-Volmer kinetics, Photoinduced electron transfer rates, Free energy dependence of electron transfer on rate, Photoinduced energy transfer, FRET, ESPIT, TBET, Rate and efficiency alculation of FRET

Unit-IV

Applications of Photochemistry and Photophyscial Principles: Measurement of fluorescence and phosphorescence and lifetimes, Introduction to time-resolved techniques for absorption and emission measurements, Detection and kinetics of reactive intermediates, Photochromic reactions and memory devices, Sensors, Switches and molecular machines, TiO2 photocatalysis, , Flash photolysis.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	The Elements of Physical Chemistry	P. W. Atkins	Oxford
2	Fundamentals of Photoinduced Electron Transfer	Kavarnos, G. J	VCH publishers Inc., NewYork (1993).
3	Molecular Fluorescence: Principles and Applications	Valeur, B	Wiley-VCH Verlag GmbH, Weinheim (2002).
4	Modern Molecular Photochemistry of Organic Molecules	Turro, N. J., Ramamurthy, V., and Scaiano, J. C.,	University Science, Books, CA (2010)
5	Ninomiya, I., and Naito, T.,	Photochemical Synthesis,	Academic Press, New York (1989).

Semester	**IV**
Course Code	**RM652**
Course Title	**Advances in Research Methodology in Biological and Chemical Sciences**
Type of course	Major
L T P	4 1 0
Credits	5
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To understand the philosophy of science and ethics, research integrity and publication ethics. To identify research misconduct and predatory publications. To understand indexing and citation databases, open access publications, research metrics (citations, h-index, impact Factor, etc.). To understand the usage of plagiarism tools.
Course Outcomes	At the end of this course, the students should be able to: 1. Understandsome basic concepts of research and its methodologies. 2. Identify appropriate research topics. 3. Select and define appropriate researchproblem and parameters

Unit-1

Advanced Research Designs and Data Collection Methods: Cross-sectional, longitudinal, cohort, case control and randomized controlled trials; Mixed methods research; Advanced data collection techniques – surveys, interviews, focus groups, observational studies; Application of advanced research designs in biological and chemical sciences; Literature review tools for research.

Unit-2

Advanced Data Analysis and Interpretation: Multivariate analysis, regression models, correlation, ANOVA and chi-square tests; Introduction to meta-analysis and systematic reviews; Data visualization tools and software – Excel, R, SPSS, GraphPad Prism; Application of bioinformatics and cheminformatics databases as research tools; Interpretation of results and avoiding bias in data analysis.

Unit-3

Research Communication and Proposal Writing: Writing advanced research papers – review articles, short communications, systematic reviews; Scientific presentations – poster designs and effective oral delivery; Research project proposal writing – structure, components, funding agencies (national and international), budget preparation; Basics of grant writing – application process, common mistakes and success strategies; Collaborative and interdisciplinary research in biological and chemical sciences.

Unit-4

Recent Advances, Research Ethics and Career in Research: Emerging research methodologies – high-throughput

screening, omics approaches, artificial intelligence and big data in research; Advanced referencing tools – Mendeley; Advanced plagiarism detection tools and research integrity; Open access publishing, journals and awareness of impact factor; Intellectual property rights – patents in biological and chemical sciences, technology transfer; Career opportunities in research – academia, industry, scientific writing and policy making.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	CSIR Guidelines for Ethics in Research and in Governance - CSIR (2019)	CSIR	CSIR (2019)
2	Ethics in Science Education, Research and Governance	Amit Ghosh, Ashok Kumar Singhvi -	INSA (2019)
3	Research Design: Qualitative, Quantitative, and Mixed Methods Approaches	John W. Creswell and . David Creswell	Sage Pubns; 5th edition (2 January 2018)
4	The Craft of Research	Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams	University of Chicago Press; 4th edition (28 October 2016)
5	Research Methodology: A Step-by-Step Guide for Beginners	Ranjit Kumar	Sage Publications
6	Research Methodology : methods and techniques	CR Kothari Booth, Colomb, Williams Gaurav Garg	New Age International Publishers; Fourth edition (1 September 2019)

Semester	**IV**
Course Code	**CHM664**
Course Title	**Inorganic Chemistry Practical-II**
Type of course	Practical (Major)
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	To impart knowledge and hand-on experiences of inorganic preparation, electrogravimetric tritration, Polarography methods, Potentiometry and pHmetry and Amperometric titrations of different inorganic acids and salt
Course Outcomes	The students will be able to: 1. Acquire knowledge of basic reparation routes of inorganic compounds. 2. Apply semi-micro qualitative analysis of mixtures. 3. Apply gravimetric analysisfor different cations and anions.

List of Experiments:

(*Note: Perform at least any three experiments from each section)*

1. **Advanced Inorganic Preparations**

i. Preparation of mercury tetraisothiocyanatocobaltate(II). Determination of its magnetic moment and interpretation of its IR spectrum.

ii. Preparation of nitro-and nitrito-pentaamminecobalt(II) chlorides from chloropenta amine cobalt(III) chloride. Recording and interpreting their electronic and IR spectra.

a. Preparation and resolution of tris(ethylenediamine)cobalt(II) ion. Measurement of optical rotation of these resolved complexes.

iii. Preparation of diaquotetraacetatedicopper(II). Determination of its magnetic susceptibility and interpretation of E.P.R., electronic absorption and IR spectra.

iv. Preparation of hexaamminenickel(II) chloride and tris(ethylenediamine)nickel(II) chloride. Interpretation of their electronic absorption spectral data and magnetic susceptibility

v. Preparation of lead tetraacetate.

vi. Preparation of potassium trioxalatoaluminate(III) trihydrate. Its TGA and DTA studies and its interpretation of its IR data.

vii. Preparation of sodium tetrathionate, potassium dithionate, and interpretation of their IR spectra.

viii. Preparation of iron(II) oxalate and potassium trioxalateferrate(III), Interpretation of their magneticdata, EPR spectra.

2. **Electrogravimetry Titrations**

i. Determination of Copper and Lead in a given sample of Brass electrogravimetrically .

ii. Determine coulometrically the concentration of Nickel and Cobalt from a given mixture.

3. **Polarography methods**

i. Polarographic Determination of Copper and Zinc in the given sample of Brass.
ii. Study the polarographic waves produced by dissolved oxygen.
iii. Plot a polarogram for a mixture of Cd^{2+}, Zn^{2+}, and Mn^{2+}, ions.

4. Potentiometry and pHmetry

i. To determine the dissociation constant of a dibasic acid(malonic acid).
ii. Potentiometric titration of a mixture of Chloride and Iodide with $AgNO_3$.
iii. To determine the degree of hydrolysis of aniline hydrochloride and hence hydrolysis constant of thesalt.
iv. Titration of Phosphoric acid solution with NaOH using quinhydrone electrode.
v. Potentiometric Determination of Solute Species in a Phosphate Mixture.
vi. Potentiometric Titration of Copper with EDTA.
vii. Apply stripping methods to determine the concentration of lead in tap water.

5. Amperometric titrations:

i. Amperomertic titration of lead solution with potassium dichromate. Amperometric titration of potassium sulphate solution with Lead nitrate solution.Amperometric titration of nickel in solution with dimethyl glyoxime.
ii. Determine transport number of silver and nitrate ions by Hittorf"s method.
iii. To study complex formation between Fe(III) and salicylic acid and find out the formula of thecomplex spectrophotometrically.
iv. To study the kinetics of hydrolysis of crystal violet spectrophotometrically.Determination of nitrite in water spectrophotometrically.
v. Determination of molecular weight of polymers by Tirbiditymetery.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Vogel's quantitative analysis 6 Edn	Mendham, Denny	Pearson Education 2002
2	Synthesis and Technique in Inorganic chemistry	G. S.Girlomi; R.J. Angleci	3rd edn.; University Science Books.
3	Advanced Practical Inorganic Chemistry	Ayodha Singh	Campus Books 2002

Semester	**IV**
Course Code	**CHM668**
Course Title	**Dissertation -II**
Type of course	Major
L T P	0 0 16
Credits	8
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	The project would develop scientific aptitude, reviewing of literature, critical thinking, hypothesis development, experiment planning, synopsis writing, problem presentation and way to solve the problem.
Course Outcomes	The students will be able to: 1. Explore research aptitude & practicalabilty of knowledge gained by student in understanding the basics of research 2. Develop critical thinking through the detailed review of litrature comprehend expertise for writing the research reports in form of review article as well as research publications. 3. Analyze & generate experimental skills towards the industrial applications.

- Project supervisor would be allocated at the start of the semester and research project would be undertaken in discussion with the project supervisor.
- At the end of the semester the student has to prepare a project report as per the university guidelines/ Format.
- Upon submission of the project report, the projects would be evaluated based on a project presentation.

Semester	**IV**
Course Code	**CHM 666**
Course Title	**Scientific &Technical Writing**
Type of course	Minor
L T P	2:0:0
Credits	2
Course prerequisite	B.Sc. with Chemistry as main subject
Course Objective	This course will help you write well-researched, organized, and correctly documented research papers.
Course Outcomes	Students will be able to: 1. Find research resources, such as online resources (research databases, reference lists), and campus resources (writing centers, research librarian help) 2. Evaluate the credibility of research sources, especially the online resources. 3. Find reference articles including scholarly articles from journals and news articles from foreign and domestic news sources.

Unit-I: Introduction to Technical Writing, what is research? , how do you structure a research paper? Basic Principles in Technical Writing: (Audience, Purpose, Organization, Flow, Style, Presentation)

Unit-II: Introduction to text analysis tools: analyzing research paper biographies, Writing a research paper abstract: choosing between indicative and informative abstracts Writing a research paper title: keywords, noun phrases, and prepositions.

Unit-III: Writing a research paper introduction: characteristic features and structure of introductions, explaining the situation, describing problems/limitations, describing the response,

Unit-IV: Writing a research paper results section: deciding the type of visual aid, explaining figures and tables, Writing a research paper discussion/conclusion section: summarizing results, adjusting the strength of interpretations using hedging.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Thesis and assignment	Anderson B.H., Dursaton, and	Wiley Eastern 1997

	writing	Poole M.:	
2	Research Design and Methods	Bordens K.S. and Abbott, B	Mc Graw Hill, 2008
3	The Student's Guide to Research Ethics	Paul Oliver	Open University Press, 2003
4	Research Methods – A Process of Inquiry	Graziano, A., M., and Raulin, M.,L	Sixth Edition, Pearson, 2007