CHOICE BASED CREDIT SYSTEM

SCHEME & SYLLABUS

B.Sc (Hons) Chemistry

Department of Physical Sciences

University Institute of Sciences and Humanities (UISH)

Sant Baba Bhag Singh University

2020

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 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.

SALIENT FEATURES OF THE DEPARTMENT

- The Department has highly qualified, young, dynamic and dedicated Faculty in various fields of Physical Sciences *viz.* Chemistry, Physics, Mathematics.
- 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 , Turbiditimeter, AbbsRefractrometer, Digital weighing balance, Magnetic plate with stirrer, pH meter, Conductometer, Flame Photometer, colorimeter and a double distillation plant, Spring balance , Sodium Lamp Transformer , Young's modulus,Ultrasonic interferometer , Rheostat , Maxwell needle apparatus kit , Magnetic field of solenoid , Ballistic Galvanometer , Deflection and vibration Magnetometer , Electron spin resonance
- 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 the 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, etc.
- Student centric, ICT enabled and interactive teaching
- Students and teachers participation in International, National, State and Regional seminars and conferences.
- Curricular and the co-curricular activities are well balanced in the Teaching Learning environment to provide holistic education to the students.
- Flexiblility in course curriculum as per the needs of students & PG Programmes with Project as research component.
- 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.

B.Sc(Hons)Chemistry

B.Sc(Hons)Chemistry is the science of the composition, structure, properties and reaction of materials, namely atomic and molecular system. It is a study of various theories of chemistry and its branches.

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 graduatess 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.
- To empower students with substantial knowledge in Computer Sciences, scientific and primitive engineering concepts required to solve computing problems and pursue higher studies.

Eligibility Criteria

B.Sc. (Hons.) Chemistry is an under-graduate chemistry course requires the minimum eligibility criteria as the candidate must complete 10+2 examination in science stream with a minimum of 50% marks secured in aggregate and should have studied Chemistry as core subject from a recognized board of the country.

Duration

The duration of BSc Honours is three years.

Career pathways

Areas that offer jobs for B.Sc. degree holder are: -Education, College, Universities, Healthcare providers, Hospitals, Research firms, Environmental management and conservation, forest services, chemical Industry, Biotechnology, Pharmaceutical companies, Geological Survey Department, Wastewater plants, Testing laboratories, Engineering firms, Oil Companies, Medical Laboratories, Food Institutes, Petroleum Companies, Power generating companies, Agricultural Research, Forensic Crime Research, Indian Civil Services etc.

- **Government Jobs:** In the government sector, the top job posts for B.(Hons.) Chmistry students include Food inspectors, Government lab technicians, Clinical research, 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 :**After B.Sc(Hons) chemistry student can do B.Ed ,M.Sc , M.phill and PhD
- **Entrepreneurship:** To set up new ventures

Programme Educational Objective (PEO)

PEO1. To impart quality education in basic physical sciences to achieve excellence in teaching-learning and Graduates will pursue higher studies in related fields.

PEO2. To provide hand on training which enable graduates to get employed in private/government institutions.

PEO3 . To construct a bridge between the theoretical and practical aspects of Physical Sciences & inculcate entrepreneur skills.

PEO4. To equip the learners to apply knowledge of Physical Sciences and to analyze the local and global impact of chemistry on individuals, organizations, and society.

PEO5. To able to formulate, investigate and analyse scientifically real life problems along with ethical attitude which works in multidisciplinary team.

Programme Outcomes (PO)(At the end of Programme/Degree mentioned above , the graduates will be able to ……)

PO1. Knowledge and understanding: Students will be able to understand specialised areas and explain major concepts in the Chemical sciences and its applications.

PO2. Problem Solving: Identify and solve complex scientific problems in research.

PO3 Practical skills: Student will be able to demonstrate the ability to read, understand, and critically review scientific information.

PO4 Graduate skills: Students will be able to motivate and communicate scientific knowledge in oral and written form accurately using a range of formats.

PO5 Investigate chemical problems using scientific tools for analysis and interpretation of data.

Programme Specific Outcomes (PSO)

PSO1. • Understand coherent knowledge of Chemical Sciences.

PSO2. • Understand good laboratory practices and safety to handle the sophisticated instruments/equipments and chemicals.

PSO3 • Use modern chemical tools, models, chem draw, charts and equipments.

PSO4 • Use standard laboratory equipments, modern instrumentation and classical techniques to carry out experiments and develop skills to interpret and explain the limits of accuracy of experimental data in terms of significance and underlying theory.

PSO5 • Think creatively (divergently and convergent) to propose novel ideas in explaining facts and figures or providing new solution to the problems.

ABOUT THE CHOICE BASED CREDIT SYSTEM (CBCS)

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. The basic idea is to look into the needs of the students so as to keep up-to-date with development of higher education in India and abroad. CBCS aims to redefine the curriculum-keeping pace with the liberalization and globalization in education. CBCS allows students an easy mode of mobility to various educational institutions spread across the world along with the facility of transfer of credits earned by students.

1. Curriculum Structure: B.Sc(non medical) degree programme will have a curriculum with Syllabi consisting of following type of courses:

I. Ability Enhancement Courses (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; these are mandatory for all disciplines. SEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc. A. Ability Enhancement Compulsory Courses (AECC): Environmental Science, English Communication/MIL Communication. 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.

II. Core Courses (CR): A course, which should compulsorily by studied by a candidate as a core requirement is termed as a Core 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/ analysing/exploring a real life situation/ difficult problem.

III. Elective Courses: Elective course is generally a course, which can be chosen from a pool of courses, and which may be very specific, specialized, 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.

2. NOMENCLATURE USED:

A. Graduate Core Courses

i. core course (CR)

ii. Theory subject (T)

iii. Practical (P)

B. Ability Enhancement Courses (AEC):

i. Ability Enhancement Compulsory Courses (AECC)

ii. Skill Enhancement Courses (SEC).

C. Elective Courses (EL)

i. Discipline Specific Elective (DSE)

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22.	CR	Physical III: Phase Equilibria & Chemical Kinetics	**CHM229**	**III**	**49-50**
23.	GE	Real Analysis	**MAT201**	**III**	**51**
24.	GE	Thermal physics and statistical mechanics	**PHY201**	**III**	**52**
25.	CR(P)	Inorganic II: sand p-Block Elements(practical)	**CHM223**	**III**	**53**
26.	CR(P)	Organic II: Oxygen Containing Functional Groups(practical)	**CHM227**	**III**	**54**
27.	CR(P)	Physical III: Phase Equilibria & Chemical Kinetics(practical)	**CHM231**	**III**	**55**
28.	GE(P)	Thermal physics and statistical mechanics practical	**PHY203**	**III**	**56**
29.	CR	Inorganic Chemistry III: Coordination Chemistry	**CHM222**	**IV**	**58-59**
30.	CR(P)	Inorganic Chemistry III: Coordination Chemistry Practical	**CHM224**	**IV**	**60**
31.	CR	Organic Chemistry III: Heterocyclic Chemistry	**CHM226**	**IV**	**61-63**
32.	CR(P)	Organic Chemistry III: Heterocyclic Chemistry Practical	**CHM228**	**IV**	**64**
33.	CR	Physical Chemistry IV: Electrochemistry	**CHM230**	**IV**	**65**
34.	CR(P)	Physical Chemistry IV: Electrochemistry Practical	**CHM232**	**IV**	**66**
35.	GE	Waves and Optics	**PHY202**	**IV**	**67-68**
36.	GE	Algebra	**MAT202**	**IV**	**69**
37.	GE(P)	Waves and Optics Practical	**PHY204**	**IV**	**70-71**
38.	CR	Organic Chemistry IV: Organic Biomolecules	**CHM321**	**V**	**73-74**
39.	CR(P)	Organic IV: Organic Biomolecules Practical	**CHM323**	**V**	**75**
40.	CR	Physical V: Quantum chemistry & Spectroscopy	**CHM325**	**V**	**76-77**
41.	CR(P)	Physical V: Quantum chemistry & Spectroscopy practical	**CHM327**	**V**	**78**
42.	DSE	DSE-1 Analytical Methods in Chemistry	**CHM329**	**V**	**79-80**
43.	DSE	DSE-1 Analytical Methods in Chemistry Practical	**CHM331**	**V**	**81-82**
44.	DSE	DSE-2 Polymer Chemistry	**CHM333**	**V**	**83-84**
45.	DSE	DSE-2 Polymer Chemistry Practical	**CHM335**	**V**	**85**
46.	DSE	DSE-3 Nuclear & Radiation Chemistry	**CHM337**	**V**	**86**
47.	DSE	DSE-3 Nuclear & Radiation Chemistry Practical	**CHM339**	**V**	**87**
48.	CR	Inorganic Chemistry IV: Organometallic Chemistry	**CHM322**	**VI**	**89-90**

49.	CR(P)	Inorganic IV: Organometallic Chemistry practical	**CHM324**	**VI**	**91-92**
50.	CR	Organic chemistry V:Spectroscopy and Applied Organic Chemistry	**CHM326**	**VI**	**93-94**
51.	CR(P)	Organic chemistry V:Spectroscopy and Applied Organic Chemistry practical	**CHM328**	**VI**	**95**
52.	DSE	DSE 1 Research Methodology for Chemistry	**CHM330**	**VI**	**96-97**
53.	DSE	DSE II Industrial Chemicals and Environment	**CHM332**	**VI**	**98-99**
54.	DSE(P)	DSE II Industrial Chemicals and Environment Practical	**CHM334**	**VI**	**100**
55.	DSE	DSE III Inorganic Materials of Industrial Importance	**CHM336**	**VI**	**101-102**
56.	DSE(P)	DSE III Inorganic Materials of Industrial Importance Practical	**CHM338**	**VI**	**103**
57.	SEC	Computer Applications in Chemistry Elective subject(skill enhancement course)III	**CSE345**	**V**	**105-106**
58.	SEC	Basic Fuel Chemistry Elective subject(skill enhancement course)III	**CHM345**	**V**	**107-108**
59.	SEC	Basic Pharmaceutical Chemistry Skill Enhancement course IV	**CHM340**	**VI**	**109-110**

Scheme for B.Sc. (Hons)Chemistry 2020 Batch

Semester 1

I. Theory Subjects

S No.	Course Type	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
	CR	CHM121	Inorganic I: Atomic Structure & Chemical Bonding-I	4:0:0	4:0:0	4	4
2	CR	CHM125	Physical I: States of Matter & Ionic Equilibrium	4:0:0	4:0:0	4	4
3	GE	MAT 101-	Calculus/	6:0:0	6:0:0	6	6
		PHY 101	Mechanics	4:0:0	4:0:0	4	4
4	AEC	ENG 101	General English-I/	3:0:0	3:0:0	3	3
	AEC	PBI101	General Punjabi	3:0:0	3:0:0	3	3
5	SEC-1	CHM109	Elective subject(Skill Enhancement Course)-I Basics of Analytical Chemistry	2:0:0	2:0:0	2	2
6		PT101/PT103/PT105	NSO /NCC/NSS	2:0:0	Non-credit	2	NC

II. Practical Subjects

1	CR	CHM123	Inorganic I: Atomic Structure & Chemical Bonding-I Practical	0:0:4	0:0:2	4	2
2	CR	CHM127	Physical I: States of Matter & Ionic Equilibrium Practical	0:0:4	0:0:2	4	2
3	GE (P)	PHY103	Mechanics Practical	0:0:4	0:0:2	4	2
	Total					**32/34**	**26**

Total Contact Hours: 32/34

Total Credit Hours: 26

CR- Core Course

AEC-Ability Enhancement Compulsory Courses

GE-Generic Elective

Scheme for B.Sc. (Hons)Chemistry 2020 Batch

Semester-II

I. Theory Subjects

S No.	Type of Course	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	CR	CHM122	Organic I: Basics & Hydrocarbons	4:0:0	4:0:0	4	4
2	CR	CHM126	Physical II: Chemical Thermodynamics & its Applications	4:0:0	4:0:0	4	4
3	GE	MAT 102	Differential Equations/	6:0:0	6:0:0	6	6
		PHY 102	Electricity and Magnetism	4:0:0	4:0:0	4	4
4	AEC	EVS001	EVS	3:0:0	3:0:0	3	3
5	SEC-II	CHM110	Elective subject(Skill Enhancement Course)-II Green Methods in Chemistry	2:0:0	2:0:0	2	2
6		PT102/PT104/PT106	NSO /NCC/NSS	2:0:0	Non-credit	2	NC

1	GE(P)	PHY 104	Electricity and Magnetism Practical	0:0:4	0:0:2	4	2
2	CR	CHM124	Organic I: Basics & Hydrocarbons Practical	0:0:4	0:0:2	4	2
3	CR	CHM128	Physical II: Chemical Thermodynamics & its Applications Practical	0:0:4	0:0:2	4	2
	Total					**29/31**	**23**

Total Contact Hours: 29/31

Total Credit Hours: 23

CR- Core Course

AECC-Ability Enhancement Compulsory Courses

GE-Generic Elective

Scheme for B.Sc. (Hons)Chemistry 2020 Batch

Semester-III

I. Theory Subjects

S No.	Type of Course	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	CR	CHM221	Inorganic II: s and p-Block Elements	4:0:0	4:0:0	4	4
2	CR	CHM225	Organic II: Oxygen Containing Functional Groups	4:0:0	4:0:0	4	4
3	CR	CHM229	Physical III: Phase Equilibria & Chemical Kinetics	4:0:0	4:0:0	4	4
4	GE	MAT 201	Real Analysis	6:0:0	6:0:0	6	6
		PHY 201	Thermal physics and statistical mechanics	4:0:0	4:0:0	4	4

1	CR	CHM223	Inorganic II: sand p-Block Elements	0:0:4	0:0:2	4	2
2	CR	CHM227	Organic II: Oxygen Containing Functional Groups	0:0:4	0:0:2	4	2
3	CR	CHM231	Physical III: Phase Equilibria & Chemical Kinetics	0:0:4	0:0:2	4	2
4	GE (P)	PHY203	Thermal physics and statistical mechanics Practical	0:0:4	0:0:2	4	2
						30/32	**24**

Total Contact Hours: 30/32

Total Credit Hours: 24

CR- Core Course

GE-Generic Elective

Scheme for B.Sc. (Hons)Chemistry 2020 Batch

Semester-IV

I. Theory Subjects

S.No.	Type of Course	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	CR	CHM222	Inorganic Chemistry III: Coordination Chemistry	4:0:0	4:0:0	4	4
2	CR	CHM226	Organic Chemistry III: Heterocyclic Chemistry	4:0:0	4:0:0	4	4
3	CR	CHM230	Physical Chemistry IV: Electrochemistry	4:0:0	4:0:0	4	4
4	GE	PHY 202	Waves and Optics	4:0:0	4:0:0	4	4
5		MAT 202	Algebra	6:0:0	6:0:0	6	6

1	CR	CHM224	Inorganic Chemistry III: Coordination Chemistry Practical	0:0:4	0:0:2	4	2
2	CR	CHM228	Organic Chemistry III: Heterocyclic Chemistry Practical	0:0:4	0:0:2	4	2
3	CR	CHM232	Physical Chemistry IV: Electrochemistry Practical	0:0:4	0:0:2	4	2
4	GE(P)	PHY 204	Waves and Optics Practical	0:0:4	0:0:2	4	2
	Total					**30/32**	**24**

Total Contact Hours: 30/32

Total Credit Hours: 24

CR- Core Course

GE-Generic Elective

Scheme for B.Sc. (Hons)Chemistry 2020 Batch

Semester-V
I. Theory Subjects

S No.	Type of Course	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	CR	CHM321	Organic Chemistry IV: Organic Biomolecules	4:0:0	4:0:0	4	4
2	CR	CHM325	Physical ChemistryV: Quantum Chemistry & Spectroscopy	4:0:0	4:0:0	4	4
3	DSE-I	CHM329	Elective Subject(Discipline))-I	4:0:0	4:0:0	4	4
4	DSE-II	CHM333/CHM337	Elective Subject(Discipline))-II	4:0:0	4:0:0	4	4
5	SEC	CHM345/CSE345	Elective subject(Skill Enhancement Course)-III	2:0:0	2:0:0	2	2
1	CR	CHM323	Organic IV: Organic Biomolecules Practical	0:0:4	0:0:2	4	2
2	CR	CHM327	Physical Chemistry V: Quantum Chemistry & Spectroscopy Practical	0:0:4	0:0:2	4	2
3	DSE -I (P)	CHM331	Elective Subject(Discipline))-I practical	0:0:4	0:0:2	4	2
4	DSE II (P)	CHM335/CHM339	Elective Subject(Discipline))-II practical	0:0:4	0:0:2	4	2
	Total					**34**	**26**

Total Contact Hours: 34

Total Credit Hours: 26

CR- Core Course

DSE-Discipline Subject course; SEC-Skill Enhancement Course

Scheme for B.Sc. (Hons)Chemistry 2020 Batch

Semester-VI

I. Theory Subjects

S No.	Type of Course	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	CR	CHM322	Inorganic Chemistry IV: Organometallic Chemistry	4:0:0	4:0:0	4	4
2	CR	CHM326	Organic Chemistry V: Spectroscopy& Applied Organic Chemistry	4:0:0	4:0:0	4	4
3	DSE-III	CHM330/ CHM332	Elective Subject(Discipline)-III	4:0:0	4:0:0	4	4
4	DSE-IV	CHM336	Elective Subject(Discipline)-IV	4:0:0	4:0:0	4	4
5	SEC	CHM340	Elective subject(Skill Enhancement Course)-IV	2:0:0	2:0:0	2	2
1	CR	CHM324	Inorganic Chemistry IV: Organometallic Chemistry Practical	0:0:4	0:0:2	4	2
2	CR	CHM328	Organic Chemistry V: Spectroscopy& Applied Organic Chemistry Practical	0:0:4	0:0:2	4	2
3	DSE-III (P)	CHM334	Elective Subject(Discipline)-III Practical	0:0:4	0:0:2	4	2
4	DSE -IV (P)	CHM338	Elective Subject(Discipline)-IV Practical	0:0:4	0:0:2	4	2
						34	**26**

Total Contact Hours: 34

Total Credit Hours: 26

CR- Core Course

DSE-Discipline Specific Elective

SEC-Skill Enhancement Course

	Summarized report of Course Scheme for B.Sc (Hons.) Chemistry

Sem	L	T	P	Contact hrs/wk	Credits hrs/wk	CR	AEC/ID	SEC	GE	DSE
1	22/24	0	6/4	32/34	26	8+4	6	2	4+2/6	
2	19/21	0	6/4	29/31	23	8+4	3	2	4+2/6	
3	12	0	8/6	30/32	24	12+6			4+2/6	
4	12	0	8/6	30/32	24	12+6			4+2/6	
5	16	0	8	34	26	8+4		2		8+4
6	16	0	8	34	26	8+4		2		8+4
Total	97/101	0	44/36	188/196	149	84	9	8	24	24

SEMESTER I

Course Code	**CHM121**
Course Title	Inorganic I: Atomic Structure & Chemical Bonding-I
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	10+2 with chemistry as core subject
Course Objective	The aim of the subject is to enhance the knowledge of students in Chemical bonding atomic / molecular structure, About basic concepts of inorganic chemistry.
Course Outcomes	1. Solve the conceptual questions using the knowledge gained by studying the quantum mechanical model of the atom, quantum numbers, electronic configuration, radial and angular distribution curves, shapes of s, p, and d orbitals, and periodicity in atomic radii, ionic radii, ionization energy. and electron affinity of elements. 2. Draw the plausible structures and geometries of molecules using Radius Ratio Rules, VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomic molecules). 3. Understand the concept of lattice energy using Born-Landé and Kapustinskii expression. 4. Rationalize the conductivity of metals, semiconductors and insulators based on the Band theory. 5. · Understand the importance and application of chemical bonds, inter-molecular and intramolecular weak chemical forces and their effect on melting points, boiling points, solubility and energetics of dissolution.

UNIT I

Atomic Structure: Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ 2 . Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

UNIT II

Periodicity of Elements: s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s and p-block.

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.

(b) Atomic radii (van der Waals)

(c) Ionic and crystal radii.

(d) Covalent radii (octahedral and tetrahedral)

(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.

(f) Electron gain enthalpy, trends of electron gain enthalpy.

(g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

UNIT III

Chemical Bonding:
(i) Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.
Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N2, O2, C2, B2, F2, CO, NO, and their ions; HCl, BeF2, CO2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

UNIT IV

Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.
Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.
Oxidation-Reduction: Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class.

Reference Books:

- Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
- Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970
- Atkins, P.W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.
- Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications, 1962.
- Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

Course Code	**CHM125**
Course Title	Physical I: States of Matter & Ionic Equilibrium
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	10+2 with chemistry as core subject
Course Objective	To develop basic and advance concepts regarding the three states of matter. To derive the expressions for determining the physical properties of gases, liquids and solids. To study the concept of ionization in aqueous solution, pH, buffers and various applications of ionization.
Course Outcomes	**students will be able to:** · Derive mathematical expressions for different properties of gas, liquid and solids and understand their physical significance. · Explain the crystal structure and calculate related properties of cubic systems. · Explain the concept of ionization of electrolytes with emphasis on weak acid and base and hydrolysis of salt. · Apply the concepts of gas equations, pH and electrolytes while studying other chemistry courses and ever day life.

UNIT I

Gaseous state:

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities. Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. van 11 der Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

UNIT II

Liquid state: Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. Qualitative discussion of structure of water.

UNIT III

Solid state: Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen

Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals.

UNIT IV

Ionic equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids (exact treatment). Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations. Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.

Reference Books: • Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford University 12 Press (2014).

- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
- Engel, T. & Reid, P. Physical Chemistry 3rd Ed. Pearson (2013).

Course Code	**MAT101**
Course Title	**Calculus**
Type of course	Theory /GE
L T P	6 0 0
Credits	6
Course prerequisite	+2 with chemisty as core subject
Course Objective(CO)	It develops the techniques to simplify algebraic expressions .In addition, it encourages students to expand their knowledge through practical application in their daily life.
Course outcome	CO1 Students will be able to locate the x and y intercepts, any undefined points, and any asymptotes. CO2 Students will demonstrate the ability to compute derivatives and integrals of real valued and vector valued functions of several variables. CO3 Students will be able to identify areas in mathematics and other fields where Calculus is useful.

Unit-I

Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications, concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, Indeterminate forms.

Unit-II

Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin nx\,dx$, $\int \cos nx\,dx$, $\int \tan nx\,dx$, $\int \sec nx\,dx$, $\int (\log x)^n\,dx$, $\int \sin(nx)\sin(mx)\,dx$, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution.

Unit-III

Rolle's theorem, Mean value theorems, Taylor's theorem with Lagrange's and Cauchy's form of remainder, Taylor's series, Maclaurin's series of sin x, cos x, e^x, log(1+x), $(1+x)^m$, Maxima and Minima.

Unit-IV

Triple product, introduction to vector functions, operations with vector-valued functions, Limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration, modeling ballistics and planetary motion, Kepler's second law.

Text and Reference Books

S. NO	Name	Author(s)	Publisher
1	Calculus	H. Anton, I. Birens And S. Davis	John Wiley And Sons
2	Calculus	G.B. Thomas And R.L. Finney	Pearson Education

Course Code	**PHY101**
Course Title	**Mechanics**
Type of course	Theory /GE
L T P	4 0 0
Credits	4
Course prerequisite	+2 with chemistry as core subject
Course Objective(CO)	The aim of the subject is to enhance the knowledge of students in electrostatics, electrodynamics and mechanics
Course outcome	CO1 Student will demonstrate a scientific knowledge of the core physics principles in Mechanics. CO2 Have a deep understanding of Newton's laws and able to solve the Newton equations for simple configurations using various methods. CO3 Understand the foundations of chaotic motion.

Syllabus

Unit -I

Vectors: Vector algebra, Scalar and vector products Derivatives of a vector with respect to a parameter, Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients, Laws of Motion: Frames of reference, Newton's Laws of motion. Dynamics of a system of particles, Centre of Mass. Momentum and Energy: Conservation of momentum.

Unit-II

Work and Energy, Conservation of energy, Motion of rockets, Rotational Motion: Angular velocity and angular momentum, Torque, Conservation of angular momentum. Gravitation: Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant), Kepler's Laws (statement only), Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness, Basic idea of global positioning system (GPS).

Unit-III

Oscillations: Simple harmonic motion, Differential equation of SHM and its solutions, Kinetic and Potential Energy, Total Energy and their time averages, Damped oscillations. Elasticity: Hooke's law – Stress - strain diagram - Elastic moduli - Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion

Unit-IV

Torsional pendulum- Special Theory of Relativity: Constancy of speed of light. Postulates of Special Theory of Relativity.Length contraction.Time dilation.Relativistic addition of velocities.

Text and Reference Books

S. No	Name	Author(S)	Publisher
1	Introduction To Electrodynamics	D J Griffith	Prentice-Hall Of India
2	Physics- Vol 2	Halliday And Resnik	
3	Electricity And Magnetism	A S Mahajan And A Arangwala	Tatamcgraw-Hill
4	Berkeley Physics Course, Vol. 1, Mechanics	E M Purcell, Ed	Tatamcgraw-Hill
5	Introduction To Classical Mechanics	R G Takwale& P S Puranik	Tatamcgraw-Hill

Course Code	**ENG101**
Course Title	**General English-I**
Type Course	Theory
L T P	3: 0: 0
Credits	3
Course Pre-requisite	**NA**
Course Objective (CO)	1. The students will critically read and analyze the prescribed texts. 2. The students will demonstrate effective word choice, vocabulary, idioms, grammar and sentence structure allowing accurate communication of meaning in written work. 3. The students will recognize the correct usage of present/past/future tenses in contextualized speech.
Course outcome	CO1 The students will critically read and analyze the prescribed texts. CO2 The students will demonstrate effective word choice, vocabulary, idioms, grammar and sentence structure allowing accurate communication of meaning in written work. CO3 The students will recognize the correct usage of present/past/future tenses in contextualized speech.

UNIT I

Tales of Life :

a. The Umbrella (Henry Rene Albert Guy de Maupassant)
b. The Story Teller (H.H. Munro Saki)
c. The Lament (Anton Pavlovich Chakhov)

UNIT II

Prose for Young Learners:

a. Universal Declaration Of Human Rights (U.N. Charter)
b. Symptoms (Jerome K. Jerome)

Exploring Tenses in English:

a. Present and Past
b. Present Perfect and Past

UNIT III

Tales of Life:

a.The Luncheon (William Somerset Maugham)
b.The Shroud (Prem Chand)

UNIT IV

Prose for Young Learners:

a. On Spendthrifts(A.G.Gardinar)
b. The Power of Women(Richard Gardon)
c. A Dialogue On Democracy (Albert Sydney Horby)

Exploring Tenses in English:

a. Future

Text and Reference Books:

S.No.	Author(S)	Year	Title	Publisher
1	Singh, S	2008	Tales of Life	Press and Publication Department, Guru Nanak Dev University, Amritsar.
2	Tewari, A. K, Midha,V.K, Sharma, R.K	2011	Prose For Young Learners	Publication Bureau, Guru Nanak Dev University, Amritsar
3	Murphy, R	2015	English Grammar in Use	Cambridge University Press

Course Code	**PBI101**
Course Title	**General Punjabi-I**
Type of Course	Theory
L T P	3: 0:0
Credits	3
Course Prerequisite	NA
Course Objectives	1. ividAwrQI AwDuink pMjwbI kvIAW dI jIvnI qoN jwxU hoxgy[2. ividAwrQIAW nUM AwDuink pMjwbI kivqw dI ivSYgq jwxkwrI ho jwvygI[3. ividAwrQIAW iv`c ryKw ic`qrW dw Alocnwqmk AiDAYn krn dw hunr auqpMn hovygw[4. ividAwrQIAW nUM pMjwbI DunIN ivauNqbMdI sMbMDI igAwn hwisl ho jwvygw[5. ividAwrQI pMjwbI aup- BwSwvW nUM pCwnxXog ho jwxgy[
Course outcome	CO1 ividAwrQI AwDuink pMjwbI kvIAW dI jIvnI qoN jwxU hoxgy[CO2 ividAwrQIAW nUM AwDuink pMjwbI kivqw dI ivSYgq jwxkwrI ho jwvygI[CO3 ividAwrQIAW iv`c ryKw ic`qrW dw AiDAYn krn dw hunr auqpMn hovygw[

iekweI- a

1. **AwDuink pMjwbI kivqw:** BweI vIr isMG (rauN ru^, smW, ie`Cw bl qy fUMGIAW SwmW), DnI rwm cwiqRk(rwDw sMdyS, isdkW vwilAW dy byVy pwr ny), pRo. pUrn isMG(purwxy pMjwb nUM AwvwzW), &IrozdIn Sr&(kurbwnI, ^Yr pMjwbI dI), pRo. mohn isMG(Awau n`cIey, nvW kOqk), nMd lwl nUrpurI(cuMm cuMm r`Ko, mzdUr), AMimRqw pRIqm(bwrW mwh, sMXog ivXog), fw. hrBjn isMG(qyry hzUr myrI hwizrI dI dwsqW), iSv kumwr btwlvI(ibrhoN dI rVHk, z^m), surjIq pwqr(cONk ShIdW ‘c ausdw Awi^rI BwSx, Zzl)
2. **pMjwb dy mhwn klwkwr(lyK):** ky. AY~l. sihgl, bVy gulwm AlI KW, soBw isMG, ipRQvIrwj kpUr, BweI smuMd isMG[

iekweI- A

1. pMjwbI DunI ivauNq : aucwrn AMg, aucwrn sQwn qy ivDIAW, svr, ivAMjn[
2. BwSw vMngIAW: BwSw dw tkswlI rUp, BwSw Aqy aup- BwSw dw AMqr, pMjwbI aupBwSwvW dy pCwx icMnH[

pusqk sUcI

pwT- pusqkW

LyKk	Swl	Pusqk	PbilSr
sMpwdk, iF`loN; h.s. Aqy srgoDIAw; p.s.	2014	do rMg	pblIkySn ibaUro, gurUu nwnk dyv XUnIvristI, AMimRqsr
gwrgI; b.	1995	pMjwb dy mhwn klwkwr	pblIkySn ibaUro, gurUu nwnk dyv XUnIvristI, AMimRqsr

sMbMiDq pusqkW

LyKk	Swl	Pusqk	PbilSr
isMG; h.	1966	pMjwbI bwry	pMjwbI XUnIvristI, pitAwlw
isMG; qIrQ (fw.)	2014	pMjwbI AiDAwpn	AY~s. jI. pbilSrz, jlMDr
syKoN; suKivMdr isMG (fw.) Aqy syKoN; mndIp kOr	2015	pMjwbI BwSw dw AiDAwpn	kilAwxI pbilSrz, luiDAwxw

Course code	**HCP101**
Course title	**History and Culture of Punjab -I**
Type of course	Theory
L T P	3:0:0
Credits	3
Course prerequisite	NA
Course objectives (CO)	1. The Student will acquire the knowledge about Punjab and its Historical Resources. 2. The Student will understand the Harppan Culture and different Vedic Periods. 3. The Students will analyze the Alexander's invasions.
Course outcome	CO1 The Student will acquire the knowledge about Punjab and its Historical Resources. CO2 The Student will understand the Harppan Culture and different Vedic Periods. CO3 The Students will analyze the Alexander's invasions.

Unit I

Ancient Punjab: Physical features, Political, Social, Economic, Geographical, Religious impact on History, Historical Sources: Literacy, Archaeological, Harappan Culture: Extent and Town Planning.

Unit II

Harppan Culture: Social, Economic and Religious life; Causes and Disappearance, Rig Vedic Age: The rise of Indo Aryans, Main features of the life in Early Vedic Age, Later Vedic Age: Political, Economic, Social, and Religious life of Later Vedic Aryans.

Unit III

Caste system: Origin and Evolution, The Epics: Historical importance of Ramayan and Mahabharat, Political condition on eve Alexander's Invasion.

Unit IV

Impact of Alexander's Invasion on Social and Culture Life., Position of Women: Harppan, Early Vedic and Later Vedic Age.

Important Historical places of Punjab: Mohenjodaro, Harappa, kotla Nihang khan, Sanghol, Banawali, Taxila, Hastinapur,Indraprastha,Srinagar, Sakala,Purusapura

Text and References Books:

S.NO.	Author's	Title	Publisher
1	Sukhdev Sharma	History And Culture Of Punjab	New Academic Publisher
2	Romila Thapar	A History of India, Vol. I	Penguin Books

Course Code	**CHM 109**
Course Title	**Basic Analytical Chemistry**
Type of course	Skill Enhancement course-I
L T P	2:0:0
Credits	2
Course prerequisite	B.sc. Ist, IInd year with Chemistry as core subject
Course Objective (CO)	**Objectives:** The objective of this course is to make students aware about the importance and the concepts of chemical analysis of water and soil,using separation techniques like chromatography and instrumentation techniques like flame photometry and spectrophotometry.
Course **Outcomes:**	**By the end of this course, students will be able to:** · Handle analytical data · Determine composition and pH of soil, which can be useful in agriculture · Do quantitative analysis of metal ions in water · Separate mixtures using separation techniques · Estimate macro nutrients using Flame photometry

UNIT I:

Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators a. Determination of pH of soil samples. b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. a. Determination of pH, acidity and alkalinity of a water sample. b. Determination of dissolved oxygen (DO) of a water sample.

UNIT II:

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration.

a. 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.

Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

a. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+})

b. To compare paint samples by TLC method.

UNIT III:

Ion-exchange: Column, ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

Analysis of cosmetics**:** Major and minor constituents and their function

a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.

b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

Unit IV:

Suggested Applications (Any one):

a. To study the use of phenolphthalein in trase cases.
b. To analyze arson accelerants.
c. To carry out analysis of gasoline.
Suggested Instrumental demonstrations**:**
a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
b. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft drink

Text and Reference Books

S. No	Name	Author(S)	Publisher
1	Concise Inorganic Chemistry	1.D. Lee	ELBS
2	Inorganic Chemistry	A.G. Sharpe	ELBS
3	Vogel's Qualitative Inorganic Analysis (7th Edition). ISBN-13:978-0582219666,	G Svehla	Prentice Hall
4	Vogel's Quantitative Chemical Analysis (6th Edition), ISBN-13:978-0582226289,	J. Mendham, R.C. Denney, J.D. Barnes, M.J.K. Thomas	Prentice Hall
5	Instrumental Analysis	G.D. Christian and J.E.G. Reily	Allegn Becon, Latest edition
6	Instrumental Methods of Chemical Analysis	G.W.Ewing,	McGraw Hill Pub, 1975.

Course Code	CHM123

Course Title	Inorganic Chemistry Practical
Type of course	Practical/CR
L T P	0 0 4
Credits	2
Course prerequisite	+2 with chemistry as core subject
Course Objective(CO)	To carry out chemical estimation and qualitative analysis using different titrimetric methods.
Course outcome	CO1 Callibrate different analytical instruments . CO2 Detection of elements (N, S and halogens) in organic compounds. CO3 Estimate different inorganic cations and anions through titrimetric methods.

Syllabus

List of Experiments

(A) Titrimetric Analysis

(i) Calibration and use of apparatus.

(ii) Preparation of solutions of different Molarity/Normality of titrants.

(iii) Use of primary and secondary standard solutions.

(B) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.

(ii) Estimation of carbonate and bicarbonate present together in a mixture.

(iii) Estimation of free alkali present in different soaps/detergents

(C) Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.

(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.

(iii) Estimation of Fe(II) with K2Cr2O7 using internal (diphenylamine, anthranilic acid) and external indicator.

Recommended Books/References:

1. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis* Sixth Edition, Pearson, 2009.

2. Svehala G. and Sivasankar I. B, Vogel's Qualitative Inorganic Analysis, Pearson, India, 2012.

Course Code	**CHM127**
Course Title	**Physical Chemistry-1 Practical**
Type of course	Practical
L T P	0 0 4
Credits	2
Course prerequisite	+2 with chemistry as core subject
Course Objective(CO)	Physical properties of each state of matter and laws related to describe the states, Liquid state and its physical properties related to temperature and pressure variation
Course outcome	CO1 Callibrate different analytical instruments. CO2 Determine and calculate different solution properties such as surface tension, viscosity CO3 Prepare buffer solutions and determination of pH through pH metric analysis

List of Experiments

1. Surface tension measurements.

a. Determine the surface tension by (i) drop number (ii) drop weight method.

b. Study the variation of surface tension of detergent solutions with concentration.

2. Viscosity measurements using Ostwald's viscometer.

a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.

b. Viscosity of sucrose solution with the concentration of solute.

3. pH metry

a. Effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.

b. Preparation of buffer solutions of different pH

i. Sodium acetate-acetic acid

ii. Ammonium chloride-ammonium hydroxide

c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.

d. Determination of dissociation constant of a weak acid.

Recommended text books/references:

1.Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).

2.Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.*; McGraw-Hill: New York (2003).

3 Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

4 Athawale V. D. amd Mathur P. Experimental Physical Chemistry,, New Age Intenational (2001)

Course Code	PHY103
Course Title	**Mechanics**
Type of course	Practical /GE
L T P	0 0 4
Credits	2
Course prerequisite	10+2 Chemistry
Course Objective (CO)	The aim of this course is to impart practical knowledge to the students and provide them with exposure of basic measuring instruments, electricity and electronics apparatuses
Course outcome	CO1 Understand basic units of measurement, convert units, and appreciate their magnitudes. CO2 Demonstrate the ability to produce a working model through hands-on experience in fluid mechanics. CO3 Measure fluid pressure and relate it to flow velocity.

List of Experiments

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To determine the Height of a Building using a Sextant.
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Young's Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
6. To determine the Elastic Constants of a Wire by Searle's method.
7. To determine g by Bar Pendulum.
8. To determine g by Kater's Pendulum.
9. To determine **g** and velocity for a freely falling body using Digital Timing Technique
10. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g

Text and Reference Books

S. No	Name	Author(S)	Publisher
01	*Practical Physics*	C. L. Arora	S. Chand

SEMESTER II

Course Code	CHM122
Course Title	**Organic I:Basics and Hydrocarbons**
Type of course	Core
L T P	4 0 0
Credits	4
Course prerequisite	10+2 with Chemistry as core subject
Course Objective (CO)	Basic of organic molecules, structure, bonding, reactivity and reaction mechanisms and Stereochemistry of organic molecules
Course Outcomes (CO)	**On completion of the course, the student will be able to:** Understand and explain the different nature and behavior of organic compounds based on fundamental concepts learnt. Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved. Learn and identify many organic reaction mechanisms including Free Radical Substitution, Electrophilic Addition and Electrophilic Aromatic Substitution. Understand the fundamental concepts of stereochemistry.

Unit I

Basics of Organic Chemistry:

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and relative stabilities of reaction intermediates (Carbocations, Carbanions, Free radicals and Carbenes). Organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Unit II

Stereochemistry: Concept of asymmetry, Fischer Projection, Newmann and Sawhorse projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixtures, Relative and absolute configuration: D/L and R/S designations.

Unit III

Chemistry of Aliphatic Hydrocarbons: A. Carbon-Carbon sigma bonds Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz- Fittig Reactions, Free radical substitutions: Halogenation - relative reactivity and selectivity.

B. Carbon-Carbon pi-bonds Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration- oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1, 2- and 1, 4- addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions.

C. Cycloalkanes and Conformational Analysis

Cycloalkanes and stability, Baeyer strain theory, Conformation analysis, Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms.

Unit IV Aromatic Hydrocarbons

Aromaticity: Huckel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation.

nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of substituent groups.

Reference Books:

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, 6th Edn., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Pine S. H. Organic Chemistry, Fifth Edition, McGraw Hill, (2007)

3. F. A. Carey, Organic Chemistry, Seventh Edition, Tata McGraw Hill (2008).

4. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., (2012), Oxford Universitiy Press.

5. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure and mechanism, Kluwer Academic Publisher, (2000).

Course Code	CHM126
Course Title	**Physical II: Chemical Thermodynamics and its applications**
Type of course	Core
L T P	4 0 0
Credits	4
Course prerequisite	10+2 with chemistry as core subject
Course Objective (CO)	Understanding the concept of system, variables, heat, work, and laws of thermodynamics & Understanding the concept of heat of reactions and use of equations in calculations of bond energy, enthalpy.
Course outcome	CO1 Identify thermodynamic property of any system to apply it for various systems. CO2 Acquire the knowledge of phase equilibria of various systems. CO3 Demonstrate an understanding of completely miscible, partially miscible and immiscible liquids.

UNIT I

Introduction to thermodynamics:

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics. *First law:* Concept of heat, *q*, work, *w*, internal energy, *U*, and statement of first law; enthalpy, *H*, relation between heat capacities, calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

UNIT II

Thermochemistry:

Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations), pressure on enthalpy of reactions.

UNIT III

Second Law

Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

Third law of thermodynamics:

Third Law of thermodynamics, residual entropy, calculation of absolute entropy of molecules.

UNIT IV

Free Energy Functions

Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

Partial molar quantities:

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

Recommended Books/References

1 Atkins P. and De Paula, J. *Physical Chemistry* Tenth Ed., OUP, 2014.
2 Castellan, G. W. *Physical Chemistry 4th Ed.*, Narosa, 2004.
3 Engel, T. and Reid, P. *Physical Chemistry 3rd Ed.*, Prentice Hall, 2012.
4 McQuarrie, D. A. and Simon, J. D. *Molecular Thermodynamics* Viva Books, 2004.
5 Roy, B. N. Fundamentals of Classical and Statistical Thermodynamics Wiley, 2001
6 Commonly Asked Questions in Thermodynamics. CRC Press, 2011.
7 Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill, 2010.
8 Metz, C.R. *2000 solved problems in chemistry*, Schaum Series, 2006.

Course Code	**MAT102**
Course Title	**Differential equations**
Type of course	Theory /GE
L T P	6 0 0
Credits	6
Course prerequisite	10+ 2 with maths as core subject
Course Objective (CO)	It develop the knowledge about Differential Equations and partial equations
Course outcome	CO1 They become able to find out the General, particular, explicit, implicit and singular solutions of a differential equation. CO2 They become able to understand the concept of Wronskian: its properties ,its applications and Linear homogeneous and non-homogeneous equations of higher order with constant coefficients. CO3 They become able to solve Partial differential equation with Lagrange's solution and Charpit's general method of solution.

Syllabus

Unit-I

First order exact differential equations. Integrating factors, rules to find an integrating factor. First order higher degree equations solvable for x, y, p. Methods for solving higher-order differential equations. Basic theory of linear differential equations, Wronskian, and its properties.Solving a differential equation by reducing its order.

Unit -II

Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations.

Unit-III

Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order,Charpit's method.

Unit-IV

Classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only.

Text and Reference Books

S. No	Name	Author(S)	Publisher
1	Differential Equations	Shepley L. Ross	John Wiley and Sons
2	Elements of Partial Differential Equations	Sneddon	McGraw-Hill

Course Code	**PHY102**
Course Title	**Electricity and Magnetism**
Type of course	Theory /GE
L T P	4 0 0
Credits	4
Course prerequisite	10+2 with chemistry as core subject
Course Objective (CO)	The subject will add one more step to the students of first year in the fields of magnetism, electromagnetic theory, & properties of matter.
Course outcome	CO1 A fundamental understanding of electromagnetic phenomena. CO2 Learn how to analyze various problems in electromagnetism with mathematical methods. CO3 Gain experience in analyzing problems within electromagnetism.

Unit-I

Vector Analysis: Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors(statement only).

Unit-II

Electrostatics: Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

Unit-III

Magnetism:Magnetostatics: Biot-Savart's law & its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law.Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para- and ferro-magnetic materials

Unit-IV

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law,self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.Maxwell`s equations and Electromagnetic wave propagation: Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.

Text and Reference Books

S. No	Name	Author(S)	Publisher
1	*Introduction to Electrodynamics*	D J Griffith	Prentice-Hall of India
2	*Physics Vol 2*	Halliday and Resnik	
3	*Electricity and Magnetism*	A S Mahajan and A A Rangwala	Tata McGraw-Hill
4	*Berkeley Physics Course, Vol. 1, Mechanics*	E M Purcell, Ed	Tata McGraw-Hill

Course Code	**EVS001**
Course Title	**Environmental Science**
Type of course	Theory/ID
L T P	3 0 0
Credits	3
Course prerequisite	NA
Course objective	To connect and sensitize the students towards the environment and prevailing environmental issues (natural, physical, social and cultural).
Course outcome	CO1 Acquire understanding of environment and ecosystem. CO2 Study environmental pollutions and natural resources. CO3 Study social issues related to environment.

SYLLABUS

UNIT I

Introduction: Definition and scope and importance of multidisciplinary nature of environment. Need for public awareness.

Natural Resources: Natural Resources and associated problems, use and over exploitation, case studies of forest resources and water resources.

Ecosystems: Concept of Ecosystem, Structure, interrelationship, producers, consumers and decomposers, ecological pyramids-biodiversity and importance. Hot spots of biodiversity

UNIT II

Environmental Pollution: Definition, Causes, effects and control measures of air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management: Causes, effects and control measure of urban and industrial wastes. Role of an individual in prevention of pollution, Pollution case studies, Disaster Management: Floods, earthquake, cyclone and landslides.

UNIT III

Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Case studies. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of pollution) Act. Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation Public awareness.

UNIT IV

Human Population and the Environment: Population growth, variation among nations. Population explosion –Family Welfare Programme. Environment and human health, Human Rights, Value Education, HIV/AIDS. Women and child Welfare. Role of Information Technology in Environment and human health.

Text and Reference Books:

S. No	Name	Author(S)	Publisher
1	Environmental Biology	Agarwal, K.C. 2001	Nidi Publ. Ltd. Bikaner.
2	Environmental Science	Miller T.G. Jr.	Wadsworth
3	Perspectives in Environmental Studies	Anubha Kaushik and Gaurav Garg	New Age International Publishers

ourse Code	**CHM 110**
Course Title	**Green methods in chemistry**
Type of course	Skill enhancement course-II
L T P	2:0:0
Credits	2
Course prerequisite	+2 with Chemistry as core subject
Course Objective (CO)	**Objectives:** · To inspire the students about the chemistry which is good for human health and environment. · To evaluate suitable technologies for the remediation of hazardous substances. · To make students aware of how chemical processes can be designed, developed and run in a sustainable way. · To acquire the knowledge of the twelve principles of green chemistry and how to apply in green synthesis. · To make students aware about the benefits of using green chemistry. · To have the idea of Biocatalytic Process—Conversion of Biomass into chemicals.
Course Outcomes:	**By the end of this course, students will be able to:** · Get idea of toxicology, environmental law, energy and the environment · Think to design and develop materials and processes that reduce the use and generation of hazardous substances in industry. · Think of chemical methods for recovering metals from used electronics materials. · Get ideas of innovative approaches to environmental and societal challenges. · Know how chemicals can have an adverse/potentially damaging effect on human and vegetation. · Critically analyse the existing traditional chemical pathways and processes and creatively think about bringing environmentally benign reformations in these protocols. · Convert biomass into valuable chemicals through green technologies.

UNIT – I

Introduction: Definitions of Green Chemistry. Brief introduction of twelve principles of Green Chemistry, with examples, special emphasis on atom economy, reducing toxicity, green solvents, Green Chemistry and catalysis and alternative sources of energy, Green energy and sustainability.

UNIT – II

The Real world Cases in Green Chemistry: Surfactants for carbon dioxide – Replacing smog producing and ozone depleting solvents with CO for precision cleaning and dry cleaning of garments.

Designing of environmentally safe marine antifoulant.

UNIT –III

Right fit pigment: Synthetic azo pigments to replace toxic organic and inorganic pigments. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.

UNIT - IV

Preparation and characterization of biodiesel from vegetable oil. Extraction of D-limonene from orange peel using liquid CO prepared from dry ice. Mechano- chemical solvent

free synthesis of azomethine. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).

Text and Reference Books

S. No	Name	Author(S)	Publisher
1	Green Chemistry- Theory and Practical, 1998	Anastas, P.T. & Warner, J.K.	Oxford University Press
2	Introduction to Green Chemistry, 2001	Matlack, A.S.	Marcel Dekker
3	Real-World cases in Green Chemistry, 2000	Cann, M.C. & Connely, M.E.	American Chemical Society, Washington
4	Introduction to Green Chemistry, 2002	Ryan, M.A. & Tinnesand, M.	American Chemical Society, Washington

Course Code	PHY104
Course Title	**Electricity and Magnetism Practical**
Type of course	Practical /GE
L T P	0 0 4
Credits	2
Course prerequisite	10+2 with chemistry as core subject
Course Objective (CO)	The course is to impart practical knowledge to the students and provide them with practical exposure of electricity and magnetism
Course outcome	CO1 "To understand the importance of experiment as the basis of the scientific method. CO2 " Better understand physics concepts covered in lecture by seeing their application in expt. CO3 Analyzing data and drawing conclusions from "real world" experiments.

List of Experiments

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.

2. Ballistic Galvanometer:

(i) Measurement of charge and current sensitivity
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(ii) Measurement of CDR

(iii) Determine a high resistance by Leakage Method

(iv) To determine Self Inductance of a Coil by Rayleigh's Method.

3. To compare capacitances using De'Sauty's bridge.

4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).

5. To study the Characteristics of a Series RC Circuit.

6. To study the a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor

7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and

(b) Quality factor Q

8. To determine a Low Resistance by Carey Foster's Bridge.

9. To verify the Thevenin and Norton theorem

10. To verify the Superposition, and Maximum Power Transfer Theorem

S. No	Name	Author(S)	Publisher
01	*Practical Physics*	C. L. Arora	S. Chand

Course Code	CHM124

Course Title	Organic II: Basics & Hydrocarbons Practical
Type of course	Core
L T P	0 0 4
Credits	2
Course prerequisite	10+2 with chemistry as core subject
Course Objective (CO)	Prepare and uses of various classes of organic compounds
Course outcome	CO1 Identify and estimate elements and organic functional groups. organic compounds. CO2 Analyse function groups through organic preparations such as acetylation, bromination, nitration, hydrolysis and benzoylation.. CO3 Prepare different organic derivatives as useful drug molecules.

List of Experiments

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents:

a. Water
b. Alcohol
c. Alcohol-Water

3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)

Effect of impurities on the melting point – mixed melting point of two unknown organic compounds

5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)
6. Chromatography

a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
b. Separation of a mixture of two sugars by ascending paper chromatography
c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

Reference Books

Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009)

Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.*, Pearson (2012)

3 Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis*, University Press (2000)

4 Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis*, University Press (2000).

Course Code	CHM128
Course Title	**Physical II: Chemical Thermodynamics & its Applications Practical**
Type of course	Core
L T P	0 0 4
Credits	2
Course prerequisite	10+2 with chemistry as core subject
Course Objective (CO)	Understanding the concept of system, variables, heat, work, and laws of thermodynamics & Understanding the concept of heat of reactions and use of equations in calculations of bond energy, enthalpy.
Course outcome	CO1 Identify thermodynamic property of any system to apply it for various systems. CO2 Study and construct phase equilibria of various systems. CO3 Demonstrate an understanding of completely miscible, partially miscible and immiscible liquids.

List of Experiments

Thermochemistry

(a) Determination of heat capacity of a calorimeter for different volumes using change ofenthalpy data of a known system (method of back calculation of heat capacity of calorimeter
from known enthalpy of solution or enthalpy of neutralization).
(b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
(c) Calculation of the enthalpy of ionization of ethanoic acid.
(d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.
(e) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
(f) Determination of enthalpy of hydration of copper sulphate.
(g) Study of the solubility of benzoic acid in water and determination of ΔH.
Any other experiment carried out in the class.

Reference Books

- Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R.Chand & Co.: New Delhi (2011).
- Athawale, V. D. & Mathur, P. *Experimental Physical Chemistry* New AgeInternational: New Delhi (2001).

SEMESTER - III

Course Code	CHM221
Course Title	**Inorganic II: s and p-Block Elements**
Type of course	Core
L T P	4 0 0
Credits	4
Course prerequisite	10+2 with chemistry as core subject
Course Objective (CO)	Understand redox reactions in hydrometallurgy processes, Structure, bonding of s and p block materials and their oxides/compounds .
Course outcome	CO1 Understand basics of mettalurgical processes. CO2 Describe chemical and physical properties of s and p block elements. CO3 Analyse different properties and applications of noble gases and inorganic polymers.

UNIT I

Oxidation-Reduction and general principle of metallurgy

Redox equations, Standard Electrode Potential and its application to inorganic reactions. Occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon or carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel- de Boer process and Mond's process, Zone refining.

UNIT II

Chemistry of *s* and *p* Block Elements

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behavior of first member of each group. Allotropy and catenation. Complex formation tendency of *s* and *p* block elements. Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate.

Structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Per-oxo acids of Sulphur inter-halogen compounds, poly-halide ions, pseudo-halogens, properties of halogens.

UNIT III

Noble Gases: Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF2, XeF4 and XeF6; Bonding in noble gas compounds (Valence bond and MO treatment for XeF2), Shapes of noble gas compounds (VSEPR theory).

UNIT IV

Inorganic Polymers: Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.

Recommended books/references:

1 Lee, J.D. *Concise Inorganic Chemistry*, ELBS, 1991.
2 Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry 3rd Ed.*, John Wiley Sons, N.Y. 1994.
3 Greenwood, N.N., Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.
4 Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
5 Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.
6 Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* Fourth Ed., Pearson, 2010

7 Atkins, P. W and Shriver D. N. *Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press (2010).

Course Code	**CHM225**
Course Title	**Organic II: Oxygen containing functional groups**
Type of course	Core
L T P	4 0 0
Credits	4
Course prerequisite	10+2 with chemistry as core subject
Course Objective (CO)	Familiarization about classes of organic compounds and their methods of preparation. Basic uses of reaction mechanisms.
Course outcome	CO1 Understand structure and bonding in halogenated hydrocarbon derivatives. CO2 Describe preparations, physical properties, and reactions of alcohols, phenols, carbonyls. CO3 Study and Identify chemical and physical properties of carboxylic acids and carboxylic acid derivatives.

UNIT I

Chemistry of Halogenated Hydrocarbons

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – SN1, SN2 and SNi mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism.

Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Organometallic compounds of Mg and Li and their use in synthesis.

UNIT II

Alcohols, Phenols, Ethers and Epoxides

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement.

Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism.

Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and LiAlH4

UNIT III

Carbonyl Compounds

Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, LiAlH4, NaBH4, MPV, PDC and PGC);

Addition reactions of unsaturated carbonyl compounds: Michael addition.

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

UNIT IV

Carboxylic Acids and their Derivatives

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic,

tartaric, citric, maleic and fumaric acids; Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group - Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmannbromamide degradation and Curtius rearrangement.

Sulphur containing compounds

Preparation and reactions of thiols, thioethers and sulphonic acids.

Recommended Books/references:

1 Solomons, T.W G., Fryhle, B. Craig. *Organic Chemistry*, John Wiley & Sons, Inc (2009).

2 McMurry, J.E. *Fundamentals of Organic Chemistry*, Seventh edition Cengage Learning, 2013.

3 P Sykes, *A Guide Book to Mechanism in Organic Chemistry*, 6th Edition (1997), Orient Longman, New Delhi.

4 Morrison R. T. and Boyd R. N. Organic Chemistry, Sixth Edition Prentice Hall India, 2003.

Course Code	CHM229
Course Title	**Physical-III: Phase Equilibria & Chemical kinetics**
Type of course	Core
L T P	4 0 0
Credits	4
Course prerequisite	10+2 with chemistry as core subject
Course Objective (CO)	Understand phases, components, Gibb's phase rule and its applications, construction of phase diagram of different systems, the application of phase diagram., Basics of chemical kinetics: determination of order, molecularity, Will provide understanding of theories of reaction rates, determination of rate of opposing/parallel/chain reactions with suitable examples, application of steady state kinetics, Steady-state approximation.
Course outcome	CO1 Acquire coherent knowledge of phase equilibrium, chemical kinetics and surface chemistry. CO2 Draw and interpret phase diagrams for one, two and three component systems. CO3 Describe chemical kinetics for different systems and interpret various adsorption isotherms.

UNIT I

Phase Equilibria

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent
and incongruent melting points, solid solutions. Three component systems, water-chloroform-acetic acid system, triangular plots. *Binary solutions:* Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.

UNIT II

Chemical Kinetics

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated rate laws for first, second and fractional order reactions, pseudounimolecular reactions, determination of the order, kinetics of complex reactions (limited to first order): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

UNIT III

Catalysis

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

UNIT IV

Surface chemistry

Physical adsorption, chemisorption, adsorption isotherms (Freundlich, Temkin, Derivation of Langumuir adsorption isotherms, surface area determination), BET theory of multilayer adsorption (no derivation), Adsorption in solution.

Recommended books/References:

1. Atkins P. W. and De Paula J., *Physical Chemistry, (*tenth edition) Oxford University Press, 2014.

2 Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa , 2004.

3 McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books, 2004.

4 Engel, T. & Reid, P. *Physical Chemistry* Third Edition, Prentice-Hall,2012.

Course Code	**MAT201**
Course Title	**Real analysis**
Type of course	Theory/GE
L T P	6 0 0
Credits	6
Course prerequisite	B.Sc. 1st with mathematics as core subject
Course Objective (CO)	To have the knowledge of basic properties of field of real numbers and convergence
Course outcome	CO1 They become able to find Bounded and unbounded sets, Infimum and supremum of a set. CO2 They can understand Bolzano- Weierstrass theorem for sets, topology of real line and Rn. CO3 They become able to understand the Theorems on limits of sequences, Subsequences, Monotone sequences, Monotone convergence Theorem.

Unit-I

Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, completeness property of R, Archimedean property of R, intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem.

Unit-II

Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences. Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof).

Unit-III

Infinite series. Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, Ratio test, alternating series, Leibnitz's test (Tests of Convergence without proof). Definition and examples of absolute and conditional convergence.

Unit-IV

Sequences and series of functions, Pointwise and uniform convergence. Mn-test, M-test, Statements of the results about uniform convergence and integrability and differentiability of functions, Power series and radius of convergence

Text and Reference Books

S. No	Name	Author(S)	Publisher
1	*Introduction to Real Analysis*	R.G. Bartle and D. R Sherbert	John Wiley and Sons
2	*Elementary Analysis*	K.A. Ross	Springer Verlag,
3	*Intermediate Real Analysis*	E. Fischer	Springer Verlag

Course Code	PHY201
Course Title	**Thermal physics and statistical mechanics**
Type of course	Theory/GE
L T P	4:0:0
Credits	4
Course prerequisite	BSc. 1st with physics as core subject
Course Objective (CO)	The aim of this course is to impart theoretical knowledge to the students in thermal, statistical and atomic physics.
Course outcome	CO1 Solve statistical mechanics problems for simple non-interacting systems. CO2 Basic understanding of the phase transitions. CO3 Use linear response theory and kinetic equation approach.

Unit-I

Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermo dynamical Processes, Applications of First Law: General Relation between CP & CV, Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

Unit-II

Thermodynamic Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius-Clapeyron Equation, Expression for (CP – CV), CP/CV, TdS equations.

Unit-III

Kinetic Theory of Gases: Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases. Theory of Radiation: Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.

Unit-IV

Statistical Mechanics: Phase space, Microstate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity - Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics.

Text and Reference Books

S. No	Name	Author(S)	Publisher
1	*Statistical Physics and Thermodynamis*	V S Bhatia	
2	*A Treatise on Heat*	Saha and Srivastava	Indian Press, Ahmedabad
3	*Thermal Physics*	C. Kittel & H. Kroemer	CBS Pub.
4	*Thermal Physics*	S C Garg, R M Bansal & C K Ghosh	TMH

Course Code	CHM223
Course Title	**Inorganic II: s and p-Block Elements Practical**
Type of course	Core
L T P	0 0 4
Credits	2
Course prerequisite	10+2 with chemistry as core subject
Course Objective (CO)	Understand the chemistry of inorganic polymers, their structures and uses.
Course outcome	CO1 Preparation of stock slotions. CO2 Estimate different cations and anions through iodometric titrations. CO3 Prepare different inorganic salts.

List of Experiments

(A) Iodo / Iodimetric Titrations

(i) Estimation of Cu(II) and K2Cr2O7 using sodium thiosulphate solution (Iodometrically).

(ii) Estimation of antimony in tartar-emetic iodimetrically

(iii) Estimation of Iodine Content in iodized salt

(B) Complexometric titrations using disodium salt of EDTA

(i) Estimation of Mg2+,Zn2+

(ii) Estimation of Ca2+ by substitution method

(iii) Estimation of Calcium content in milk.

(C) Paper chromatographic separation of following metal ions:

(i) Ni (II) and Co (II)

(ii) Cu(II) and Cd(II)

(D) Inorganic preparations

(i) Cuprous Chloride, Cu2Cl2

(ii) Aluminium potassium sulphate KAl(SO4)2 .12H2O (potash alum) or Chromium potassium sulphate

KCr(SO4)2.12H2O (chrome alum).

Recommended books/references:

- Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989),Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons.

Course Code	**CHM227**
Course Title	**Organic II: Oxygen Containing Functional Groups Practical**
Type of course	Core
L T P	0 0 4
Credits	2
Course prerequisite	10+2 with chemistry as core subject
Course Objective (CO)	Preparation and uses of various classes of organic compounds. Organometallic compounds and their uses.
Course Outcomes	CO1 Analyse chemical kinetics of acid hydrolysis of esters CO2 Find out the adsorption isotherms and molecular weight of organic compounds through rast method. CO3 Study conductometric titrations.

List of Experiments

1.Identification of elements (N, S, and halogen) and Functional group tests for alcohols, phenols, carbonyl, carboxylic acid and amine group of compounds.

2. Organic preparations:

i. Acetylation of one of the following compounds: amines (aniline, *o*-, *m*-, *p*-toluidines and *o*-, *m*-, *p*-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method: (Using conventional method.and Using green chemistry approach)

ii. Benzolyation of one of the amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-, *m*-, *p*-anisidine) and one of the phenols (*β*-naphthol, resorcinol, *p*-cresol) by Schotten-Baumann reaction.

iii. Oxidation of ethanol/ isopropanol (Iodoform reaction).

iv. Bromination (any one)

a. Acetanilide by conventional methods

b. Acetanilide using green approach (Bromate-bromide method)

v. Nitration: (any one)

a. Acetanilide/nitrobenzene by conventional method

b. Salicylic acid by green approach (using ceric ammonium nitrate).

vi. Selective reduction of *meta* dinitrobenzene to *m*-nitroaniline.

vii. Reduction of *p*-nitrobenzaldehyde by sodium borohydride.

viii. Hydrolysis of amides ix. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.

x. *S*-Benzylisothiouronium salt of one each of water soluble/ insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).

xi. Aldol condensation with either conventional or green method.

xii. Benzil-Benzilic acid rearrangement.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point and TLC.

Recommended Books/References:

1 Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009)

2 Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.* Pearson (2012)

3 Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,* University Press (2000)

4 Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press (2000). and esters.

Course Code	CHM231
Course Title	**Physical III: Phase Equilibria & Chemical Kinetics Practical**
Type of course	Core
L T P	0 0 4
Credits	2
Course prerequisite	10+2 with chemistry as core subject
Course Objective (CO)	Understanding the concept of system, variables, heat, work, and laws of thermodynamics & Understanding the concept of heat of reactions and use of equations in calculations of bond energy, enthalpy.
Course outcome	CO1 Analyse chemical kinetics of acid hydrolysis of esters CO2 Find out the adsorption isotherms and molecular weight of organic compounds through rast method. CO3 Study conductometric titrations.

List of Experiments

Phase Equilibria:

I. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.

II. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:

a. simple eutectic and

b. congruently melting systems.

III. Distribution of acetic/ benzoic acid between water and cyclohexane.

IV. Study the equilibrium of at least one of the following reactions by the distribution method:

(i) I2(aq) + I - → I3-(aq)2+

(ii) Cu2+(aq) + *n*NH3 → Cu(NH3)*n*

Potentiometry:

1. Perform the following potentiometric titrations:

i. Strong acid vs. strong base

ii. Weak acid vs. strong base

iii. Dibasic acid vs. strong base

iv. Potassium dichromate vs. Mohr's salt.

Chemical Kinetics

Study the kinetics of the following reactions.

1. Initial rate method: Iodide-persulphate reaction

2. Integrated rate method:

a. Acid hydrolysis of methyl acetate with hydrochloric acid.

b. Saponification of ethyl acetate.

3. Compare the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methyl acetate.

Recommended Books/References:

1.Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand, New Delhi, 2011.

2.Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry*, Eighth Edition, McGraw-Hill(2003).

3 Halpern, A. M. and McBane, G. C. *Experimental Physical Chemistry*, Third Edition, W, H. Freeman (2003).

Course Code	**PHY203**
Course Title	**Thermal physics and statistical mechanics Practical**
Type of course	Practical/GE
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. 1st with physics as core subject
Course Objective (CO)	The aim of this course is to impart practical knowledge to the students and provide them with exposure of thermodynamics.
Course outcome	CO1 Different ensemble theories to explain the behaviour of the systems. CO2 Connection between statistics and thermodynamics. CO3 Statistical behaviour of ideal Bose and Fermi systems.

List of Experiments

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To determine Stefan's Constant.
4. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system
10. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge

Text and Reference Books

S. No	Name	Author(S)	Publisher
1	*Advanced Practical Physics for students*	B.L. Flint & H.T. Worsnop	Asia Publishing House.
2	*Advanced level Physics Practicals*	Michael Nelson and Jon M. Ogborn	Heinemann Educational Publishers
3	*A Text Book of Practical Physics*	Indu Prakash and Ramakrishna	Kitab Mahal, New Delhi

Semester IV

Course Code	**CHM222**
Course Title	**Inorganic Chemistry III: Coordination chemistry**
Type of course	CR
L T P	4:0:0
Credits	4
Course prerequisite	10+2 with as a core chemistry
Course Objective (CO)	**Objectives:** The course introduces the students to coordination compounds which find manifold applications in diverse areas like qualitative and quantitative analysis, metallurgy, as catalysts in industrial processes as medicines, paints and pigments as well as in life. The student is also familiarized with the d and f block elements and get an idea about horizontal similarity in a period in addition to vertical similarity in a group.
Course outcomes	**By the end of the course, the students will beable to:** · Understand the terms, ligand, denticity of ligands, chelate, coordination number and use standard rules to name coordination compounds. · Discuss the various types of isomerism possible in such compounds and understand the types of isomerism possible in a metal complex. · Use Valence Bond Theory to predict the structure and magnetic behaviour of metal complexes and understand the terms inner and outer orbital complexes · Explain the meaning of the terms Δo., Δt, pairing energy, CFSE, high spin and low spin and how CFSE affects thermodynamic properties like lattice enthalpy and hydration enthalpy · Explain magnetic properties and colour of complexes on basis of Crystal Field Theory · Understand the important properties of transition metals like variable oxidation states, colour, magnetic and catalytic properties and use Latimer diagrams to predict and identify species which are reducing, oxidizing and tend to disproportionate and calculate skip step potentials · Understand reaction mechanisms of coordination compounds and differentiate between kinetic and thermodynamic stability.

UNIT I

Coordination Chemistry:

Werner's theory, EAN rule, piano-stool compounds, valence bond theory (inner and outer orbital complexes), Crystal field theory, d-orbital splitting, , weak and strong fields, pairing energies, factors affecting the magnitude of (Δ). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar complexes, d orbital splitting in trigonal bipyramidal, square pyramidal and cubic ligand field environment, CFSE, Variation of lattice energies, enthalpies of hydration and crystal radii variations in halides of first and second row transition metal series, Qualitative aspect of Ligand field theory, MO diagrams of representative coronation complexes, IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with the coordination number 4 and 6, Chelate effect

UNIT II

Transition Elements:

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, and ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Difference between the

first, second and third transition series. Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their mettelergy).

UNIT III

Lanthanoids and Actinides:

Electronic configuration, oxidation states, color, spectra and magnetic behavior, lanthanide contraction, separation of lanthanides (ion-exchange method only)

UNIT IV

Bioinorganic Chemistry:

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), toxicity, chelating agents in medicine. Iron and its application in biosystems, Haemoglobin; Storage

Text and Reference Books

S. No	Name	Author(S)	Publisher
1	*Inorganic Chemistry*	Purcell, K.F & Kotz	W.B. Saunders Co, 1977
2	*Inorganic Chemistry*	Huheey, J.E	Prentice Hall, 1993
3	*Principles of Bioinorganic Chemistry*	Lippard, S.J. & Berg, J.M	Panima Publishing Company 1994
4.	*Advanced Inorganic Chemistry*	Cotton, F.A. & Wilkinson, G	Wiley-VCH, 1999

Course Code	CHM224
Course Title	**Inorganic Chemistry III: Coordination Chemistry Practical**
Type of course	CR
L T P	0:0:4
Credits	2
Course prerequisite	10+2 with Chemistry as one core subject
Course Objective (CO)	Understanding the transition metals stability in reactions, origin of colour and magnetic properties. Understanding the separation of Lanthanoids and Actinoids, its color, spectra and magnetic behavior. Understanding the bioinorganic chemistry of metals in biological systems.
Course outcomes	Estimate qualitative semi microanalysis of mixtures Prepare different coordination complexes of transition metals. Analysis of different cations and anions in mixtures through qualitative estimation.

List of Experiments

Gravimetric Analysis:

i. Estimation of nickel (II) using Dimethylglyoxime (DMG).
ii. Estimation of copper as CuSCN
iii. Estimation of iron as Fe2O3 by precipitating iron as Fe(OH)3.
iv. Estimation of Al (III) by precipitating with oxine and weighing as Al(oxine)3 (aluminium oxinate).

Inorganic Preparations:

i. Tetraamminecopper (II) sulphate, [Cu(NH3)4]SO4.H2O
ii. *Cis* and *trans* K[Cr(C2O4)2. (H2O)2] Potassium dioxalatodiaquachromate (III)
iii. Tetraamminecarbonatocobalt (III) ion
iv. Potassium tris(oxalate)ferrate(III)

Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

i. Ni (II) and Co (II)
ii. Fe (III) and Al (III)

Properties of Complexes

1. Measurement of 10Dq/ Δo by spectrophotometric method.
2. Verification of spectrochemical series.
3. Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetone, DMG, glycine) by substitution method.

Text and Reference Books

S. No	Name	Author(S)	Publisher
1	Vogel's *Qualitative Inorganic Analysis,*	Revised by G. Svehla	Pearson Education, 2002.
2	Marr & Rockett *Practical Inorganic Chemistry*	John Wiley & Sons 1972	

Course Code	CHM226
Course Title	**Organic Chemistry III: Heterocyclic Chemistry**
Type of course	CR
L T P	4:0:0
Credits	4
Course prerequisite	10+2 with Chemistry as one core subject
Course Objective (CO)	Understanding the structure, mechanism of reactions of selected heterocyclic compounds and natural compounds *viz.* terpenes and alkaloids. A comprehensive understanding of these topics will be developed by taking examples of representative members of each class. The chemical synthesis, properties and reactions of these compounds will be discussed in detail. This course will also discuss some of the key applications of each class of compounds in diverse fields.
Course outcomes	**On completion of this course, the students will be able to:** · Gain theoretical understanding of chemistry of compounds having nitrogen containing functional groups, heterocyclics, polynuclear hydrocarbons, alkaloids and terpenes which includes various methods for synthesis through application of the synthetic organic chemistry concepts learnt so far. · Become familiar with their particular properties, chemical reactions, criterion of aromaticity with reference to polynuclear hydrocarbons and heterocyclic compounds, trends in basicity of amines and heterocyclic compounds and their behaviour at different pH. · Learn practical approach to structural elucidation of organic compounds with specific examples of terpenes and alkaloids. · Predict the carbon skeleton of amines and heterocyclic compounds via use of Hoffmann's exhaustive methylation and Emde's modification methods. · Understand the applications of these compounds including their medicinal applications through their reaction chemistry.

Unit I

Nitrogen Containing Functional Groups

A) Amines: Introduction, classification, chirality in amines (pyramidal inversion), importance and general methods of preparation. Properties: Physical properties, Basicity of amines: Effect of substituents, solvent and steric effects. Distinction between Primary, secondary and tertiary amines. Discussion of the following reactions: Gabriel Phthalimide synthesis, Hoffmann-Bromamide reaction, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction and Cope elimination.

Diazonium Salts: Preparation and synthetic applications of diazonium salts including preparation of arenes, haloarenes, phenols, cyano and nitro compounds. Coupling reactions of diazonium salts(preparation of azo dyes).

B) **Nitro compounds (**Aliphatic and Aromatic**)**:Nomenclature, classification and general methods of preparation: from alkyl halides, alkanes, oxidation of amines and oximes and diazonium salts.

Properties: Physical properties, Reaction with alkali and its synthetic applications, condensation reaction, Mannich reaction, Hydrolysis, Reduction-electrolytic reduction, reduction in acidic, basic and neutral medium (for aromatic compounds),reaction with nitrous acid. Electrophilic

substitution-Halogenation, nitration and sulphonation reaction, and Nucleophilic substitution on the ring.

C) Nitriles : Introduction, Nomenclature and uses. Preparation from the following reactions: Dehydration of amides and aldoximes, substitution reaction in alkyl halides and tosylates, from Grignard reagents and from dehydrogenation of primary amines.

Properties: Physical properties, discussion on the following reactions with mechanism: Reaction with Grignard reagent, hydrolysis,addition reaction with HX,NH3,reaction with aqueous ROH, Reduction reactions-catalytic reduction and Stephen's reaction, Condensation reactions-Thorpe Nitrile Condensation.

D) Isonitriles: Introduction, Nomenclature and uses. Preparation from the following reactions: Carbylamine reaction, substitution in alkyl halides and dehydrogenation of N-substituted formamides. Properties: Physical properties, discussion on the following reactions with mechanism: Hydrolysis, reduction, addition of– HX, X2 and sulphur, Grignard reaction, oxidation and rearrangement.

Unit II

Polynuclear Hydrocarbons

Introduction, Classification, Structure, Nomenclature and uses. Aromaticity of polynuclear hydrocarbons, structure elucidation of Naphthalene and general methods of preparation of naphthalene, phenanthrene and anthracene(including Haworth method,Friedel Craft acylation, Diels Alder reaction,Elbs reaction and Pschorr Synthesis).Relative reactivity of naphthalene, phenanthrene and anthracene in comparison to benzene. Properties: Physical properties, discussion on the following reaction (with mechanism) for Naphthalene, Anthracene and Phenanthrene: Addition reactions, Oxidation, Electrophilic substitution- Friedel Craft reaction, Chloromethylation, Halogenation, Formylation, Nitration and sulphonation. Reduction reaction and Diels Alder reaction.

Unit III

Heterocyclic Compounds

Introduction, importance, classification and nomenclature of heterocyclic compounds (containing only one hetero atom). General discussion on the following aspects of heterocyclic compounds: Structure, aromaticity in 5-membered and 6-membered rings containing one heteroatom; Basicity and relative reactivity towards electrophilic substitution reactions(amongst five membered and six membered rings)

General methods of synthesis for: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Indole(Fischer indole synthesis and Madelung synthesis, reduction of o-nitrobenzaldehyde), Quinoline and isoquinoline, (Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction)

Properties: Physical properties, discussion on the following reaction (with mechanism) for Furan, Pyrrole, thiophene, Pyridine, Indole, Quinoline and Isoquinoline: Electrophilic substitution- Nitration, sulphonation, halogenation, Formylation, acylation, mercuration and carboxylation. Oxidation,Reduction, Addition, Reactions showing acidic /basic character. Reaction with diazonium salts, Ring opening, Ring expansion and Nucleophilic substitution reaction wherever applicable should be discussed

Unit IV

Alkaloids

Introduction, Natural occurrence, Classification, Uses, general structural features, general methods for structure elucidation including Hoffmann's exhaustive methylation and Emde's method. Structure elucidation, synthesis and physiological action of Nicotine.

Terpenes

Introduction, Occurrence, Uses, classification, isoprene and special isoprene rule; general methods of structure elucidation including distinction between isopropylidene and isopropenyl group, Elucidation of structure, synthesis and industrial applicationof Citral.

Recommended Books/references:

1. Morrison, R. T.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1& 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Solomons, T. W. G.; Fryhle, C. B. ; Snyder, S. A. (2016),Organic Chemistry, 12th Edition, Wiley.
4. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P. (2013),Organic Chemistry, Oxford University Press.
5. Gilchrist, T.L. (1997),Heterocyclic Chemistry, Pearson Education.
6. Ram V. J.; Sethi, A.; Nath, M.; Pratap, R.; (2019), The Chemistry of Heterocycles (Nomenclature and Chemistry of three to five membered Heterocycles), Elsevier publication.
7. Ram V. J.; Sethi, A.; Nath, M.; Pratap, R.; (2019), The Chemistry of Heterocycles (Chemistry of six to eight membered N, O, S, P and Se heterocycles), Elsevier publication.

Course Code	CHM228
Course Title	**Organic Chemistry III: Heterocyclic Chemistry Practical**
Type of course	CR
L T P	0:0:4
Credits	2
Course prerequisite	10+2 with as one core subject
Course Objective (CO)	Understanding the structure, mechanism of reactions of selected heterocyclic compounds
Course outcomes	**On completion of this course, the students will be able to:** · Identify heteroatom in organic compounds. · Learn practical approach to structural elucidation of organic compounds with specific examples of terpenes and alkaloids. · Predict the carbon skeleton of amines and heterocyclic compounds via use of Hoffmann's exhaustive methylation and Emde's modification methods. Identification of heterocyclic compounds through chromatographic and spectrometric methods. Preparation of some practically useful heterocyclic compound.

List of Experiments:

1. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols, carbonyl compounds and esters).
2. Isolation of caffeine from tea leaves.
3. Estimation of aniline by any one of the following methods:a) Acetylation b) Bromate-bromide method
4. Detection of extra elements.
5. Functional group test for nitro, amine and amide groups.
6. Identification of hetero atoms (S, N, X) in given organic compounds in lab.
7. Identification/separation of simple organic compounds containing hetero atoms using column chromatography/TLC) in lab.
8. Spectroscopic identification of simple organic compounds (spectra may be provided to identify the compounds using spectra).
9. Melting point/boiling point of the compounds may be checked for its purity.
10. Preparation of : Indigo (using aldol condensation reaction of 2-nitrobenzaldehyde with acetone in basic condition).

Recommended Books/References:

1.Vogel, A.I. *Quantitative Organic Analysis,* Part 3, Pearson (2012).
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.*, Pearson (2012)
4. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,* University Press (2000).
5. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press (2000)

Course Code	CHM230
Course Title	**Physical- Chemistry IV: Electrochemistry**
Type of course	CR
L T P	4:0:0
Credits	4
Course prerequisite	10+2 with as one core subject
Course Objective (CO)	Understanding about chemical cells and their function or Understanding about electrodes, EMF measurement.
Course outcomes	**On completion of this course, the students will be able to:** · Acquire thorough understanding of electrochemistry, conductance in solution of electrolytes. · Learn quantitative aspects of different laws of electrochemistry. · Understanding of different electroanalytical methods. · Understand magnetic and electric properties of matter.

Unit-I

Electrolytic conductance**,** Conductivity,specific, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes, cell constant. Kohlrausch law of independent migration of ions. Ionic velocities, mobilities and their relation. Direct determination of ionic mobility. Application of Kohlrausch law: Molar conductivity at infinite dilution for weak electrolyte, diffusion and ionic mobility, Walden's rules,Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii)ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

Unit-II

Oswald Dilution law, the Debye-Hukel theory of strong electrolyte, Debye-Hückel-Onsager equation,Wien effect. Oxidation number, balancing of chemical equation, Rules of oxidation/reduction of ions based on half-cell potentials,. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement,Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells.

Unit-III:

Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, (iii) pH values, using hydrogen electrodes. Concentration cells, liquid junction potential; **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-IV:

Batteries, primary & secondary, Dry cell, Mercury Battery, Lead storage battery, Solid State Lithium Battery , Fuel Cells, Introduction to corrosion, homogeneous theory, forms of corrosion, corrosion monitoring and Prevention corrosion and corrosion prevention. Electrolysis, Electrolysis of Water. applications of electrolysis in metallurgy and industry

Recommended books/reference books

1.Atkins, P.W & Paula, J.D. Physical Chemistry, 10th Ed., Oxford University Press (2014).
2.Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
3.Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
4.Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006).
5.Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement,
molecular interpretation.

Course Code	**CHM232**
Course Title	**Physical Chemistry-IV: Electrochemistry practical**
Type of course	CR
L T P	0:0:4
Credits	2
Course prerequisite	10+2 with as one core subject
Course Objective (CO)	To enhance the practical knowledge of titrations
Course outcomes	**On completion of this course, the students will be able to:** · Determine pH of solution through pH meters. · Analyse conductance of solution through different conductometic titrations. · Use potentiometric titrations for estimation of strong acid, strong base and mixtures.

List of experiments

Conductometry

I. Determination of cell constant

II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.

III. Perform the following conductometric titrations:

i. Strong acid vs. strong base

ii. Weak acid vs. strong base

iii. Mixture of strong acid and weak acid vs. strong base

iv. Strong acid vs. weak base

Potentiometry

I Perform the following potentiometric titrations:

i. Strong acid vs. strong base

ii. Weak acid vs. strong base

iii. Dibasic acid vs. strong base

iv. Potassium dichromate vs. Mohr's s

Determination of pH of a given solution using glass electrode.

Recommended books/reference books:

1.Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).

2.Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* Universities Press.

3.Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).

4. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

Course Code	**PHY202**
Course Title	**Waves and optics**
Type of course	Theory/GE
L T P	4:0:0
Credits	4
Course prerequisite	B.Sc 1st with Physics as core subject
Course Objective (CO)	The main objective of the course is to enhance the knowledge of students in wave and optics, the two key subjects of physics.
Course outcome	CO1 The wave optics part of the course will give the student a thorough fundamental knowledge within interferometry. CO2 The student will become able to analyze and understand interference between plane waves and spherical waves. CO3 The student will get a thorough knowledge of the polarization of light and its changes upon reflection.

Unit-I

Superposition of Two Collinear Harmonic oscillations: Linearity and Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats). Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses. Waves Motion- General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity.

Unit-II

Fluids: Surface Tension: Excess of pressure - Application to spherical and cylindrical drops and bubbles - variation of surface tension with temperature - Jaegar's method. Viscosity: Viscosity - Rate flow of liquid in a capillary tube - Poiseuille's formula - Determination of coefficient of viscosity of a liquid - Variations of viscosity of a liquid with temperature lubrication. Detection of leakage Sound: Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria.

Unit-III

Wave Optics: Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle. Interference: Interference: Division of amplitude and division of wave front. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index. Michelson's Interferometer: Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index and Visibility of fringes.

Unit-IV

Diffraction: Fraunhofer diffraction: Single slit; Double Slit. Multiple slits & Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction patternof a straight edge, a slit and a wire using half-period zone analysis. Polarization: Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization.

Text and Reference Books

S. No	Name	Author(S)	Publisher
1	*University Physics*	FW Sears, MW Zemansky and HD Young 13/e	Addison-Wesley
2	*Fundamentals of Optics*	H.R. Gulati and D.R. Khanna	R. Chand Publication
3	*Fundamentals of Optics*	F A Jenkins and H E White	McGraw-Hill
4	*Principles of Optics*	B.K. Mathur	Gopal Printing

Course Code	**MAT202**
Course Title	**Algebra**
Type of course	Theory/GE
L T P	6 0 0
Credits	6
Course prerequisite	B.Sc 1st with Mathematics as one core subject
Course Objective (CO)	It develops the techniques to simplify algebraic expressions using commutative, associative and distributive properties.
Course outcome	CO1 Students will have a working knowledge of important mathematical concepts in abstract algebrasuch as definition of a group, order of a finite group and order of an element. CO2 Students will be knowledgeable of different types of subgroups such asnormal subgroups, cyclic subgroups and understand the structure and characteristics of these subgroups. CO3 Students will see and understand the connection and transition between previously studied mathematics and more advanced mathematics.

Unit-I

Definition and examples of groups, examples of abelian and non-abelian groups, the group Zn of integers under addition modulo n and the group U(n) of units under multiplication modulo n. Cyclic groups from number systems, complex roots of unity, circle group, the general linear group GLn (n,R), groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, the permutation group Sym (n), Group of quaternions.

Unit-II

Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange's theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups.

Unit-III

Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Zn the ring of integers modulo n, ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions.

Unit-IV

Subrings and ideals, Integral domains and fields, examples of fields: Zp, Q, R, and C. Field of rational functions.

Text and Reference Books

S. No	Name	Author(S)	Publisher
1	*A First Course in Abstract Algebr*	John B. Fraleigh	Pearson
2	*Abstract Algebra*	M. Artin	Pearson
3	*Contemporary Abstract Algebra*	Joseph A Gallian	Narosa

Course Code	PHY204
Course Title	**Waves and optics Practical**
Type of course	Practical /GE
L T P	0:0:4
Credits	2
Course prerequisite	B.Sc 1st with Physics as one core subject
Course Objective (CO)	This course is designed for improving practical knowledge among the students and provides them with exposure on wave and optics related experiments.
Course outcome	CO1 Apply knowledge of thermodynamics, sound waves, and light waves to explain natural physical processes. CO2 Use an understanding of algebraic mathematics along with physical principles to effectively solve problems. CO3 Design experiments and acquire data in order to explore physical principles.

List of Experiments

1. To investigate the motion of coupled oscillators
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify λ^2 – T Law.
3. To study Lissajous Figures
4. Familiarization with Schuster`s focussing; determination of angle of prism.
5. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
6. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
7. To determine Dispersive Power of the Material of a given Prism using Mercury Light
8. To determine the value of Cauchy Constants of a material of a prism.
9. To determine the Resolving Power of a Prism.
10. To determine wavelength of sodium light using Fresnel Biprism.
11. To determine wavelength of sodium light using Newton's Rings.
12. To determine the wavelength of Laser light using Diffraction of Single Slit.
13. To determine wavelength of (1) Sodium & (2) spectrum of Mercury light using plane diffraction Grating
14. To determine the Resolving Power of a Plane Diffraction Grating.
15. To measure the intensity using photosensor and laser in diffraction patterns of single and double slits.

Text and Reference Books

S. No	Name	Author(S)	Publisher
1	*Advanced Practical Physics for students*	B.L. Flint & H.T. Worsnop	Asia Publishing House.
2	*Advanced level Physics Practicals*	Michael Nelson and Jon M. Ogborn	Heinemann Educational Publishers
3	*A Text Book of Practical Physics*	Indu Prakash and Ramakrishna	Kitab Mahal, New Delhi

Semester V

Course Code	CHM321
Course Title	Organic Chemistry-IV: Organic Biomolecules
Type of course	CR
L T P	4:0:0
Credits	4
Course prerequisite	
Course Objective (CO)	**Objectives:** This core course aims to introduce the learner to the fascinating chemistry of some biomolecules,i.e., amino acids, peptides, proteins, carbohydrates, lipids andnucleic acidsthat work within biological systems. It aims to build the concept of metabolism by the study of chemistry and energetics of biological system.
Course Outcomes	**On completion of this course, the students will be able to:** · Understand and demonstrate how structure of biomolecules determines their reactivity and biological functions. · Gain insight into concepts of heredity through the study of genetic code, replication, transcription and translation. · Demonstrate understanding of metabolic pathways, their inter-relationship, regulation and energy production from biochemical processes.

Unit I

Nucleic Acids

Components of nucleic acids, Nucleosides and nucleotides; Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; **Structure of DNA/RNA:** Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

Amino Acids, Peptides and Proteins

Amino acids, Peptides and their classification. α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, p*K*a values, isoelectric point and electrophoresis;

Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups -Solid-phase synthesis

Unit II

Enzymes

Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition).

Unit III

Carbohydrates and lipids

Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projection and conformational structures; Interconversion of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation; Disaccharides – Structure elucidation of maltose, lactose and sucrose. Polysaccharides – Elementary treatment of starch, cellulose and glycogen.

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

Unit IV

Concept of Energy in Biosystems

Cells obtain energy by the oxidation of foodstuff (organic molecules). Introduction to metabolism (catabolism, anabolism).

ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change.

Agents for transfer of electrons in biological redox systems: NAD+, FAD.

Conversion of food to energy: Outline of catabolic pathways of carbohydrate- glycolysis, fermentation, Krebs cycle. Overview of catabolic pathways of fat and protein. Interrelationship in the metabolic pathways of protein, fat and carbohydrate. Caloric value of food, standard caloric content of food types.

Reference Books:

Berg, J.M., Tymoczko, J.L. & Stryer, L. (2006) *Biochemistry*. 6th Ed. W.H. Freeman and Co.

Nelson, D.L., Cox, M.M. & Lehninger, A.L. (2009) *Principles of Biochemistry. IV Edition.* W.H. Freeman and Co.

Murray, R.K., Granner, D.K., Mayes, P.A. & Rodwell, V.W. (2009) *Harper's Illustrated Biochemistry.* XXVIII edition. Lange Medical Books/ McGraw-Hill.

Course Code	**CHM323**
Course Title	**Organic Chemistry-IV: Organic Biomolecules Practical**
Type of course	CR
L T P	0:0:4
Credits	2
Course prerequisite	
Course Objective (CO)	Able to enhance the practical knowledge of **Biomolecules**
Course outcomes	Acquire knowledge of basic tests and methods to separate,analyse biomolecules. Analyze biochemical analysis of proteins, amino acids and carbohydrates. Idetify and carry out qualitative &quantitative analysis of biomolecules in stock solutions.

List of Experiments

1. Estimation of glycine by Sorenson's formalin method.
2. Study of the titration curve of glycine.
3. Estimation of proteins by Lowry's method.
4. Study of the action of salivary amylase on starch at optimum conditions.
5. Effect of temperature on the action of salivary amylase.
6. Saponification value of an oil or a fat.
7. Determination of Iodine number of an oil/ fat.
8. Isolation and characterization of DNA from onion/ cauliflower/peas.
9. To study the acidic and basic properties of amino acids by plotting its titration curve and determine pKa values to recognize the unknown amino acid
10. Estimation of blood glucose by Glucose oxidase method
11. Study of the activity of Trypsin using fresh tissue extracts.
12. To analyse the effect of substrate concentration on the activity of enzyme
13. To study the effect of temperature on the activity of enzyme amylase
14. to study the extraction of esterase from orange peel
15. Effect of temperature, organic solvents, on semi-permeable membrane.

** Perform any 10 experiments.*

Reference Books:

Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.

Arthur, I. V. *Quantitative Organic Analysis,* Pearson.

Course Code	CHM325
Course Title	**Physical Chemistry V: Quantum chemistry and spectroscopy**
Type of course	CR
L T P	4:0:0
Credits	4
Course prerequisite	10+2 with as one core subject
Course Objective (CO)	**Objectives:** Understand the limitations of classical mechanics and the need of quantum chemistry, Familiarize them with postulates of quantum chemistry and apply the same to derive equations for various models and hydrogen atoms. Understand the basis of molecular spectroscopy and its applications.
Course outcomes	**By the end of this course, students will be able to:** · Learn about limitations of classical mechanics and solution in terms of quantum mechanics for atomic/molecular systems. · Develop an understanding of quantum mechanical operators, quantization, probability distribution, uncertainty principle and application of quantization to spectroscopy. · Interpret various types of spectra and know about their application in structure elucidation

Unit 1:

Quantum Chemistry: Heisenberg's uncertainty principle, Representation of a Particle by a Wave Packet, Wave Packets in Three Dimensions, Heisenberg's Uncertainty Principle, General Statement of the Uncertainty Principle, The Ground State Energy and the Radius of the Hydrogen Atom, Nonexistence of Electrons Inside the Nucleus. Operators, normal and orthogonal functions, Hermitian and unitary operators, Eigen value equation. Hamiltonian operator, interpretation of wave function, postulates of quantum mechanics.

Unit 2:

Schrödinger equation and its application to free particle and particle in a box (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wave functions, probability distribution functions, nodal properties, Extension to two and three dimensional, boxes, separation of variables, degeneracy. Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point energy.

Unit 3:

Molecular Spectroscopy: Interaction of electromagnetic radiation with molecules and various types of spectra; Born Oppenheimer approximation. Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution. Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, dissociation energies, fundamental frequencies, overtones, , degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies.

Unit 4

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, electronic transitions of polyenes using free electron model.

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, chemical shift and low resolution spectra, different scales (δ and T), spin-spin coupling and high resolution spectra, interpretation of PMR spectra of simple organic molecules like methanol, ethanol, acetaldehyde, acetic acid and aromatic proton.

Reference Books:

1. Banwell, C.N.; McCash, E.M.(2006), **Fundamentals of Molecular Spectroscopy**, Tata McGraw-
Hill.
2. Kapoor, K.L.(2015),**A Textbook of Physical Chemistry**, McGraw Hill Education, ,Vol 4, 5th Edition, McGraw Hill Education.
3. House, J.E.(2004), **Fundamentals of Quantum Chemistry**, 2nd Edition, Elsevier.
4. McQuarrie, D.A.(2016),**Quantum Chemistry**, Viva Books.
5. Chandra, A. K.(2001),**Introductory Quantum Chemistry**, Tata McGraw-Hill.
6. Kakkar, R. (2015),**Atomic & Molecular Spectroscopy**, Cambridge University Press.
Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press (2005).

Course Code	CHM327
Course Title	**Physical Chemistry V: Quantum chemistry and spectroscopy Practical**
Type of course	CR
L T P	0:0:4
Credits	2
Course prerequisite	10+2 with as one core subject
Course Objective (CO)	To make students understand the limitations of classical mechanics and the need of quantum chemistry, Familiarize them with postulates of quantum chemistry and apply the same to derive equations for various models and hydrogen atoms. Understand the basis of molecular spectroscopy and its applications.
Course outcomes	Learn about limitations of classical mechanics and solution in terms of quantum mechanics for atomic/molecular systems. Develop an understanding of quantum mechanical operators, quantization, probability distribution, uncertainty principle and application of quantization to spectroscopy. Interpret various types of spectra and know about their application in structure elucidation

List of Experiments:

1. To learn how to construct or draw chemical representations of molecules using chem draw and molecular modeling using HyperChem (Hyper Cube,Inc.),
2. To perform geometry optimizations (energy minimizations).

Colorimetry:

1. Verify Lambert-Beer's law and determine the concentration of CuSO4/KMnO4/K2Cr2O7 in a solution of
unknown concentration.
2. Determine the concentrations of KMnO4 and K2Cr2O7 in a mixture.
3. Study the kinetics of iodination of propanone in acidic medium.4. Determine the amount of iron present in a sample using 1, 10-phenanthroline.
5. Determine the dissociation constant of an indicator (phenolphthalein).
6. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.

Spectrophotometry:

1. Study the 200-500 nm absorbance spectra of KMnO4 and K2Cr2O7 (in 0.1 M H2SO4) and determine the λmax values. Calculate the energies of the two transitions in different units (kJ molecule-1, kJ mol-1,cm-1, eV).
2. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of K2Cr2O7.
3. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.
4. Analysis of the given vibration-rotation spectrum of HCl (g)

Suggested books/reference books:

Khosla, B.D.; Garg, V.C.; Gulati, A. (2015),**Senior Practical Physical Chemistry**, R. Chand &Co, New Delhi.
2. Kapoor, K.L. (2019),**A Textbook of Physical Chemistry**, Vol.7, 1st Edition, McGraw Hill Education.
3. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P.(2003),**Experiments in Physical Chemistry**, 8th Edition, McGraw-Hill, New York.

Course Code	CHM 329
Course Title	**Analytical Methods in Chemistry**
Type of course	DSE-I
L T P	4:0:0
Credits	4
Course prerequisite	10+2 with as one Chemistry core subject
Course Objective (CO)	The objective of this course is to make student aware of the concept of sampling, Accuracy, Precision, Statistical test data-F, Q and t test. The course exposes students to the laws of spectroscopy and selection rules governing the possible transitions in the different regions of the electromagnetic spectra. Thermal and electroanalytical methods of analysis are also dealt with. Students are exposed to important separation methods like solvent extraction and chromatography. The practicals expose students to latest instrumentation and they learn to detect analytes in a mixture.
Course Outcomes	**By the end of this course, students will be able to:** · Perform experiment with accuracy and precision. · Develop methods of analysis for different samples independently. · Test contaminated water samples. · Understand basic principle of instrument like Flame Photometer, UV-vis spectrophotometer. · Learn separation of analytes by chromatography. · Apply knowledge of geometrical isomers and keto-enol tautomers to analysis. · Determine composition of soil. · Estimate macronutrients using Flame photometry

UNIT I

Qualitative and quantitative aspects of analysis:

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

Optical methods of analysis:

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument;

Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

UNIT II

Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques.

Structural illustration through interpretation of data, Effect and importance of isotope substitution.

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.

UNIT III

Thermal methods of analysis:

Theory of thermogravimetry (TG), basic principle of instrumentation.
Techniques for quantitative estimation of Ca and Mg from their mixture.

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 IV

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 nonaqueous media.
Chromatography: Classification, principle and efficiency of the technique.
Mechanism of separation: adsorption, partition & ion exchange.
Development of chromatograms: frontal, elution and displacement methods.
Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.
Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC).
Role of computers in instrumental methods of analysis.

Reference Books:

- Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.
- Willard, H.H. *et al*.: *Instrumental Methods of Analysis*, 7th Ed. WardsworthPublishing Company, Belmont, California, USA, 1988.
- Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
- Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
- Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age InternationalPublisher, 2009.
- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*,Cengage Learning India Ed.
- Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, EllesHarwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
- Ditts, R.V. Analytical Chemistry; Methods of separation, van Nostrand, 1974.

Course Code	**CHM 331**
Course Title	**Analytical Methods in Chemistry Practical**
Type of course	DSE
L T P	0:0:4
Credits	2
Course prerequisite	10+2 with as one core subject
Course Objective (CO)	The basics of analytical chemistry, Analytical tools and techniques
Course Outcomes	**By the end of this course, students will be able to:** • Perform experiment with accuracy and precision. • Analysis for different samples of contaminated water samples. • Understand basic principle of instrument like Flame Photometer, UV-vis spectrophotometer. • Analyze different cations through chromatography. • Qualititively and Quantitatively analyze composition of soil and Estimate macronutrients using Flame photometry.

List of Experiments

I. Separation Techniques: Chromatography:

(a) Separation of mixtures

(i) Paper chromatographic separation of Fe3+, Al3+, and Cr3+.

(ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values.

(b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values.

(c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

II. Solvent Extractions:

(i) To separate a mixture of Ni2+& Fe2+

by complexation with DMG and extracting the Ni2+-

DMG complex in chloroform, and determine its concentration by spectrophotometry.

(ii) Solvent extraction of zisconium with amberliti LA-1, separation from a mixture of irons and gallium.

3. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.

4. Determination of Na, Ca, Li in cola drinks and fruit juices using fame photometric techniques.

5. **Analysis of soil:**

(i) Determination of pH of soil.

(ii) Total soluble salt

(iii) Estimation of calcium, magnesium, phosphate, nitrate

6. Ion exchange:

(i) Determination of exchange capacity of cation exchange resins and anion exchange resins.

(ii) Separation of metal ions from their binary mixture.

(iii) Separation of amino acids from organic acids by ion exchange chromatography.

III Spectrophotometry

1. Determination of pKa values of indicator using spectrophotometry.
2 Structural characterization of compounds by infrared spectroscopy.
3 Determination of dissolved oxygen in water.
4 Determination of chemical oxygen demand (COD).
5 Determination of Biological oxygen demand (BOD).
6 Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.

Reference Books:

- Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.
- Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth publishing Company, Belmont, California, USA, 1988.
- Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
- Harris, D.C. *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
- Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
- Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition.
- Mikes, O. & Chalmes, R.A. *Laboratory Handbook of Chromatographic & Allied Methods*, Elles Harwood Ltd. London.
- Ditts, R.V. *Analytical Chemistry: Methods of separation.* Van Nostrand, New York, 1974.

Course Code	**CHM 333**
Course Title	**Polymer Chemistry**
Type of course	DSE-II
L T P	4:0:0
Credits	4
Course prerequisite	10+2 with as one core subject
Course Objective (CO)	**Objectives:** The primary objective of this paper is to help the student to know about the synthesis, properties and applications of polymers.
Course Outcomes	**By the end of this course, students will be able to:** · Know about history of polymeric materials and their classification · Learn about different mechanisms of polymerization and polymerization techniques · Evaluate kinetic chain length of polymers based on their mechanism · Differentiate between polymers and copolymers · Learn about different methods of finding out average molecular weight of polymers · Differentiate between glass transition temperature (Tg) and crystalline melting point (Tm) · Determine Tg and Tm · Know about solid and solution properties of polymers · Learn properties and applications of various useful polymers in our daily life.

Unit I

Introduction and history of polymeric materials:

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers. degree of polymerization, Criteria for synthetic polymer formation, classification of polymerization processes,
Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems. process.

Unit II

Kinetics of Polymerization:

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Crystallization and crystallinity:

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

Nature and structure of polymers-Structure Property relationships.

Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

Unit III

Polymerization Chemistry

Industrial methods of polymerization such as a bulk, solution, emulsion, suspension. Stereochemistry of polymers and stereo-specific polymerization, Catalysts-their utility in polymers and stereo-specific polymerizations, Catalysts their utility in polymer manufacture, Zieglar-Natta, Metallocene and others.

Properties of Polymers (Physical, thermal, Flow & Mechanical Properties).
Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes,
Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

Unit IV

Determination of molecular weight of polymers (*Mn*, *Mw*, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index. Gel Permeation Chromatography; Application, of FTIR, UV-visible, NMR, and Mass Spectroscopy for Identification of polymers.

Reference Books:

- R.B. Seymour & C.E. Carraher: *Polymer Chemistry: An Introduction*, Marcel Dekker,Inc. New York, 1981.
- G. Odian: *Principles of Polymerization*, 4th Ed. Wiley, 2004.
- F.W. Billmeyer: *Textbook of Polymer Science*, 2nd Ed. Wiley Interscience, 1971.
- P. Ghosh: Polymer Science & Technology, Tata McGraw-Hill Education, 1991.
- R.W. Lenz: *Organic Chemistry of Synthetic High Polymers.* Interscience Publishers, New York, 1967.

Course Code	CHM335
Course Title	**Polymer Chemistry Practical**
Type of course	DSE-II(P)
L T P	0:0:4
Credits	2
Course prerequisite	10+2 with as one core subject
Course Objective (CO)	Able to understand the Behaviour of polymer and how it will uses in daily life
Course Outcomes	**On the completion of this course , students will be:** Able to synthesizes different industrially important polymers. Able to characterize and analyze physicochemical properties of polymers

List of Experiments

1.Free radical solution polymerization of any one: Styrene, methylmethacrylate, methyl acrylate, methacrylic acid (using free radical initiators). (purification of monomer should be taught)

2. Preparation of phenol-formaldehyde resins
3. Redox polymerization of acrylamide
4. Emulsion polymerization of polymethylmethacrylate.
5. Preparation of urea-formaldehyde resin
6. Preparations of novalac resin/ resold resin.
7. Microscale Emulsion Polymerization of Poly(methylacrylate).

Polymer characterization

1. Determination of molecular weight by viscometry:
(a) Polyacrylamide-aq.NaNO2 solution; (b) (Poly vinyl proplylidine (PVP) in water
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
4. Testing of mechanical properties of polymers.
5. Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques FTIR/TGA/DSC – for polymer characterization
3. IR studies of polymers
4. DSC analysis of polymers
5. Preparation of polyacrylamide and its electrophoresis

Reference Books:

- M.P. Stevens, *Polymer Chemistry: An Introduction*, 3rd Ed., Oxford University Press,1999.
- H.R. Allcock, F.W. Lampe & J.E. Mark, *Contemporary Polymer Chemistry*, 3rd ed.Prentice-Hall (2003)
- F.W. Billmeyer, *Textbook of Polymer Science*, 3rd ed. Wiley-Interscience (1984)
- J.R. Fried, *Polymer Science and Technology*, 2nd ed. Prentice-Hall (2003)
- P. Munk & T.M. Aminabhavi, *Introduction to Macromolecular Science*, 2nd ed. JohnWiley & Sons (2002)
- L. H. Sperling, *Introduction to Physical Polymer Science*, 4th ed. John Wiley & Sons(2005)

Course Code	CHM337
Course Title	**Nuclear and radiation chemistry**
Type of course	DSE
L T P	4:0:0
Credits	4
Course prerequisite	10+2 with as one core subject
Course Objective (CO)	
Course Outcomes	

Unit I

Nucleus and its classification, nuclear forces, nuclear stability, binding energy, nuclear models. Radioactive decay (Radioactive elements, general characteristics of radioactive decay, decay kinetics - decay constant, half life, mean life period), units of radioactivity, Transient and secular equilibria, Carbon dating and its usefulness.

Unit II

Nuclear reactions: Bethe notation, types of nuclear reactions (n, p, α, d and γ), conservation of quantities (mass-energy and linear momentum) in nuclear reactions, reaction cross-section, compound nucleus theory and nuclear reactions. Nuclear fission: the process, fragments, mass distribution, and fission energy.

Unit III

Measurement of radioactivity, idea about accelerator and detectors, Van de Graaaf and linear acceletors, synchrontrons, Geiger-Muller detector, Scintillaton detectors, Type of nuclear reactions, Nuclear fission, Nuclear fusion, Nuclear reactor: classification of reactors, the natural
uranium reactor, breeder reactor. Nuclear fusion and stellar energy.

Unit IV

Radiation chemistry: Elementary ideas of radiation chemistry, radiolysis of water and aqueous solutions, unit of radiation chemical yield (G-value), radiation dosimetry (Fricke's dosimeter), units of radiation energy (Rad, Gray, Rontgen, RBE, Rcm, Sievert) Nuclear pollution and Radiological safety: Interaction of radiation with matter, Radiolysis of water,Radiation dosimetry. Radioactive isotopes and their applications, Isotopic dilution analysis,Neutron activation analysis, diposal of nuclear waste, nuclear disaster and its management

Recommended Books/references:

1. Friendlander G, Kennedy G and Miller J. M. Nuclear and Radiochemistry, Wiley Interscience
2. Harvey, B. G. Introduction to Nuclear Physics & Chemistry, Prentice – Hall,
3. Overman R. T, Basic concept of Nuclear Chemistry, Chapman & Hall.
4. A. N. Nesmeyanov, Radiochemistry, MIR Publication, Moscow.
5. Spinks J. W. T. and Woods R. J. An Introduction to Radiation Chemistry, Wiley
6. Arnikar H. J., Essentials of Nuclear Chemistry, Wiley Eastern, Second Edition.

Course Code	**CHM339**
Course Title	**Nuclear and radiation chemistry Practical**
Type of course	DSE
L T P	0:0:4
Credits	2
Course prerequisite	10+2 with as one core subject
Course Objective (CO)	Able to enhance knowledge of how radiation in work in practically
Course Outcomes	

Suggested laboratory practicals:

1.The safe laboratory use of radionuclide and radioisotopes
2. demonstration of activity on Geiger-Muller and scintillation based counter.
3.liquid scintillation counting, alpha spectrometry, gamma spectrometry – to identify and quantify
radioisotopes
4. occurrence of radon daughter particles in environmental samples.
5. Liquid-liquid separation/extraction of radio nuclide from environmental samples/water samples.
6. Isotopic application in removal process adsorption / ion exchange.

Semester VI

SANT BABA BHAG SINGH
UNIVERSITY
SBBSU
KHIALA, DISTT. JALANDHAR (PUNJAB)

Course Code	CHM322
Course Title	**Inorganic Chemistry IV : Organometallic Chemistry**
Type of course	Core
L T P	4:0:0
Credits	4
Course prerequisite	Bsc. Ist, IInd year with Chemistry as core subject
Course Objective (CO)	Understand the knowledge of oxidation states of various compounds To acquire knowledge of important area of organometallic chemistry Specific organometallic compounds are studied in detail to further understand the basic concepts: metal carbonyls, metal alkyls, Zeise's salt and ferrocene. To study and apply role of organometallic compounds in catalysis
Course Outcomes	**By the end of the course, the students will be able to:** • Understand and explain the basic principles of qualitative inorganic analysis Apply 18-electron rule to rationalize the stability of metal carbonyls and related species • Understand the nature of Zeise's salt and compare its synergic effect with that of carbonyls. • Identify important structural features of the metal alkyls tetrameric methyl lithium and dimeric trialkyl aluminium and explain the concept of multicenter bonding in these compounds • Get a general idea of catalysis and describe in detail the mechanism of Wilkinson's catalyst, Zeigler- Natta catalyst and synthetic gasoline manufacture by Fischer-Tropsch process.

Unit I

Chemistry of 3d metals: Oxidation states displayed by Cr, Fe, Co, Ni and Co. A study of the following compounds (including preparation and important properties); Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.

Unit II

Organometallic Compounds

Definition and classification of organometallic compounds on the basis of bond type. Concept of
hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct

combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. pi-acceptor behaviour of CO (MO diagram of CO to be discussed),synergic effect and use of IR data to explain extent of back bonding. Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

Unit III

Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.

Catalysis by Organometallic Compounds General principles of catalysis, properties of catalysts, homogeneous and heterogeneous catalysis (catalytic steps, examples and industrial applications), deactivation and regeneration of catalysts, catalytic poison, promoter.

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinson's Catalyst)
2. Synthetic gasoline (Fischer Tropsch reaction)
3. Polymerisation of ethene using Ziegler-Natta catalyst

Unit IV

Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene. Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behaviour of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IR frequencies). Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.

Recommended books/reference books

1.Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company
1994.
2. Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry* Wiley-VCH, 1999
3. Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967

Course Code	CHM324
Course Title	**Inorganic Chemistry IV : Organometallic Chemistry Practical**
Type of course	Core
L T P	0:0:4
Credits	2
Course prerequisite	Bsc. Ist, IInd year with Chemistry as core subject
Course Objective (CO)	The course introduces some important topics of Inorganic Chemistry in a compact way. Course introduces students to the basic principles of qualitative inorganic analysis. The influence of solubility products and the common ion effect on the separation of cations is made clear. Interfering anions are identified and their removal is studied.
	Learning Outcomes: **By the end of the course, the students will be able to:** · Understand and explain the basic principles of qualitative inorganic analysis Able to synthesize and analyse various metal halides, organomettalic based complexes Able to interpret the structural properties of organomettalic complexes.

List of Experiments

Quantitative analysis:

1.Reaction of metal with halide – preparation of Grignard reagent. (only demonstration purpose)

2. Grignard preparation of dye (malachite green (using methylbenoate)/crystal violet (using diethylcarbonate) (starting material as p-bromo N, N-dimethyl aniline) (only demonstration purpose)

3. Preparation of various Schiff base-metal complexes and their identification using spectroscopy.

4. Preparation of any two of the following complexes and measurement of their conductivity measurement:

a. tetraamminecarbonatocobalt (III) nitrate

b. tetraamminecopper (II) sulphate

c. potassium trioxalatoferrate (III) trihydrate

Qualitative Analysis:

1. Qualitative semi-micro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested: CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-},SO_4^{2-} ,$S_2O_3^{2-}$, CH_3COO^- , F^- ,Cl^- , Br^- , I^- , NO_3^- , BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+ , K^+ , Pb^{2+} , Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}

2. Mixtures should preferably contain one interfering anion, or insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) or combination of anions e.g. CO_3^{2-} and SO_3^{2-}, NO_2^- and NO_3^- , Cl-and Br- , Cl- and I- , Br- and I- , NO_3^- and Br- , NO_3^- and I- . Spot tests should be done whenever possible.

Recommended books/reference books

1.Synthesis of organometallic compounds: A practical guide, S. Komiya, Wiley.
2. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall
5. Svehla, G. (1996),Vogel's Qualitative Inorganic Analysis, Prentice Hall.

Course Code	**CHM326**
Course Title	**Organic Chemistry -V: Spectroscopy and Applied Organic Chemistry**
Type of course	Core
L T P	4:0:0
Credits	4
Course prerequisite	Bsc. Ist, IInd year with Chemistry as core subject
Course Objective (CO)	The course introduces the learner to various tools and techniques for identifying and characterizing the organic compounds through their interactions with electromagnetic radiation viz. UV-Visible, IR and NMR spectroscopy. This course also deals with some classes of organic compounds finding applications in everyday life namely; polymers, dyes, and pharmaceutical compounds. The chemistry of these compounds in general will be explained through naturally occurring and synthetic compounds.
Course Outcomes	**On completion of this course, the students will be able to:** • Gain insight into the basic principles of UV, IR and NMR spectroscopic techniques. • Use spectroscopic techniques to determine structure and stereochemistry of known and unknown compounds. • Develop a sound understanding of the structure of Pharmaceutical Compounds. They will also understand the importance of different classes of drugs and their applications for treatment of various diseases. • Learn about the chemistry of natural and synthetic polymers including fabrics and rubbers. • Understand the chemistry of biodegradable and conducting polymers and appreciate the need of biodegradable polymers with emphasis on basic principles. • Learn about the theory of colour and constitution as well as the chemistry of dyeing. • Know applications of various types of dyes including those in foods and textiles.

Unit I

General principles Introduction to absorption and emission spectroscopy.

UV Spectroscopy: Types of electronic transitions, λmax, Chromophores and Auxochromes,Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λmax for the following systems: α,β-unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and

heteroannular; Extended conjugated systems (aldehydes, ketones and dienes);distinction between cis and trans isomers by UV.
IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorptionpositions of O, N and S containing functional groups; Effect of H-bonding, conjugation,resonance and ring size on IR absorptions; Fingerprint region and its significance; application of IR in functional group analysis.

Unit II

NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Equivalent and non-equivalent protons, Spin – Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds. Applications of IR, UV and NMR for identification of simple organic molecules.

Unit III

Dyes Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing. Synthesis and applications of Azo dyes – Methyl orange, Congo red; Triphenyl methane dyes-Malachite green, Rosaniline and Crystal violet; Phthalein Dyes – Phenolphthalein; Natural dyes –Structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples.
Pharmaceutical Compounds Classification, structure and therapeutic uses of antipyretics - Paracetamol (with synthesis);AnalgesicsIbuprofen (with synthesis); Antimalarials - Chloroquine (with synthesis); Antitubercular drugs - Isoniazid. An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

Unit IV

Polymers Introduction and classification including di-block, tri-block and amphiphilic polymers; weight average molecular weight, number average molecular weight, glass transition temperature (Tg) of polymers; Polymerisation reactions -Addition and condensation. Mechanism of cationic, anionic and free radical addition polymerization;
Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene); Fabrics – natural and synthetic (acrylic, polyamide, polyester). Rubbers – natural and synthetic, Buna-S, Chloroprene and Neoprene. Vulcanization - Polymer additives; Introduction to Biodegradable and conducting polymers with examples.

Recommended Books/References:

1. R.M. Silverstein, G.C. Bassler & T.C. Morrill: *Spectroscopic Identification of Organic Compounds*, John Wiley & Sons.
2.John R. Dyer, Applications of absorption spectroscopy of organic compounds, Prentice Hall India (2012).

Course Code	CHM328
Course Title	**Organic Chemistry V: Spectroscopy and applied Organic Chemistry Practical**
Type of course	Core
L T P	0:0:4
Credits	2
Course prerequisite	Bsc. Ist, IInd year with Chemistry as core subject
Course Objective (CO)	The course introduces the learner to various tools and techniques for identifying and characterizing the organic compounds through their interactions with electromagnetic radiation viz. UV-Visible, IR and NMR spectroscopy. This course also deals with synthesis and analysis of some organic compounds of everyday life such as polymers, dyes, and pharmaceutical compounds.
Course Outcomes	**By the end of the course, the students will be able to:** Prepare some simple organic compounds of industrial importance Able to analyse qualitatively and quantitatively some organic compounds such as caffeine, acrylate polymers, salicylic acid, cinnamic acid Able to characterize and interprete spectra of simle organic compounds.

List of experiments

1. Purification method for liquid, solid organic substance (distillation, recrystallization, chromatography)
2. To prepare simple organic compounds following given protocol (azodyes, acetanilides, benzoic acid, etc.)
3. Extraction of caffeine from tea leaves.
4. Preparation of sodium polyacrylate.
5. Preparation of urea formaldehyde.
6. Qualitative analysis of unknown organic compounds containing monofunctional groups (nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols, etc.
7. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).
8. Preparation of methyl orange.

Reference Books:

- Vogel, A.I. Quantitative Organic Analysis, Part 3, Pearson (2012).
- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
- Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
- Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

Course Code	**CHM330**
Course Title	**Research Methodology for Chemistry**
Type of course	DSE
L T P	5:1:0
Credits	6
Course prerequisite	10+2 with as Chemistry as core subject
Course Objective (CO)	The objective of this paper is to formulate the research problems and connect the research outcomes to the society. Student should be able to assess the local resources and opportunities in public domains. It further helps in gaining the knowledge of safety and ethical handlings of chemicals in lab and households.
	By the end of the course, the students will be able to: · Learn how to identify research problems. · Evaluate local resources and need for addressing the research problem · Find out local solution. · Know how to communicate the research findings.

UNIT I

Literature Survey:

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.

Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, SciFinder, Scopus.

UNIT II

Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information.

Methods of Scientific Research and Writing Scientific Papers:

Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation.

Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.

UNIT III

Chemical Safety and Ethical Handling of Chemicals:

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

UNIT IV

Data Analysis

The Investigative Approach: Making and Recording Measurements. SI Units and their

use.Scientific method and design of experiments.
Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests. Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, *r* and its abuse. Basic aspects of multiple linear regression analysis. Basic fundamentals of electronic circuits and their components used in circuits of common
instruments like spectrophotometers, typical circuits involving operational amplifiers for electrochemical instruments. Elementary aspects of digital electronics.

Reference Books

- Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) *Practical skills in chemistry*. 2nd Ed. Prentice-Hall, Harlow.
- Hibbert, D. B. & Gooding, J. J. (2006) *Data analysis for chemistry*. Oxford University Press.
- Topping, J. (1984) *Errors of observation and their treatment.* Fourth Ed., Chapman Hall, London.
- Harris, D. C. *Quantitative chemical analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
- Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*. Cambridge Univ. Press (2001) 487 pages.
- Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.

Course Code	CHM332
Course Title	**Industrial Chemicals and Environment**
Type of course	DSE
L T P	4:0:0
Credits	4
Course prerequisite	B.Sc I and B.Sc II year with as Chemistry as core subject
Course Objective (CO)	The objective of this course is to make students aware about the concepts of different gases and their industrial production, uses, storage and hazards. Manufacturing, applications, analysis and hazards of the Inorganic Chemicals, Preparation of Ultra-Pure metals for semiconducting technology, Air and Water pollution, control measures for Air and Water Pollutants, Catalyst and Biocatalyst, Energy and Environment.
Course Outcomes	**By the end of this course students will be able to:** · Understand the different toxic gases and their toxicity hazards · Safe design systems for large scale production of industrial gases. · Manufacturing processes, handling and storage of inorganic chemicals. · Hazardous effects of the inorganic chemicals on human beings and vegetation. · The requirement of ultra-pure metals for the semiconducting technologies · Composition of air, various air pollutants, effects and control measures of air pollutants. · Different sources of water, water quality parameters, impacts of water pollution, water treatment. · Different industrial effluents and their treatment methods. · Different sources of energy. · Generation of nuclear waste and its disposal. · Use of biocatalyst in chemical industries.

UNIT I

Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

UNIT II

Industrial Metallurgy

Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor

Environment and its segments

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.

Pollution by SO2, CO2, CO, NOx, H2S and other foul smelling gases. Methods of estimation of CO, NOx, SOx and control procedures.

Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

UNIT III

Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.
Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal.
Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

UNIT IV

Energy & Environment Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.
Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.
Biocatalysis Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

Reference Books:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
- S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
- K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
- S.E. Manahan, *Environmental Chemistry*, CRC Press (2005).
- G.T. Miller, *Environmental Science* 11th edition. Brooks/ Cole (2006).
- A. Mishra, *Environmental Studies*. Selective and Scientific Books, New Delhi (2005).

Course Code	CHM334
Course Title	**Industrial Chemicals and Environment Practical**
Type of course	DSE
L T P	0:0:4
Credits	2
Course prerequisite	B.Sc I and B.Sc II year with as Chemistry as core subject
Course Objective (CO)	The objective of this course is to make students aware about the concepts of different gases and their industrial production, uses, storage and hazards. Will Learn about manufacturing, applications, analysis and hazards of the Inorganic Chemicals, Will acquire knowledge about Air and Water pollution, control measures for Air and Water Pollutants, Catalyst and Biocatalyst, Energy and Environment.
Course Outcomes	**By the end of this course students will be able to understand:** · Analyse various physical, chemical and biological parameters of water Perform qualitative and quantitative analysis of some industrially important chemicals

List of Experiments:

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method (AgNO3 and potassium chromate).
6. Estimation of total alkalinity of water samples (CO32-, HCO3-) using double titration method.
7. Measurement of dissolved CO2.
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Reference Books:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, WileyPublishers, New Delhi.
- J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
- S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
- K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.

Course Code	CHM336
Course Title	Inorganic Materials of Industrial Importance
Type of course	DSE
L T P	4:0:0
Credits	4
Course prerequisite	B.Sc I and B.Sc II year with as Chemistry as core subject
Course Objective (CO)	The course introduces learners to the diverse roles of inorganic materials in the industry. It gives an insight into how these raw materials are converted into products used in day to day life. Students learn about silicates, fertilizers, surface coatings, batteries, engineering materials for mechanical construction as well as the emerging area of nano-sized materials. The course helps develop the interest of students in the frontier areas of inorganic and material chemistry.
Course Outcomes	**By the end of the course, the students will be able to:** · Learn the composition and applications of the different kinds of glass. · Understand glazing of ceramics and the factors affecting their porosity. · Give the composition of cement and discuss the mechanism of setting of cement. · Explain the suitability of fertilizers for different kinds of crops and soil. · Explain the process of formulation of paints and the basic principle behind the protection offered by the surface coatings. · Explain the principle, working and applications of different batteries. · List and explain the properties of engineering materials for mechanical construction used in day to day life. · Explain the synthesis and properties of nano-dimensional materials, various semiconductor and superconductor oxides.

UNIT I

Silicate Industries *Glass:* Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

UNIT II

Fertilizers: Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

Surface Coatings: Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

(UNIT III

Batteries: Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

Alloys: Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

UNIT IV

Catalysis: General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts.

Phase transfer catalysts, application of zeolites as catalysts.

Chemical explosives: Origin of explosive properties in organic compounds, preparation and explosive properties of

lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, WileyPublishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, WileyPublishers, New Delhi.
4. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
5. P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
7. Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut(1996).

Course Code	CHM338
Course Title	**Inorganic Materials of Industrial Importance Practical**
Type of course	DSE
L T P	0:0:4
Credits	2
Course prerequisite	B.Sc I and B.Sc II year with as Chemistry as core subject
Course Objective (CO)	The course introduces learners to the diverse roles of inorganic materials in the industry. It gives an insight into how these raw materials are converted into products used in day to day life. Students learn about silicates, fertilizers, surface coatings, batteries, engineering materials for mechanical construction. The course helps develop the interest of students in the frontier areas of inorganic and material chemistry.
Course Outcomes	**By the end of the course, the students will be able to:** Able to perform qualitative and quantitative analysis of industrially important chemicals. Able to analyse composition of alloy, cement and fertilizers Able to prepare industrially significant pigments.

List of Experiments:

1. Electroless metallic coatings on ceramic and plastic material.
2. Determination of composition of dolomite (by complexometric titration).
3. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.
4. Analysis of Cement.
5. Preparation of pigment (zinc oxide).
6. Detection of constituents of Ammonium Sulphate fertilizer (Ammonium and Sulphate ions) by qualitative analysis and determine its free acidity.
7. Detection of constituents of CAN fertilizer (Calcium, Ammonium and Nitrate ions) fertilizer and estimation of Calcium content.
8. Detection of constituents of Superphosphate fertilizer (Calcium and Phosphate ions) and estimation of phosphoric acid content.
9. Detection of constituents of Dolomite (Calcium, Magnesium and carbonate ions) and determination of composition of Dolomite (Complexometric titration).
10. Analysis of (Cu, Ni) in alloy or synthetic samples (Multiple methods involving Complexometry, Gravimetry and Spectrophotometry).
11. Analysis of (Cu, Zn) in alloy or synthetic samples (Multiple methods involving Iodometry, Complexometry and Potentiometry).

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley
3. Publishers, New Delhi.
4. Svehla, G.(1996),Vogel's Qualitative Inorganic Analysis, Prentice Hall. 2. Banewicz, J. J.; Kenner, C.T. Determination of Calcium and Magnesium in Limestones and Dolomites, Anal. Chem., 1952, 24 (7), 1186–1187.

Skill Enhancement Course
Semester V & VI

Course Code	**CSE345**
Course Title	**Computer Application in Chemistry**
Type of course	Skill enhancement course
L T P	2:0:0
Credits	2
Course prerequisite	Bsc. Ist, IInd year with Chemistry as core subject
Course Objective (CO)	**Objectives:** The objective of this course is to introduce the students to fundamental mathematical techniques and basic computer skills that will help them in solving chemistry problems. It aims to make the students understand the concept of uncertainty and error in experimental data. It acquaints the students with different software for data tabulation, calculation, graph plotting, data analysis and document preparation.
	Learning Outcomes: **By the end of the course, the students will be able to:** · Become familiar with the use of computers · Use software for tabulating data, plotting graphs and charts, carry out statistical analysis of the data. · Solve chemistry problems and simulate graphs. · Prepare documents that will incorporate chemical structure, chemical equations, mathematical expressions from chemistry.

Unit I:

Spreadsheet Applications Introduction of spreadsheet (MS Excel), application, formulas and functions, performing basic statistics using spreadsheet applications, creating basic graphs using spreadsheet applications,logical (Boolean) operators.

Unit II:

Internet Resources Advanced Google search operators and Boolean functions, Introduction to Google Scholar and accessing scholarly literature from Internet, Fake News and spotting the fake news, multimedia resources and podcasts, RSS/XML Feeds and feed subscription using a feed reader.

Unit III:

Bibliography management Introducing a bibliography management software (for e.g. Endnote), Styles and Templates, Changing the bibliography style as per journal format, Citing while typing in the office application, downloading citations from Google Scholar.

Unit IV:

Other software resources Introduction to advanced functions of MS Word and its Open Office substitutes including tracking changes, inserting page numbers and automatic table of contents, Google Docs and Forms, MS Power point, Microphotography and scale calibration with ImageJ, digital image processing (Paint.net or GIMP).

Suggested Readings

1. User manual and online user manual of respective soft wares for the most updated content
2. Published books are not recommended as versions keep on updating very frequently; therefore, it is not easy to follow

10.1021/ed050p626

Course Code	**CHM 345**
Course Title	**Basic Fuel Chemistry**
Type of course	Skill enhancement course
L T P	2:0:0
Credits	2
Course prerequisite	Bsc. Ist, IInd year with Chemistry as core subject
Course Objective (CO)	The course aims to provide students with a basic scientific and technical understanding of the production, behaviour and handling of hydrocarbon fuels and lubricants, including emerging alternative & renewable fuels. This will enable them to be industry ready to contribute effectively in the field of petroleum chemistry and technology.
Course Outcomes	The course covers both conventional petroleum-based fuels, and alternative & renewable fuels, including gaseous fuels. · The students will learn the chemistry that underpins petroleum fuel technology, will understand the refining processes used to produce fuels and lubricants and will know how differences in chemical composition affect properties of fuels and their usage in different applications. · The course will also cover origin of petroleum, crude oil, composition, different refining processes employed industrially to obtain different fractions of petroleum. Further, course will cover various alternative and renewable fuels like Biofuels (Different generations), Gaseous Fuels (e.g. CNG, LNG, CBG, Hydrogen etc.). · The course will also cover fuel product specifications, various test methods used to qualify different types of fuels as well characterization methods. · Review of energy scenario (Global & India), Energy sources (renewable and non-renewable). Types of Crude Oils, Composition and Properties. Crude oil assay

UNIT I

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.

Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

UNIT II

Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications.

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking),

UNIT III

Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived

from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.

UNIT IV

Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants.

Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Reference Books:

- Stocchi, E. *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK (1990).
- Jain, P.C. & Jain, M. *Engineering Chemistry* Dhanpat Rai & Sons, Delhi.

Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996).

Course Code	CHM 340
Course Title	**Basic Pharmaceutical Chemistry**
Type of course	Skill enhancement course
L T P	2:0:0
Credits	2
Course prerequisite	Bsc. Ist, IInd year with Chemistry as core subject
Course Objective (CO)	The objective of this paper is to develop basic understanding of drugs discovery, design, development and their side effects. The course will cover synthesis of major drug classes including-analgesics, antipyretics, anti- inflammatory agents, antibacterial and antifungal agents, antiviral agents, central nervous system agents and drugs for HIV--AIDS. An overview of fermentation process and production of certain dietary supplements and certain common antibiotics will be discussed
Course Outcomes	**By the end of this course, students will be able to:** · Gain insight into retro-synthesis approach in relation to drug design and drug discovery. · Learn synthetic pathways of major drug classes. · Understand the fermentation process and production of ethanol, citric acids, antibiotics and some classes of vitamins.

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Unit 1:

Introduction

Drug discovery, design and development: Sources of drugs: biological, marine, minerals and plant tissue culture, physio-chemical aspects (optical, geometric and bioisosterism) of drug molecules and biological action, drug receptor interaction, basic retro-synthetic approach for development of drug. Cause of side effect of drugs like ibuprofen, cetirizine, thalidomide. Difference between drug and poison.

Unit II Drugs and Pharmaceuticals

Study of pharmaceutical aids like talc, diatomite, kaolin, bentomite, gelatin and natural colours

Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), central nervous system agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Unit 3:

Fermentation

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

UNIT 4

1. Preparation of aspirin and its analysis.
2. Preparation of paracetamol and its analysis.
3. Preparation of sulphacetamide of sulphonamide and its analysis.
4. Determination of alcohol contents in liquid drugs/galenical.
5. Determination of ascorbic acid in vitamin C tablets by iodometric or coulometric titrations.
6. Synthesis of ibuprofen.
7. Analysis of commercial vitamin C tablets by iodometric and coulometric titrimetry.

References:

Theory:

1. Patrick, G. (2017), **Introduction to Medicinal Chemistry**, Oxford University Press.
2. Singh H.; Kapoor V.K. (1996), **Medicinal and Pharmaceutical Chemistry**, Vallabh Prakashan.
3. Foye, W.O.; Lemke, T. L.; William, D.A. (1995),**Principles of Medicinal Chemistry**, B.I. Waverly Pvt. Ltd.

Practical:

1. Kjonaas, R.A.; Williams, P.E.; Counce, D.A.; Crawley, L.R. **Synthesis of Ibuprofen**. J. Chem. Educ., 2011, 88 (6), pp 825–828 DOI: 10.1021/ed100892p.
2. Marsh, D.G.; Jacobs, D.L.; Veening, H. **Analysis of commercial vitamin C tablets by iodometric and coulometric titrimetry**. J. Chem. Educ., 1973, 50 (9), p 626.