FACULTY OF CHEMICAL SCIENCES

SYLLABUS

FOR

B.Sc. (Honours) CHEMISTRY

(SEMESTER: I-VI)

(Under Choice based Credit System)

Batch: 2021 Onwards

For

University Main Campus, Constituent Campuses and Affiliated colleges

I K GUJRAL PUNJAB TECHNICAL UNIVERSITY KAPURTHALA

Note:

(i) Subject to change in the syllabi at any time. Please visit the University website time to time.

IK Gujral Punjab Technical University

VISION

To be an institution of excellence in the domain of higher technical education that serves as the fountainhead for nurturing the future leaders of technology and techno- innovation responsible for the techno-economic, social, cultural and environmental prosperity of the people of the State of Punjab, the Nation and the World.

MISSION

To provide seamless education through the pioneering use of technology, in partnership with industry and society with a view to promote research, discovery and entrepreneurship and
To prepare its students to be responsible citizens of the world and the leaders of technology and techno-innovation of the 21st Century by developing in them the desirable knowledge, skill and attitudes base for the world of work and by instilling in them a culture for seamlessness in all facets of life.

OBJECTIVES

- To offer globally-relevant, industry-linked, research-focused, technology- enabled seamless education at the graduate, postgraduate and research levels in various areas of engineering & technology and applied sciences keeping in mind that the manpower so spawned is excellent in quality, is relevant to the global technological needs, is motivated to give its best and is committed to the growth of the Nation;
- To foster the creation of new and relevant technologies and to transfer them to industry for effective utilization;
- To participate in the planning and solving of engineering and managerial problems of relevance to global industry and to society at large by conducting basic and applied research in the areas of technologies. To develop and conduct continuing education programmes for practicing engineers and managers with a view to update their fundamental knowledge base and problem-solving capabilities in the various areas of core competence of the University;

- To develop strong collaborative and cooperative links with private and public sector industries and government user departments through various avenues such as undertaking of consultancy projects, conducting of collaborative applied research projects, manpower development programmes in cutting-edge areas of technology, etc;
- To develop comprehensive linkages with premier academic and research institutions within the country and abroad for mutual benefit;
- To provide leadership in laboratory planning and in the development of instructional resource material in the conventional as well as in the audio- visual, the video and computer-based modes;
- To develop programmes for faculty growth and development both for its own faculty as well as for the faculty of other engineering and technology institutions;
- To anticipate the global technological needs and to plan and prepare to cater to them;
- To interact and participate with the community/society at large with a view to inculcate in them a feel for scientific and technological thought and endeavour; and
- To actively participate in the technological development of the State of Punjab through the undertaking of community development programmes including training and education programmes catering to the needs of the unorganized sector as well as that of the economically and socially weaker sections of society.

ACADEMIC PHILOSOPHY

The philosophy of the education to be imparted at the University is to awaken the "**deepest potential**" of its students as holistic human beings by nurturing qualities of self-confidence, courage, integrity, maturity, versatility of mind as well as a capacity to face the challenges of tomorrow so as to enable them to serve humanity and its highest values in the best possible way.

Department of Chemical Sciences

VISION

The Chemical Sciences at IKGPTU campus will address the challenging and important questions in the physical and life sciences of current era using its multi-disciplinary vision, its culture of synergistic collaboration and translational science, and its excellence in the physical, medical and engineering sciences. Chemical Sciences Department continues to explore the new fields and frontiers and, with them, fundamentally new and innovative ways to address the increasingly complex scientific, health, energy and environmental problems of our time.

MISSION

- Inspiring and educating undergraduate students in chemistry and molecular-driven sciences in the core concepts of chemistry and the scientific methodology.
- To explore the new frontier area of organometallic catalysis in synthetic chemistry.
- Developing more-economic and greener strategies for chemical synthesis and production
- Understanding how molecules and materials behave, interact and transform at macroscopic, molecular, atomic and electronic levels, and exploring the contribution of geometric and electronic structure to function.
- Informing the public about the excitement of science, its impact on everyday life, and the crucial role it plays in human health, energy and environmental stewardship
- Building centralized, state-of-the-science facilities designed to promote collaborative synergies among faculty, staff and students and across disciplinary boundaries.
- Sharing the excitement of new chemical knowledge across IKGPTU and to other institutions, educators, and the global community through scientific communications and outreach.

TITLE OF THE PROGRAM: B.Sc. (Honours) CHEMISTRY

YEAR OF IMPLIMENTATION: New Syllabus will be implemented from June 2019 onwards.

DURATION: The course shall be three years, with semester system (6 semesters, with two semesters in a year). The Choice based credit system will be applicable to all the semesters.

ELGIBILITY FOR ADMISSION: Candidates with 50% marks (5% relaxation for SC/ST) in aggregate in 10+2 in any science subject or any other examination recognized equivalent thereto.

INTAKE CAPACITY: 45 (Forty five)

MEDIUM OF INSTRUCTION: English.

PROGRAM EDUCATIONAL OBJECTIVES:

The Program Educational Objectives (PEOs) of the B.Sc. (Honours) Chemistry Program indicate expectations from our graduates a few years after graduation

PEO1	Apply scientific knowledge of chemical sciences and its allied sciences and maturity of experience to lead in the solution of complex problems in chemical Sciences
PEO2	Become a technically qualified chemist to address complex problems and be able to apply learned skills in chemical world.
PEO3	Maintain and enhance professional competence by acquiring new knowledge and refining skills
PEO4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PEO5	Apply reasoning using scientific knowledge to assess health, safety, legal and cultural issues of society.
PEO6	Fulfill the needs of society in solving technical problems using chemistry techniques, principles, tools and practices, in an ethical and responsible manner.

PROGRAM OUTCOMES: At the end of the program, the student will be able to:

PO1	Describe and apply the basic principles of chemistry and to carry out practical techniques important in chemical analysis.
PO2	Create and evaluate hypotheses, theories, methods and evidence within their proper contexts. Solve complex problems by critical understanding, analysis and synthesis
PO3	Develop proficiency in the analysis of complex chemistry problems and the use of allied fields or other appropriate techniques to solve them.
PO4	Be familiarised with the emerging areas of Chemistry and their applications in various spheres of Chemical sciences and to apprise the students of its relevance in future studies.
PO5	Engage in lifelong learning and adapt to changing professional and societal needs.
PO6	Communicate effectively scientific information both in written and oral formats.

PROGRAM SPECIFIC OUTCOMES:

At the end of the program,

PSO1	Students will have an ability to identify, formulate, and solve complex chemical problems by applying principles of chemistry, science, and mathematics
PSO2	The students will acquire in-depth knowledge to understand the role of chemistry in society and critically interpret the chemical literature.
PSO3	Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to problems related to chemical sciences.
PSO4	Students will be able to address social, economic, and environmental issues.
PSO5	Students will be able to learn and analyze the various principles using various scientific experiments.
PSO6	Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
PSO7	Students will have an ability to communicate effectively with a range of audiences in writing and orally.

SCHEME OF THE PROGRAM:

Semester-I

Sr. No	Code	Theory Papers	Hours	L-T-P	Credits	Marks Distribution		Marks
						Internal	External	
1.	BHCL101-19	Inorganic Chemistry-I	45	3-1-0	4	40	60	100
2.	BHCL102-19	Organic Chemistry-I	45	3-1-0	4	40	60	100
3.	UC-BSHP-112-19	Electricity and Magnetism	45	3-1-0	4	40	60	100
4.	UC-BSHM-104-19	Maths-I (Calculus-I)	45	3-1-0	4	40	60	100
5.	BHHL105-19	Communicative English-I	30	2-0-0	2	20	30	50
6.	BHHL106A-19 BHHL106B-19	Punjabi Compulsory-I OR Mudhli Punjabi-I	30	2-0-0	2	20	30	50
7.	BHCP107-19	Inorganic Chemistry Lab-I	40	0-0-4	2	30	20	50
8.	BHCP108-19	Organic Chemistry Lab-I	40	0-0-4	2	30	20	50
9	UC-BSHP-113-19	Physics Lab-I	40	0-0-4	2	30	20	50
		Total		**16-4-12**	**26**			**650**

Semester-II

Sr. No	Code	Theory Papers	Hours	L-T-P	Credits	Marks Distribution		Marks
						Internal	External	
1.	BHCL111-19	Inorganic Chemistry-II	45	3-1-0	4	40	60	100
2.	BHCL112-19	Physical Chemistry-I	45	3-1-0	4	40	60	100
3.	UC-BSHP-124-19	Waves and Vibrations	45	3-1-0	4	40	60	100
4.	UC-BSHM-204-19	Vector Algebra & Vector Analysis	45	3-1-0	4	40	60	100
5.	BHHL115-19	Communicative English-II	30	2-0-0	2	20	30	50
6.	BHHL116A-19 BHHL116B-19	Punjabi Compulsory-II OR Mudhli Punjabi-II	30	2-0-0	2	20	30	50
7.	BHCP117-19	Inorganic Chemistry Lab-II	40	0-0-4	2	30	20	50
8.	BHCP118-19	Physical Chemistry Lab-I	40	0-0-4	2	30	20	50
9	UC-BSHP-125--19	Physics Lab-II	40	0-0-4	2	30	20	50
		Total		**16-4-10**	**26**			**650**

Semester-III								
Sr. No	**Code**	**Theory Papers**	**Hours**	**L-T-P**	**Credits**	**Marks Distribution**		**Marks**
						Internal	External	
1.	BHCL201-19	Organic Chemistry-II (Chemistry of Functional Groups-II)	45	3-1-0	4	40	60	100
2.	BHCL202-19	Physical Chemistry-II (Chemical Thermodynamics)	45	3-1-0	4	40	60	100
3.	BHCL203-19	Spectroscopy	45	3-1-0	4	40	60	100
4.	UC-BSHP-214-19	Physics-III (Elements of Modern Physics)	45	3-1-0	4	40	60	100
5.	BHCL205-19	Environmental Science	30	2-0-0	2	20	30	50
6.	BHCP206-19	Organic Chemistry Lab-II (Functional group Transformations and their Identifications)	40	0-0-4	2	30	20	50
7.	BHCP207-19	Physical Chemistry Lab-II	40	0-0-4	2	30	20	50
8.	UC-BSHP-215-19	Physics Lab-III (Elements of modern physics lab)	40	0-0-4	2	30	20	50
		Total		**14-4-12**	**24**			**600**

Semester-IV								
Sr. No	**Code**	**Theory Papers**	**Hours**	**L-T-P**	**Credits**	**Marks Distribution**		**Marks**
						Internal	External	
1.	BHCL211-19	Inorganic Chemistry-III (Crystal field theory and transition elements)	45	3-1-0	4	40	60	100
2.	BHCL212-19	Physical Chemistry-III (Phase Equilibria and Chemical Kinetics)	45	3-1-0	4	40	60	100
3.	BHCL2XX-19	Discipline Specific Elective -I	45	3-1-0	4	40	60	100
4.	UC-BSHM-408-19	Maths-III (Matrices & Ordinary differential equations)	45	3-1-0	4	40	60	100
5.	BHCL216-19	Basic Analytical Chemistry	30	2-0-0	2	20	30	50
6.	BHCP217-19	Inorganic Chemistry Lab-III	40	0-0-4	2	30	20	50
7.	BHCP218-19	Physical Chemistry Lab-III	40	0-0-4	2	30	20	50
8.	BHCP219-19	Basic Analytical Chemistry Lab	40	0-0-4	2	30	20	50
		Total		**14-4-12**	**24**			**600**

Discipline Specific Elective-I								
Sr. No	**Code**	**Theory Papers**	**Hours**	**L-T-P**	**Credits**	**Marks Distribution**		**Marks**
						Internal	External	
1	BHCL213-19	Green Chemistry	45	3-1-0	4	40	60	100
2	BHCL214-19	Polymer Chemistry	45	3-1-0	4	40	60	100

Semester-V								
Sr. No	**Code**	**Theory Papers**	**Hours**	**L-T-P**	**Credits**	**Marks Distribution**		**Marks**
						Internal	External	
1.	BHCL301-19	Inorganic Chemistry-IV (Organometallic Chemistry)	45	3-1-0	4	40	60	100
2.	BHCL302-19	Organic Chemistry-III (Heterocyclic Chemistry)	45	3-1-0	4	40	60	100
3.	BHCL303-19	Quantum Chemistry	45	3-1-0	4	40	60	100
4.	BHCL3XX-19	Discipline Specific Elective-II	45	3-1-0	4	40	60	100
5.	BHCL306-19	Ligand Field Theory	45	3-1-0	4	40	60	100
6.	BHCP307-19	Inorganic Chemistry Lab-IV	40	0-0-4	2	30	20	50
7.	BHCP308-19	Organic Chemistry Lab-III	40	0-0-4	2	30	20	50
		Total		**15-5-8**	**24**			**600**

Discipline Specific Elective-II								
Sr. No	**Code**	**Theory Papers**	**Hours**	**L-T-P**	**Credits**	**Marks Distribution**		**Marks**
						Internal	External	
1	BHCL304-19	Analytical Clinical Biochemistry	45	3-1-0	4	40	60	100
2	BHCL305-19	Industrial Chemicals and Environment	45	3-1-0	4	40	60	100

Semester-VI								
Sr. No	**Code**	**Theory Papers**	**Hours**	**L-T-P**	**Credits**	**Marks Distribution**		**Marks**
						Internal	External	
1.	BHCL311-19	Organic Chemistry-IV (Natural Products and Biochemistry)	45	3-1-0	4	40	60	100
2.	BHCL312-19	Physical Chemistry-IV (Electrochemistry)	45	3-1-0	4	40	60	100
3.	BHCL3XX-19	Discipline Specific Elective-III	45	3-1-0	4	40	60	100
4.	BHCL3XX-19	Discipline Specific Elective-IV	45	3-1-0	4	40	60	100
5.	BHCP318-19	Organic Chemistry Lab-IV	40	0-0-4	2	30	20	50
6.	BHCP319-19	Physical Chemistry Lab-IV	40	0-0-4	2	30	20	50
		Total		**12-4-8**	**20**			**500**

Discipline Specific Elective-III & IV								
Sr. No	**Code**	**Theory Papers**	**Hours**	**L-T-P**	**Credits**	**Marks Distribution**		**Marks**
						Internal	External	
1	BHCL313-19	Catalysis	45	3-1-0	4	40	60	100
2	BHCL314-19	Analytical Methods in Chemistry	45	3-1-0	4	40	60	100
3	BHCL315-19	Nanochemistry	45	3-1-0	4	40	60	100
4	BHCL316-19	Molecular Modelling and Drug Design	45	3-1-0	4	40	60	100

EXAMINATION AND EVALUATION

THEORY					
S.No.			Weightage in Marks		Remarks
1	Internal Evaluation	Mid-Semester Examination	30	10	MSTs, Quizzes, assignments, attendance, etc. Constitute internal evaluation. Best of two mid-semester exams will be considered for evaluation
2		Attendance	5	5	
3		Assignments	5	5	
4	External Evaluation	End-Semester Examination	60	30	Conduct and checking of the answer sheets will be at the university level.
	Total		**100**	**50**	
PRACTICAL					
1	Internal Evaluation	Daily evaluation of practical performance/ record/ viva voce	15		
2		Attendance	5		
3		Internal Practical Examination	10		
4	External Evaluation	Final Practical Examination	20		
		Total	**50**		

PATTERN OF END-SEMESTER EXAMINATION

I. **Part A** will be One Compulsory question consisting of short answer type questions [Q No. 1(a-h)] covering whole syllabus. There will be no choice in this question. It will be of 16 marks comprising of **8 questions of 2 marks each**.

II. **Part B** will be comprising of eight questions [2-9]. Student will have to attempt any six questions from this part. It will be of 24 marks with **6 questions of 4 marks each**.

III. **Part C** will be comprising of two compulsory questions with internal choice in both these questions [10-11]. It will be of 20 marks with **2 questions of 10 marks each**.

SYLLABUS OF THE PROGRAM

The syllabus has been upgraded as per provision of the UGC module and demand of the academic environment. The contents of the syllabus have been duly arranged unit wise and included in such a manner so that due importance is given to requisite intellectual and laboratory skills. The application part of the respective contents has been appropriately emphasized.

SEMESTER-I

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL101-19**			
Subject Title:	**INORGANIC CHEMISTRY-I**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	To teach the fundamental concepts of Inorganic Chemistry and their applications.			

Details of the Course (Atomic Structure and Chemical Bonding)

Unit	Contents	Contact Hours
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.	10
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 & 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.	11

III	**Chemical Bonding I:** (a) Properties of ionic substances, Occurrence of ionic bonding, The radius ratio rules, Efficiency of packing, Hexagonal close packing, Cubic close packing, Structures of different crystal lattices, Sodium chloride, Cesium chloride, Wurtzite, Zinc blende, Fluorite, Rutile, Cristobalite, Nickel arsenide, Pervoskite, Rhenium oxide, Calcium carbide, The calcite and aragonite structures. (b) Lattice energy, Born-Haber cycle, The calculations of the lattice energy on the basis of Born- Lande equation, The predictive power of thermochemical calculations on ionic compounds, Covalent character in predominantly ionic compounds, Imperfections of crystals, Conductivity in ionic solids, Band theory, Intrinsic and photoexcited semiconductors, Transistors, High temperature superconductors.	12
IV	**Chemical Bonding II:** The Lewis theory, Valence bond theory - A mathematical approach, Resonance, Valence Shell Electron Pair Repulsion Model (VSEPR theory), Prediction of structures and variation of bond angles on the basis of VSEPR theory, Shortcomings of VSEPR theory, Concept of hybridization, Rules for obtaining hybrid orbitals, Extent of d-orbital participation in molecular bonding (SO_2, PCl_5, SO_3), Molecular orbital theory (LCAO method), Symmetry of molecular orbitals, Applications of MOT to homo- and hetero-nuclear diatomic molecules, Molecular orbital energy level diagrams (Be_2, N_2, O_2, F_2, LiH, NO, CO, HCl, NO_2, BeH_2, NO_2^-).	12

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	Lee, J.D.	Concise Inorganic Chemistry	ELBS, 1991.
2	Douglas, B.E. and Mc Daniel, D.H.	Concepts & Models of Inorganic Chemistry	Oxford, 1970
3	Atkins, P.W. & Paula	J. Physical Chemistry	Oxford Press, 2006
4	Day, M.C. and Selbin, J.	Theoretical Inorganic Chemistry	ACS Publications 1962

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand the fundamental concepts and postulates of various theories regarding the structure of atom

CO2. Learn the periodicity of the s & p block elements

CO3. Understand the various types of bonding present in the different inorganic compounds.

CO4. Learn about the various theories pertaining to the different types of bonding

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	2	2	3	3	2	3
CO2	2	1	2	3	2	3	3
CO3	1	2	2	2	3	3	2
CO4	0	2	1	3	2	2	2

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL102-19**			
Subject Title:	**ORGANIC CHEMISTRY-I**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	1. To teach the basic principles, reaction mechanisms and stereochemistry of organic compounds. 2. To impart knowledge regarding physical properties and chemical reactions of alkanes, alkenes, dienes, alkynes, arenes, alkyl and aryl halides etc. 3. To predict and account for the most commonly encountered reaction mechanisms (substitution, addition and elimination) in organic chemistry.			

Details of the Course

Unit	Contents	Contact Hours
I	**Structure and Bonding** Hybridization, bond lengths, bond angles, bond energy, localized and delocalized chemical bond, van der Waals interactions, inclusion compounds, clatherates, charge transfer complexes, resonance, hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding. **Mechanism of Organic Reactions** Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, homolytic and heterolytic bond breaking, Types of reagents-electrophiles and nucleophiles, Types of organic reactions, Energy considerations, Reactive intermediates (carbocations, carbanions, free radicals, carbenes, arynes and nitrenes), Assigning formal charges on intermediates and other ionic species. **Stereochemistry of Organic Compounds I** Isomerism and its types, Optical isomerism-elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogeric centers, diastereomers, threo and erythro, diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature.	12
II	**Stereochemistry of Organic Compounds II** Geometric isomerism-determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds, Conformational isomerism-conformational analysis of ethane and n-butane, conformational analysis of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivative, Newman projection and Sawhorse formulae, Fischer and flying wedge formulae, Difference between configuration and conformation. **Alkanes** Introduction, IUPAC nomenclature, Isomerism and classification of carbon atoms of alkanes, Sources, methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids), Physical properties and chemical reactions of alkanes, Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity. **Cycloalkanes** Cycloalkanes-nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring; banana bonds	13

III	**Alkenes, Cycloalkenes, Dienes and Alkynes** *Alkenes* Nomenclature, methods of synthesis (mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. Saytzeff rule, Hofmann elimination), physical properties and relative stabilities of alkenes. Chemical reactions of alkenes - mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikiff's rule, hydroboration-oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$, Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethylene and propene. *Cycloalkenes* Methods of formation, conformation and Chemical reactions of cycloalkenes. *Dienes* Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions – 1, 2 and 1,4 addition, Diels-Alder reaction. *Alkynes* Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration oxidation, metal-ammonia reductions, oxidation and polymerization.	10
IV	**Alkyl and Aryl Halides** Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanisms of nuclephilic substitution reactions of alkyl halides, SN2 and SN1 reactions with energy profile diagrams. Polyhalogen compounds: chloroform, carbon tetrachloride. Methods of formation of aryl halides, nuclear and side chain reactions. The addition elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions. Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides. Synthesis and uses of DDT and BHC. **Arenes and Aromaticity** Nomenclature of benzene derivatives. The aryl group. Aromatic nucleus and side chain. Structure of benzene: Molecular formula and Kekule structure. Stability and carbon-carbonbond lengths of benzene, resonance structure, MO picture. Aromaticity: The Huckel rule, aromatic ions, Aromatic electrophilic substitution -general pattern of mechanism, role of sigma and pi complexes. Machansim of nitration, halogenation, sulponation, mercuration and Friedel-Crafts reaction. Energy profie diagrams. Activating and deactivating substituents, orientation and ortho/para	10

	ratio. Side chain reactions of benzene derivations. Birch reduction. Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl.	

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	R. T. Morrison and P. S. Boyd	Organic Chemistry, 5th Edition	Allyn and Bacon Inc., Boston, 1992
2	S. M. Mukerji, S. P. Singh and R. P. Kapoor	Organic Chemistry Vol. I/II	Wiley Eastern Ltd., New Delhi, 1985
3	F. A. Carey	Organic Chemistry	McGraw-Hill, Inc, 2003
4	G. Solomons	Fundamentals of Organic Chemistry	John Wiley, 2002
5	Jerry March	Organic Reaction Mechanism	John Wiley Ed. 5, 2002
6	L. G. Jr. Wade	Organic Chemistry	Prentice-Hall,1990
7	T. L. Gilchrist and C.W. Rees	Carbenes, Nitrenes and Arynes	Thomas Nelson and Sons Ltd., London

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand the fundamental concepts of organic chemistry i.e structure, bonding and various effects in organic compounds.

CO2. To learn the stereochemistry viz. optical isomerism, stereoisomerism and conformational isomerism of organic compounds.

CO3. To study the various known reactive intermediate in organic synthesis

CO4. To learn the fundamental and advanced concepts of reaction mechanisms along with the study of reaction mechanisms in various types of substitution addition and elimination reactions.

CO5. To predict the relationships between organic chemical structures and their reactivity.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	4	3	3	-	3	1	2
CO2	3	-	3	1	3	2	1
CO3	4	2	1	-	4	4	-
CO4	4	4	4	-	4	3	-
CO5	4	3	4	-	4	-	-

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY DEPARTMENT OF CHEMICAL SCIENCES				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**UC-BSHP-112-19**			
Subject Title:	**ELECTRICITY AND MAGNETISM**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	The objective of the course is to expose the students to the formal structure of electricity and magnetism so that they can use these as per their requirement.			

Details of the Course

Unit	Contents	Contact Hours
I	**Review of Vector Analysis:** Vector algebra, scalar and vector product; Concept of Fields; scalar and vector field; gradient, divergence and curl and their physical significance; Conservative field, Line, surface and volume integral of a vector field, Gauss-divergence theorem and Stoke's theorem.	10
II	**Electrostatics:** Electrostatic field; electric flux; Gauss's law in differential and integral form; Applications of Gauss law-Electric filed due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charge sheet; Electric potential	13

	as line integral of electric field, potential due to point charge and electric dipole; calculation of electric field from potential; Poisson's equation and Laplace's equation(Cartesian coordinate); Capacitance; capacitance of a spherical conductor and cylindrical capacitor, Energy per unit volume in electrostatic field, Dielectric medium, dielectric polarization and its types, Displacement vector, Boundary conditions.	
III	**Magnetostatics:** Magnetic flux; magnetic flux density; Faraday's law; magnetomotive force; Biot-Savart's law and its applications-straight conductor, circular coil, divergence and curl of magnetic field; Ampere's Circuital law in differential and integral form; Magnetic vector potential; ampere's force law; magnetic vector potential; Energy stored in a magnetic field, boundary conditions on magnetic fields.	12
IV	**Maxwell's Equations and Electromagnetic Waves:** Equation of continuity for time varying fields; Inconsistency of ampere's law; concept of sinusoidal time variations (Phasor notation); Maxwell's equations in differential and integral form, physical significance; Maxwell equations in free space, static field and in Phasor notation; Difference between displacement current and conduction current; Wave equation in free space and in homogenous medium, Concept of Poynting vector; Poynting Theorem.	11

Reference Books

1. David Griffiths, Introduction to Electrodynamics, Pearson Education India Learning Private Limited; 4th Edition.
2. E.C. Jordan and K.G. Balmain, Electromagnetic waves and radiating systems, Prentice Hall.
3. Kraus John D, Electromagnetics, McGraw-Hill Publisher
4. W. Saslow, Electricity, magnetism and light, Academic Press
5. A Textbook of Electricity and Magnetism, S K Sharma, Shalini Sharma, S Dinesh & Co.
6. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014.

Course Outcomes and Mapping

At the end of the course, the student will be able to	
CO1	Understand and describe the different concepts of electromagnetism
CO2	To obtain the electric and magnetic fields for simple configurations under static conditions.
CO3	To analyse time varying electric and magnetic fields.
CO4	To understand Maxwell's equation in different forms and different media.
CO5	have a solid foundation in fundamentals required to solve problems and also to pursue higher studies.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	1	2	2	2	1	2
CO2	3	2	1	-	2	2	1
CO3	3	2	3	-	2	1	2
CO4	3	2	3	2	-	2	2
CO5	2	2	3	2	-	2	2

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**UC-BSHM-104-19**			
Subject Title:	**CALCULUS-I**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	1. The fundamental concepts of differential and integral calculus. 2. The geometrical meaning of functions, limits, continuity, derivatives, mean value theorems. 3. Applications of derivatives and integrals. 4. Limit, Continuity, partial derivatives and their applications in finding extreme values. 5. The utility of double and triple integrals in finding area and volume bounded by surfaces.			

Details of the Course

Unit	Contents
I	Functions of single variable, Simple examples of limit, continuity, differentiability, Derivative of elementary functions (t-ratios, logarithmic functions, exponential functions), Higher order derivatives, Statement of Mean value theorems and simple applications, Applications of derivative: increasing decreasing functions, extreme values of functions. (**Ref. 1**)
II	Integration as an inverse process of differentiation, Finding integrals by partial fractions, by parts, Statement of fundamental theorem of calculus, Finding definite integrals by method of substitution, Applications of definite integral in finding length of an arc, area under simple curves, area enclosed between two curves. (**Ref. 1**)
III	Introduction of Limit, continuity of functions of two variables with simple examples, partial derivatives, Total derivatives, Homogeneous functions, Statement of Euler's theorem, Simple examples of maxima-minima of functions of several variables, Lagrange's method of multipliers.
IV	Double integrals, Change of order of integration, Jacobian, Double integral in polar coordinates, Triple integrals, Simple applications in finding area and volumes.

Reference Books

1. Mathematics, A Text book for Class XII (Parts I & II), New Delhi: NCERT, 2003. (Unit I & II)
2. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Pub., 4th Edition, 2015.
3. James Stewart, Calculus, 5th Edition, Brooks/Cole (Thomson), 2003.

Course Outcomes and Mapping

At the end of the course, the student will be

CO1. Understand the basic concepts of Differential and Integral Calculus.

CO2. Visualize all concepts geometrically.

CO3. Apply the knowledge of derivatives in finding extreme values of the function and definite integrals to find area under the curve.

CO4. Explain the concept of Limit, Continuity, partial derivatives of functions of severable variables and their applications.

CO5. Utilize the concept of multiple integrals in finding areas and volumes of different geometrical shapes.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	-	3	2	3	2	-
CO2	3	1	3	2	-	-	-
CO3	1	1	3	1	2	1	-
CO4	3	3	3	1	2	1	-
CO5	3	3	3	1	2	1	-

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHHL105-19**			
Subject Title:	**COMMUNICATIVE ENGLISH-I**			
Contact Hours:	**L:2**	**T:0**	**P:0**	**Credits:2**
Examination Duration (hours)	**2**			
Objective(s):	1. To help the students become proficient in LSRW-Listening, Speaking, Reading & Writing skills. 2. To help the students become the independent users of English language. 3. To develop in them vital communication skills, integral to their personal, social and professional interactions. 4. To teach them the appropriate language of professional communication.			

Details of the Course

Unit	Contents	Contact Hours
I	**(A)** ***The Poetic Palette*** **(Orient Black Swan, Second Edition, 2016)** The following poems from this anthology are prescribed: 1. Pippa's Song: Robert Browning 2. Apparently With No Surprise: Emily Dickinson **3.** Fool and Flea: Jeet Thayil **(B)** ***Prose Parables*** **(Orient Black Swan, 2013)** The following stories from the above volume are prescribed: a. The Kabuliwallah : Rabindranath Tagore b. The Eyes Are Not Here: Ruskin Bond c. Grief: Anton Chekov	10
II	**Vocabulary: Word Formation Processes;** Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives; Synonyms, antonyms **Grammar:** Subject-verb agreement; Noun-pronoun agreement; Misplaced modifiers; Articles; Determiners; Modals; Prepositions	06
III	**Reading and Understanding** Close Reading; Comprehension	04
IV	**Mechanics of Writing & Speaking Skills** Essay Writing (Descriptive/Narrative/Argumentative); Business letters; Précis Writing; Self Introductions; Group Discussion	10

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	John Eastwood	Oxford Practice Grammar	Oxford University Press, 2014
2	Michael Swan	Practical English Usage.	OUP. 1995.
3	F.T. Wood	Remedial English Grammar	Macmillan.2007
4	William Zinsser	On Writing Well	Harper Resource Book. 2001
5	Sanjay Kumar and Pushp Lata	Communication Skills	Oxford University Press. 2011
6	Liz Hamp-Lyons and Ben Heasly	Study Writing	Cambridge University Press. 2006.

Course Outcomes and Mapping

At the end of the course,

CO1. Students will acquire basic proficiency in reading &listening, writing and speaking skills.

CO2. Students will be able to understand spoken and written English language, particularly the language of their chosen technical field.

CO3. They will be able to converse fluently and produce on their own clear and coherent texts.

CO4. Students will become proficient in professional communication such as interviews, group discussions, office environments, important reading skills as well as writing skills

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	2	2	3	2	2	2
CO2	3	3	2	3	2	3	3
CO3	2	3	3	2	2	3	3
CO4	2	2	3	3	3	2	3
CO5	2	1	1	3	1	1	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHHL106A-19**			
Subject Title:	**PUNJABI COMPULSORY-I (ਪੰਜਾਬੀ ਲਾਜ਼ਮੀ-I)**			
Contact Hours:	**L:2**	**T:0**	**P:0**	**Credits:2**
Examination Duration (hours)	**2**			
Objective(s):	1. To enhance the language ability of students. 2. To enhance the ability of Learning science and developing science literacy through local language teaching with science subjects.			

Details of the Course

Unit	Contents	Contact Hours
I	**ਕਵਿਤਾ ਭਾਗ:** ਭਾਈ ਵੀਰ ਸਿੰਘ: ਸਮਾਂ, ਚਸ਼ਮਾ ਪ੍ਰੋ. ਪੂਰਨ ਸਿੰਘ : ਪੰਜਾਬ ਨੂੰ ਕੂਕਾਂ ਮੈਂ, ਹੱਲ ਵਾਹੁਣ ਵਾਲੇ ਪ੍ਰੋ.ਮੋਹਨ ਸਿੰਘ : ਮਾਂ, ਕੋਈ ਆਇਆ ਸਾਡੇ ਵਿਹੜੇ, ਪਿਆਰ ਪੰਧ ਅੰਮ੍ਰਿਤਾ ਪ੍ਰੀਤਮ: ਆਖਾਂ ਵਾਰਿਸ ਸ਼ਾਹ ਨੂੰ, ਅੰਨਦਾਤਾ	8
II	**ਕਹਾਣੀ ਭਾਗ:** ਸੰਤ ਸਿੰਘ ਸੇਖੋਂ : ਪੇਮੀ ਦੇ ਨਿਆਣੇ ਸੁਜਾਨ ਸਿੰਘ : ਕੁਲਫੀ ਕੁਲਵੰਤ ਸਿੰਘ ਵਿਰਕ : ਤੂੜੀ ਦੀ ਪੰਡ ਗੁਰਦਿਆਲ ਸਿੰਘ : ਸਾਂਝ	8
III	ਭਾਸ਼ਾ ਦਾ ਟਕਸਾਲੀ ਰੂਪ, ਭਾਸ਼ਾ ਤੇ ਉਪ-ਭਾਸ਼ਾ ਵਿਚ ਅੰਤਰ, ਪੰਜਾਬੀ ਦੀਆਂ ਉਪ-ਭਾਸ਼ਾਵਾਂ,ਪੰਜਾਬੀ ਭਾਸ਼ਾ:ਨਿਕਾਸ ਤੇ ਵਿਕਾਸ। ਭਾਸ਼ਾ ਤੇ ਲਿਪੀ, ਗੁਰਮੁਖੀ ਲਿਪੀ ਦੀਆਂ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ, ਗੁਰਮੁਖੀ ਲਿਪੀ: ਨਿਕਾਸ ਤੇ ਵਿਕਾਸ।	8
IV	ਸੰਖੇਪ ਰਚਨਾ (ਪ੍ਰੈਸੀ) ਪੈਰ੍ਹਾ ਰਚਨਾ ਸਰਲ ਅੰਗਰੇਜ਼ੀ ਪੈਰ੍ਹੇ ਦਾ ਪੰਜਾਬੀ ਅਨੁਵਾਦ	6

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	ਸੰਪ.ਡਾ.ਮਹਿਲ ਸਿੰਘ	ਸਾਹਿਤ ਦੇ ਰੰਗ	ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ,2016.

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Translate and transfer/broadcast the western scientific knowledge in the local language.

CO2. Translate and transfer the indigenous/traditional scientific knowledge available in local knowledge into English and other global languages.

CO3. Understand the society through Punjabi language, literature and culture.

CO4. Learning science and in developing science literacy.

CO5. Improve the internal communication.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	2	1	1	2	2	2
CO2	2	2	2	2	1	2	3
CO3	2	1	2	3	1	1	3
CO4	1	2	1	2	2	2	1
CO5	2	1	1	2	2	2	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHHL106B-19**			
Subject Title:	**MUDHLI PUNJABI-I (ਮੁਢਲੀ ਪੰਜਾਬੀ)**			
Contact Hours:	**L:2**	**T:0**	**P:0**	**Credits:2**
Examination Duration (hours)	**2**			
Objective(s):	1. To enhance the language ability of students. 2. To enhance the ability of Learning science and developing science literacy through local language teaching with science subjects.			

Details of the Course

Unit	Contents	Contact Hours
I	ਪੈਂਤੀ ਅੱਖਰੀ (ਵਰਣਮਾਲਾ), ਅੱਖਰ ਕ੍ਰਮ ਮਾਤਰਾਵਾਂ : ਮੁਢਲੀ ਜਾਣ-ਪਛਾਣ ਲਗਾਖਰ :ਬਿੰਦੀ, ਟਿੱਪੀ, ਅੱਧਕ	8
II	ਪੰਜਾਬੀ ਸ਼ਬਦ ਬਣਤਰ: ਮੁਢਲੀ ਜਾਣ-ਪਛਾਣ ਮੂਲ ਸ਼ਬਦ , ਅਗੇਤਰ, ਪਿਛੇਤਰ ਸਮਾਨਾਰਥਕ ਸ਼ਬਦ, ਵਿਰੋਧਾਰਥਕ ਸ਼ਬਦ ਸ਼ੁੱਧ- ਅਸ਼ੁੱਧ: ਦਿੱਤੇ ਪੈਰ੍ਹੇ ਵਿੱਚੋਂ ਅਸ਼ੁੱਧ ਸ਼ਬਦ ਨੂੰ ਸ਼ੁੱਧ ਕਰਨਾ	8
III	ਹਫਤੇ ਦੇ ਸੱਤ ਦਿਨਾਂ ਦੇ ਨਾਂ ਬਾਰ੍ਹਾਂ ਮਹੀਨਿਆਂ ਦੇ ਨਾਂ ਰੁੱਤਾਂ ਦੇ ਨਾਂ ਇਕ ਸੌ ਤੱਕ ਗਿਣਤੀ ਸ਼ਬਦਾਂ ਵਿਚ	6
IV	ਸਧਾਰਣ ਸ਼ਬਦਾਂ ਦਾ ਅੰਗਰੇਜ਼ੀ ਤੋਂ ਪੰਜਾਬੀ ਅਨੁਵਾਦ ਸਧਾਰਣ ਸ਼ਬਦਾਂ ਦਾ ਪੰਜਾਬੀ ਤੋਂ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ	8

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Translate and transfer/broadcast the western scientific knowledge in the local language.

CO2.	Translate and transfer the indigenous/traditional scientific knowledge available in local knowledge into English and other global languages.
CO3.	Understand the society through Punjabi language, literature and culture.
CO4.	Learning science and in developing science literacy.
CO5.	Improve the internal communication.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	2	1	1	2	2	2
CO2	2	2	2	2	1	2	3
CO3	2	1	2	3	1	1	3
CO4	1	2	1	2	2	2	1
CO5	2	1	1	2	2	2	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCP107-19**			
Subject Title:	**INORGANIC CHEMISTRY LAB-I**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**
Examination Duration (hours)	**3**			
Objective(s):	The objective of this course is to provide practical knowledge and illustrative experiments about various types of inorganic titrations and preparation of simple inorganic compounds.			

Details of the Course

Unit	Contents
I	**(A) Titrimetric Analysis** (i) Calibration and use of apparatus (ii) Preparation of solutions of different Molarity/Normality of titrants **(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 $KMnO_4$ solution. (ii) Estimation of oxalic acid and sodium oxalate in a given mixture. (iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator. **(D) Iodo / Iodimetric Titrations** (i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically). (ii) Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically (iii) Estimation of available chlorine in bleaching powder iodometrically. **(E) Inorganic preparations** (i) Cuprous Chloride, Cu_2Cl_2 (ii) Preparation of Manganese (III) phosphate, $MnPO_4.H_2O$ (iii) Preparation of Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum.

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	Vogel, A.I.	A Textbook of Quantitative Inorganic Analysis	ELBS

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand to calibrate and run the instruments for analysis.

CO2. Learn to the quantitative analysis of various metal ions/cations and anions.

CO3. Understand the various principles of different techniques involved in the quantitative analysis.

CO4. Learn to prepare various inorganic compounds.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	2	2	3	3	2	2
CO2	2	1	2	2	1	2	3
CO3	1	2	2	2	2	3	2
CO4	2	2	1	2	3	2	1
CO5	1	1	2	2	1	1	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCP108-19**			
Subject Title:	**ORGANIC CHEMISTRY LAB-I**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**
Examination Duration (hours)	**3**			
Objective(s):	The objective of this course is to provide practical knowledge and illustrative experiments regarding qualitative analysis, isolation, and purification of organic compounds.			

Details of the Course

Unit	Contents
I	**Determination of melting point** Napthalene 80-82^o, Benzoic acid 121.5-122^o, Urea 132.5-133^o, Succinic acid 184.5-185^o, Cinnamic acid 132.5-133^o, Salicylic acid 157.5-158^o, Acetanilide 113.5-114^o, m-Dinitrobenzene 90^o, p-Dichlorobenzene 52^o, Aspirin 135^o **Determination of boiling point** Ethanol 78^o, Cyclohexane 81.4^o, Toluene 110.6^o, Benzene 80^o
II	**Distillation** Simple distillation of ethanol-water mixture using water condenser Distillation of nitrobenzene and aniline using air condenser **Crystallization** Concept of induction of crystallization Phthalic acid from hot water (using fluted filter paper and stemless funnel) Acetanilide from boiling water Napthalene from ethanol Benzoic acid from water
III	**Qualitative Analysis** ***Elemental analysis*** nitrogen, sulphur, chlorine, bromine, iodine ***Functional groups*** -phenols, carboxylic acids -carbonyl compounds - ketones, aldehydes -carbohydrates -aromatic amines -amides, ureas and anilides

	-aromatic hydrocarbons and their halo- derivatives

Reference Books

S.No.	Author(s)	Title of the Book	Publisher
1	Brian S. Furniss, Antony J. Hannaford, Peter W.G. Smith and Austin R. Tatchell	Vogel's Textbook of Practical Organic Chemistry, 5th Edition	Longman, London
2	F.G. Mann and B. C. Saunders	Practical Organic Chemistry	Longman, New York
3	J.T. Sharp	Practical Organic Chemistry: A student handbook of techniques	Springer
4	Philippa B. Cranwell, Laurence M. Harwood and Cristopher J. Moody	Experimental Organic Chemistry, 3rd Edition	Wiley

Course Outcomes and Mapping

At the end of the course, the students will be able

CO1. To check the purity of organic compounds by determining the melting or boiling points

CO2. To develop preparative skills for purification of organic compounds by crystallization method.

CO3. To determine the element or functional groups present in organic compound by organic qualitative analysis.

CO4. To present their work with practical skills and the awareness of health and safety procedures.

CO5. To apply related experiments for their research work

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	-	2	-	3	1	-
CO2	2	-	3	-	3	3	-
CO3	3	3	4	-	3	3	-
CO4	3	4	3	4	4	5	4
CO5	2	3	4	2	4	4	4

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY DEPARTMENT OF CHEMICAL SCIENCES				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**UC-BSHP-113-19**			
Subject Title:	**PHYSICS LAB -I**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**
Examination Duration (hours)	**3**			
Objective(s):	The aim and objective of the lab course is to introduce the students to the formal structure of electromagnetism and phenomenon of wave optics so that they can use these as per their requirement.			

Details of the Course:

Note: Students are expected to perform about 8-10 experiments from the following list, selecting minimum of 6-7 from the Physical Lab and 2-3 from the Virtual lab.

List of experiments:

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the laser beam characteristics like; wave length, aperture, spot size, etc. using diffraction grating.
3. To study the diffraction using laser beam and thus to determine the grating element.
4. To study wavelength and laser interference using Michelson's Interferometer.
5. To find the refractive index of a material/glass using spectrometer.
6. To find the refractive index of a liquid using spectrometer.
7. To determine the resolving power of a prism.
8. To study the magnetic field of a circular coil carrying current using a Steward and Gees Tangent Galvanometer.
9. Determine the radius of circular coil using the Circular coil.
10. To study B-H curve using CRO.
11. To find out polarizability of a dielectric substance.
12. To find out the horizontal component of earth's magnetic field (Bh).

Reference Books

1. A Text -book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.
2. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.

3. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University
4. Press.Practical Physics, C L Arora. S. Chand & Company Ltd.
5. http://www.vlab.co.in

Course Outcomes and Mapping

Course Outcomes: At the end of the course, the student will be able to	
CO1	Able to verify the theoretical concepts/laws learnt in theory courses.
CO2	Trained in carrying out precise measurements and handling sensitive equipment.
CO3	Understand the methods used for estimating and dealing with experimental uncertainties and systematic "errors".
CO4	Learn to draw conclusions from data and develop skills in experimental design.
CO5	Document a technical report which communicates scientific information in a clear and concise manner.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	2	2	1	2
CO2	3	3	1	-	2	2	1
CO3	3	3	2	-	2	1	2
CO4	3	2	2	2	-	2	2
CO5	2	2	2	2	-	2	2

SEMESTER-II

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL111-19**			
Subject Title:	**INORGANIC CHEMISTRY-II**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	To teach the fundamental concepts of Inorganic Chemistry and their applications.			

Details of the Course

Unit	Contents	Contact Hours
I	**Chemistry of s & p block elements:** **IA-VII A and Zero Groups:** General remarks about each group, trends in electronic configuration, structure of elements, atomic and ionic, Radii, ionization potential, electron affinity, electronegativity, oxidation states, Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements, Important classes of Compounds of s and p block elements. **Alkali Metals:** Oxides, hydroxides, peroxides and super oxides, halides, halides, hydrides, solutions of metals in liquid ammonia, complexes crowns and cryptands and podands. **Alkaline Earth Metals:** Solutions of the metals in liquid ammonia, hydroxides, oxides, sulfates, hydrides, halides, carbides, structures of calcium carbide, structures of basic beryllium acetate $Be_4O(CH_3COO)_6$, beryllium oxalate complexes $Be(Oxalate)_2$. Structure of chlorophyll `a'.	11
II	**Chemistry of s & p block elements:** **Group III (Boron Group):** Oxides, halides and hydrides of group III elements, boron sesquioxide and borates structure of borates, trihalides and lower halides of boron, preparation of boron hydrides reactions and structures of boranes. **Group IV (Carbon Group):** Structure and allotropy of the elements, types and structure of carbides, oxides of carbon and silicon, types and structures of silicates, Organo-silicon compounds and the silicones, halides of IV group elements.	13

	Group V (Nitrogen Group): Hydrides, properties and structure of ammonia, hydrazine, hydroxylamine, trihalides and Pentahalides of V groups elements, oxides of nitrogen, structure of N_2O, NO, N_2O_3, N_2O_4 and N_2O_5, oxo acids of nitrogen and phosphorous, phosphazenes and cyclophosphazenes.	
III	**Chemistry of s & p block elements:** **Group VI (Oxygen Group):** Structure and allotropy of the elements. Oxides of sulfur (structure of SO_2 and SO_3) oxoacids of sulfur halides of sulfur, selenium and tellurium, compounds of Sulfur and nitrogen (S_4N_4). **Group VII:** Oxides of halogens (OF_2, O_2F_2, Cl_2O, ClO_2, Cl_2O_6, BrO_2, I_2O_5) (structures), Preparation, reaction and structure interhalogen compounds. (ClF_3, BrF_3, I_2, Cl_5, IF_5, IF_7) Polyhalides, basic properties of halogens. **Zero Group (Chemistry of noble gases):** Clatharate compounds, preparation, structure and bonding of noble gas compounds (XeF2, XeF4, XeF6, XeO3, XeO2F2, XeO4).	11
IV	**Coordination Chemsitry I:** Werner's theory, nomenclature of coordination complexes, isomerism in coordination complexes, chelating agents, metal chelates and chelate effects, names and abbreviations of important ligands, polydenate ligands, polypyarzolyborates, macrocylic ligands, macrocylic effect, ketoenolates, troplonates, tripod ligands, conformation of chelate rings, stereochemistry of coordination numbers 2-12, factors determining kinetic and thermodynamic stability.	10

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	J.D. Lee	Concise Inorganic Chemistry, 4th Ed.	ELBS, 1991
2	J.E. Huheey	Inorganic Chemistry	Harper & Row
3	F.A.Cotton and G. Wilinson	Advanced Inorganic Chemistry	Wiley, VCH, 1999
4	N.N. Greenwood and A. Earnshaw	Chemistry of Elements	Butterworth Heinemann 1997
5	G. L. Miessler & A. Tarr. Donald	Inorganic Chemistry 4th Ed.,	Pearson, 2010
6	B.E. Douglas, D.H. Mc Daniel, & J.J. Alexander	Concepts & Models of Inorganic Chemistry 3rd Ed.	John Wiley Sons, N.Y. 1994.

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand the fundamental concepts and theories of s & p block elements

CO2. Learn about the different compounds of s & p block elements, their structure, synthesis and stability of the coordination complexes.

CO3.	Understand the structure, formation and properties of various compounds of s & p block elements.
CO4.	Learn about various ligands and their effect on the formation of coordination compounds.
CO5.	Learn about the terms and theories of the coordination compounds.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	2	3	2	2	3	2
CO2	2	1	2	3	3	2	2
CO3	1	2	2	3	2	2	1
CO4	1	2	2	3	2	2	1
CO5	0	1	2	2	1	2	1

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL112-19**			
Subject Title:	**PHYSICAL CHEMISTRY-I**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of physical chemistry viz. different states of matter and ionic equilibrium. The problem solving skills of students are expected to be enhanced through due weightage given to numerical problems in each unit.			

Details of the Course

Unit	Contents	Contact Hours
I	**Gaseous state** Kinetic molecular theory of gases: 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, 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. 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 behavior. van der Waals equation of state, its derivation and application in explaining real gas behaviour, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states, Numericals.	12
II	**Liquid state:** Qualitative treatment of the structure of the liquid state; 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.	10
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	11

	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.	
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. 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.	12

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	P.W. Atkins & J. de Paula	Atkin's Physical Chemistry	Oxford University Press (2006)
2	S.H. Maron & C.F. Prutton	Principles of Physical Chemistry, 1st edition	Oxford and IBH (1958)
3	G.W. Castellan	Physical Chemistry, 4th edition	Narosa (2004)
4	D. W. Ball	Physical Chemistry	Thomson Press, India (2007)

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand the basic principles and theories pertaining to various states of matter

CO2. Solve various problems related to real gases and pH concept.

CO3. Define the various types of crystal systems and defects in solids.

CO4. Familiarise with the concept of acids and bases and differentiate between them

CO5. Rationalise bulk properties and processes governing gaseous, liquid and solid states.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7

CO1	3	1	1	-	2	1	1
CO2	3	2	3	-	1	-	1
CO3	2	2	1	-	2	1	1
CO4	3	2	2	-	2	1	1
CO5	3	2	2	-	1	-	1

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY DEPARTMENT OF CHEMICAL SCIENCES				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**UC-BSHP-124-19**			
Subject Title:	**WAVES AND VIBRATIONS**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	The objective of the course is to develop basic understanding of Interference, Diffraction and Polarization among students. The Students also learn about the LASER and its applications. Students will be equipped with knowledge to measure wavelength, refractive index and other related parameters, which will act as a strong background if he/she chooses to pursue sciences as a career.			

Details of the Course

Unit	Contents	Contact Hours
I	**Interference:** Electromagnetic nature of light, Definition and properties of wave front, Huygens Principle, Temporal and Spatial Coherence, Division of amplitude and wavefront, Young's double slit experiment, Lloyd's single mirror and Fresnel's Biprism, Interference in Thin Films, Newton's Rings and Michelson Interferometer.	11
II	**Diffraction and Polarization:** Huygens Principle, Huygens-Fresnel Diffraction theory, Fraunhofer diffraction: Single slit. Circular aperture, Rayleigh criterion of resolution, Resolving Power of a telescope, Double slit, Multiple slits, Diffraction grating; Polarization, Plane polarized light, Representation of Unpolarized and Polarized light, Polarization by Reflection, Brewster's law, Malus Law, Polarization by Selective absorption by Crystals, Polarization by Scattering, Polarization by Double Refraction.	11
III	**Simple Harmonic Motion:** Simple harmonic motion, Energy of a SHO, Simple, Compound and Torsional pendulum, Electrical Oscillations, damped oscillations, damped harmonic oscillator – heavy, critical, and light damping, Damping coefficients, energy decay in a damped harmonic oscillator, quality factor, forced mechanical oscillators, resonance.	12
IV	**Laser and Application:** Lasers, Spontaneous emission, Stimulated absorption, Stimulated emission, Einstein coefficients, Conditions for Laser actions, Population inversion, Different types of Laser, Pumping mechanism: Optical Pumping, Electric Discharge and Electrical pumping, Resonators, Two, Three, and Four level laser	11

	systems, Ruby laser, He-Ne gas Laser, Semiconductor laser, CO2 laser, applications of laser: Holography, Principle of Holography.	

Reference Books

1. Optics: A.K. Ghatak (Tata-McGraw Hill), 1992.
2. Fundamentals of Optics: F.A. Jenkins and H.E. White (McGraw Hill), 1981.
3. A Text Book of Optics: Subrahmaniyam N. & et al.(S. Chand Publishing) (2006).
4. O. Svelto, "Principles of Lasers", Springer Science & Business Media, 2010.

Course Outcomes and Mapping

At the end of the course, the student will be	
CO1	Able to understand the theoretical concepts learned in the theory course.
CO2	Trained in carrying out precise measurements and handling equipment.
CO3	Learn to draw conclusions from data and develop skills in experimental design.
CO4	Able to understand the principles of error analysis and develop skills in experimental design.
CO5	Able to document a technical report which communicates scientific information in a clear and concise manner.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	2	2	1	2
CO2	3	3	1	-	2	2	1
CO3	3	3	2	-	2	1	2
CO4	3	2	2	2	-	2	2
CO5	2	2	2	2	-	2	2

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**UC-BSHM- 204-19**			
Subject Title:	**VECTOR ALGEBRA & VECTOR ANALYSIS**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	The objectives of this course are to make the students understand the following: 1. The fundamental concepts of Scalars and Vector algebra. 2. The geometrical meaning of projections and orthogonality. 3. Applications of gradient, divergence and curl. 4. Geometric meaning of scalar and vector valued functions, gradient of scalar point function. 5. The utility of Gauss, Green and Stokes Theorem.			

Details of the Course

Unit	Contents
I	Definitions of Scalars, vectors, position vector, unit vector, types of vectors, Addition of vectors, direction ratios, direction cosines, multiplication by a scalar, dot product, cross product of vectors, projection of vectors on a line.
II	Vector joining two points, section formula, angle between two vectors, Cauchy-Schwartz inequality, Solenoidal vectors, orthogonality, Area of triangle, area of parallelogram, Scalar and vector product of three vectors.
III	Scalar valued point functions, vector valued point functions, Derivative along a curve, directional derivatives, Differentiation and partial differentiation of a vector function. Derivative of sum, dot product and cross product of two vectors, Gradient, divergence and curl Gradient of a scalar point function. Geometrical interpretation of gradient of a scalar point function (grad φ).
IV	Divergence and curl of a vector point function, Character of divergence and curl of a vector point function, relation between Cartesian and cylindrical or spherical coordinates, Statements of Theorems of Gauss, Green and Stokes (without proof).

Reference Books

1. Mathematics, A Text book for Class XII (Parts I & II), New Delhi: NCERT, 2003. (Unit I & II)
2. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
3. H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and Sons (Asia) P. Ltd. 2002.

4. P.C. Matthew's, Vector Calculus, Springer Verlag London Limited, 1998.

Course Outcomes and Mapping

At the end of the course, the students will be able to	
CO1	Understand the basic concepts of Scalars and Vector algebra.
CO2	Visualize all concepts geometrically.
CO3	Apply the knowledge of dot product and cross product in finding projections, area and orthogonality.
CO4	Utilize the concept of scalar and vector valued functions, gradient of scalar point function, divergence and curl of vector point functions, their geometrical interpretation.
CO5	Acquire the knowledge of the concept of relation between cartesian, cylindrical and spherical polar coordinates, Gauss, Green and Stokes Theorem.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	-	3	2	3	2	-
CO2	3	1	3	2	-	-	-
CO3	1	1	3	1	2	1	-
CO4	3	3	3	1	2	1	-
CO5	3	3	3	1	2	1	-

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHHL115-19**			
Subject Title:	**COMMUNICATIVE ENGLISH-II**			
Contact Hours:	**L:2**	**T:0**	**P:0**	**Credits:2**
Examination Duration (hours)	**2**			
Objective(s):	1.To help the students become proficient in LSRW-Listening, Speaking, Reading & Writing skills 2.To develop in them vital communication skills, integral to their personal, social and professional interactions 3.To teach them the appropriate language of professional communication. 4.To help the students become the independent users of English language.			

Details of the Course

Unit	Contents	Contact Hours
I	**(Literature)** **(A)** ***The Poetic Palette*** **(Orient BlackSwan, Second Edition, 2016)** The following poems from this anthology are prescribed: 4. The Soul's Prayer: Sarojini Naidu 5. I Sit and Look Out: Walt Whitman 6. Women's Rights: Annie Louise Walker **(B)** ***Prose Parables*** **(Orient Black Swan, 2013)** The following stories from the above volume are prescribed: a. The Doctor's Word: R.K. Narayan b. The Doll's House: Katherine Mansfield c. Dusk: H.H. Munroe (Saki)	10
II	**Vocabulary:** Standard abbreviations; One word substitution; Word Pairs (Homophones/Homonyms) **Grammar:** Sentence Structures; Use of phrases and clauses in sentences; Transformation of Sentences; Importance of proper punctuation	06
III	**Reading and Understanding:**	04

	Summary Paraphrasing; Analysis and Interpretation; Translation (from Hindi/Punjabi to English and vice-versa) Close Reading; Comprehension;	
IV	**Mechanics of Writing & Speaking Skills:** Report writing; Career Documents- Job applications, Resume/CV writing, Common Everyday Situations: Conversations & Dialogues, Formal Presentations	10

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	John Eastwood	Oxford Practice Grammar	Oxford University Press,2014
2	Michael Swan.	Practical English Usage.	OUP. 1995.
3	F.T. Wood	Remedial English Grammar	Macmillan.2007
4	William Zinsser	On Writing Well	Harper Resource Book. 2001
5	Sanjay Kumar and Pushp Lata.	Communication Skills	Oxford University Press. 2011
6	Liz Hamp-Lyons and Ben Heasly	Study Writing	Cambridge University Press. 2006.

Course Outcomes and Mapping

At the end of the course,

CO1. Students will acquire basic proficiency in LSRW skills- listening, speaking, reading, and writing.

CO2. To develop their vocabulary so that they can understand spoken and written English language, particularly the language of their chosen technical field

CO3. To introduce students to the skills and strategies of reading and writing by identifying organizational patterns, spotting classification systems and understanding associations between ideas through study of literary texts.

CO4. They will be able to converse fluently and produce on their own clear and coherent texts.

CO5. To improve the employability of students and make them proficient in professional communication through understanding of career documents; job interviews; group discussions; internal communication in office environments etc.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	2	2	3	2	2	2
CO2	3	2	2	3	2	3	3

CO3	2	3	3	2	2	3	3
CO4	2	2	3	3	3	2	3
CO5	2	1	1	3	1	1	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHHL116A-19**			
Subject Title:	**PUNJABI COMPULSORY-II (ਪੰਜਾਬੀ ਲਾਜ਼ਮੀ-II)**			
Contact Hours:	**L:2**	**T:0**	**P:0**	**Credits:2**
Examination Duration (hours)	**2**			
Objective(s):	1. To enhance the language ability of students. 2. To enhance the ability of Learning science and developing science literacy through local language teaching with science subjects.			

Details of the Course

Unit	Contents	Contact Hours
I	ਡਾ.ਹਰਿਭਜਨ ਸਿੰਘ: ਅਪ੍ਰਮਾਣਿਕ, ਤੇਰੇ ਹਜ਼ੂਰ ਮੇਰੀ ਹਾਜ਼ਰੀ ਦੀ ਦਾਸਤਾਨ ਸ਼ਿਵ ਕੁਮਾਰ ਬਟਾਲਵੀ: ਕੰਡਿਆਲੀ ਥੋਰ੍ਹ, ਧਰਮੀ ਬਾਬਲ ਪਾਪ ਕਮਾਇਆ, ਰੁੱਖ ਪਾਸ਼: ਇਨਕਾਰ,ਸਭ ਤੋਂ ਖਤਰਨਾਕ,ਦਹਿਕਦੇ ਅੰਗਿਆਰਾਂ ‘ਤੇ ਸੁਰਜੀਤ ਪਾਤਰ: ਹੁਣ ਘਰਾਂ ਨੂੰ ਪਰਤਣਾ, ਕੁਝ ਕਿਹਾ ਤਾਂ..., ਪੁਲ	8
II	**ਕਹਾਣੀ ਭਾਗ:** ਸੰਤੋਖ ਸਿੰਘ ਧੀਰ: ਕੋਈ ਇਕ ਸਵਾਰ ਪ੍ਰੇਮ ਪ੍ਰਕਾਸ਼: ਲੱਛਮੀ ਮੋਹਨ ਭੰਡਾਰੀ : ਘੋਟਣਾ ਵਰਿਆਮ ਸਿੰਘ ਸੰਧੂ : ਆਪਣਾ ਆਪਣਾ ਹਿੱਸਾ	8
III	ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦੀਆਂ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਉਪਰ ਪਏ ਪ੍ਰਭਾਵ	6
IV	ਰਿਪੋਰਟਿੰਗ, ਸਮਾਚਾਰ ਲਿਖਣ ਦੀ ਵਿਧੀ ਤੇ ਤੱਤ ਪੰਜਾਬੀ ਪੈਰ੍ਹੇ ਦਾ ਸਰਲ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ ਦਫਤਰੀ ਚਿੱਠੀ ਪੱਤਰ	8

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	ਸੰਪ.ਡਾ.ਮਹਿਲ ਸਿੰਘ	ਸਾਹਿਤ ਦੇ ਰੰਗ	ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ,2016.

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Translate and transfer/broadcast the western scientific knowledge in the local language.

CO2. Translate and transfer the indigenous/traditional scientific knowledge available in local knowledge into English and other global languages.

CO3. Understand the society through Punjabi language, literature and culture.

CO4. Learning science and in developing science literacy.

CO5. Improve the internal communication.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	2	1	1	2	2	2
CO2	2	2	2	2	1	2	3
CO3	2	1	2	3	1	1	3
CO4	1	2	1	2	2	2	1
CO5	2	1	1	2	2	2	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHHL116B-19**			
Subject Title:	**MUDHLI PUNJABI-II (ਮੁਢਲੀ ਪੰਜਾਬੀ-II)**			
Contact Hours:	**L:2**	**T:0**	**P:0**	**Credits:2**
Examination Duration (hours)	**2**			
Objective(s):	1. To enhance the language ability of students. 2. To enhance the ability of Learning science and developing science literacy through local language teaching with science subjects.			

Details of the Course

Unit	Contents	Contact Hours
I	ਸ਼ਬਦ ਸ਼੍ਰੇਣੀਆਂ : ਪਛਾਣ ਤੇ ਵਰਤੋਂ- ਨਾਂਵ ਪੜਨਾਂਵ ਵਿਸ਼ੇਸ਼ਣ ਕਿਰਿਆ ਕਿਰਿਆ ਵਿਸ਼ੇਸ਼ਣ	8
II	ਰੋਜ਼ਾਨਾ ਵਰਤੋਂ ਦੀ ਪੰਜਾਬੀ ਸ਼ਬਦਾਵਲੀ: ਬਾਜ਼ਾਰ, ਵਪਾਰ, ਰਿਸ਼ਤੇ-ਨਾਤੇ ਤੇ ਕਿੱਤਿਆਂ ਸਬੰਧੀ।	6
III	ਪੰਜਾਬੀ ਵਾਕ ਬਣਤਰ : ਸਧਾਰਣ ਵਾਕ ਸੰਯੁਕਤ ਵਾਕ ਮਿਸ਼ਰਤ ਵਾਕ	8
IV	ਸਧਾਰਣ ਵਾਕਾਂ ਦਾ ਅੰਗਰੇਜ਼ੀ ਤੋਂ ਪੰਜਾਬੀ ਅਨੁਵਾਦ ਸਧਾਰਣ ਵਾਕਾਂ ਦਾ ਪੰਜਾਬੀ ਤੋਂ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ	8

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1.	Translate and transfer/broadcast the western scientific knowledge in the local language.
CO2.	Translate and transfer the indigenous/traditional scientific knowledge available in local knowledge into English and other global languages.
CO3.	Understand the society through Punjabi language, literature and culture.

CO4.	Learning science and in developing science literacy.
CO5.	Improve the internal communication.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	2	1	1	2	2	2
CO2	2	2	2	2	1	2	3
CO3	2	1	2	3	1	1	3
CO4	1	2	1	2	2	2	1
CO5	2	1	1	2	2	2	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCP117-19**			
Subject Title:	**INORGANIC CHEMISTRY LAB-II**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**
Examination Duration (hours)	**3**			
Objective(s):	The objective of this course is to provide practical knowledge regarding salt analysis.			

Details of the Course

Unit	Contents
I	Identification of cations and anions in a mixture which may contain combinations of acid ions. These must contain interferring acid anions and one, the insoluble. **(a) Special Tests for Mixture of Anions** (i) Carbonate in the presence of sulphate. (ii) Nitrate in the presence of nitrite (iii) Nitrate in the presence of bromide and iodide. (iv) Nitrate in the presence of chlorate. (v) Chloride in the presence of bromide and iodide. (vi) Chloride in the presence of bromide. (vii) Chloride in the presence of iodide. (viii) Bromide and iodide in the presence of each other and of chloride. (ix) Iodate and iodide in the presence of each other. (x) Phosphate, arsenate and arsenite in the presence of each other. (xi) Sulphide, sulphite, thiosulphate and sulphate in the presence of each other. (xii) Borate in the presence of copper and barium salts. (xiii) Oxalate in the presence of fluoride. (xiv) Oxalate, tartrate, acetate, citrate in the presence of each other. **(b) Separation and Identification of Cations in Mixtures** (i) Separation of cations in groups. (ii) Separation and identification of Group I, Group II (Group IIA and IIB), Group III, Group IV, Group V and Group VI cations. **(c) Identification of Cations Including Less Familiar Elements by Spot Tests Assisted by Group Analysis (3 cations).**

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	Vogel, A.I.	Vogel's book on Inorganic Qualitative Analysis	ELBS

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand the concept of qualitative analysis.

CO2. Learn to identify present cations and anions through qualitative analysis of various metal ions/cations and anions.

CO3. Understand the various techniques/principles involved in the qualitative analysis of mixtures in presence or absence of interfering ions.

CO4. Learn to separate and identify less familiar ions through qualitative analysis.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	2	2	3	2	2	1
CO2	2	2	1	1	0	2	2
CO3	1	2	0	2	2	2	3
CO4	2	3	2	2	2	3	2

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc.(Honours) Chemistry**			
Subject Code:	**BHCP118-19**			
Subject Title:	**PHYSICAL CHEMISTRY LAB-I**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**
Examination Duration (hours)	**3**			
Objective(s):	To provide students practical knowledge and skills about various topics taught in theory class of physical chemistry, which in turn will enhance their problem solving and analytical skills.			

Details of the Course

Unit	Contents
I	**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.
II	**Viscosity measurement using Ostwald's viscometer.** **a)** Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature. **b)** Study the variation of viscosity of sucrose solution with the concentration of solute.
III	Indexing of a given powder diffraction pattern of a cubic crystalline system.
IV	**pH metry** a) Study the 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.

Reference Books

S.No.	Author(s)	Title of the Book	Publisher
1	J.B. Yadav	Practical Physical Chemistry	Krishna
2	Findlay	Practical Physical Chemistry	Longman, New York

Course Outcomes and Mapping

At the end of the course, the students will be able to

CO1. Understand the basic procedures for carrying out a physical chemistry practical like preparation and standardisation of solutions, handling the equipments and measuring with precision.

CO2. Correlate the theoretical and practical aspects and know about the limits of the experimental error.

CO3. Determine the various physical parameters for the various problems under study.

CO4. Verify various laws studied in the theory part.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	1	3	-	3	2	1
CO2	2	2	3	-	3	2	2
CO3	2	3	3	-	2	1	1
CO4	2	3	3	-	3	2	1

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY DEPARTMENT OF CHEMICAL SCIENCES				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**UC-BSHP-125-19**			
Subject Title:	**PHYSICS LAB -II**			
Contact Hours:	**L:0**	**T:0**	**P:0**	**Credits:2**
Examination Duration (hours)	**3**			
Objective(s):	The aim and objective of the Physics Lab course is to introduce the students of B. Sc. (Hons.) to the formal structure of wave and vibrations and mechanics so that they can use these as per their requirement.			

Details of the Course:

Note: Students are expected to perform about 8-10 experiments from the following list, selecting minimum of 6-7 from the Physical Lab and 2-3 from the Virtual lab.

List of experiments:

1. Measurement of volume using travelling microscope. Use of Plumb line and Spirit level.
2. To determine the frequency of an electrically maintained tuning fork in a) Transverse mode of vibration b) Longitudinal mode of vibration.
3. To find out the frequency of AC mains using sonometer.
4. To study the characteristic of Ge-Si junction diode.
5. To analyze the suitability of a given Zener diode as a power regulator.
6. To determine the horizontal and vertical distance between two points using a Sextant.
7. To determine the height of an inaccessible object using a Sextant.
8. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g and (c) Modulus of rigidity.
9. To determine the time period of a simple pendulum for different length and acceleration due to gravity.
10. To study the variation of time period with distance between centre of suspension and centre of gravity for a compound pendulum and to determine: (i) Radius of gyration of the bar about an axis through its C.G. and perpendicular to its length. (ii) The value of g in the laboratory.
11. To find the moment of inertia of an irregular body about an axis through its C.G with the torsional pendulum.
12. To determine the angular acceleration α, torque τ, and Moment of Inertia of flywheel.

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.
4. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
6. Practical Physics, C L Arora, S. Chand & Company Ltd.
7. http://www.vlab.co.in

Course Outcomes and Mapping

At the end of the course, the student will be	
CO1	Able to understand the theoretical concepts learned in the theory course.
CO2	Trained in carrying out precise measurements and handling equipment.
CO3	Learn to draw conclusions from data and develop skills in experimental design.
CO4	Able to understand the principles of error analysis and develop skills in experimental design.
CO5	Able to document a technical report which communicates scientific information in a clear and concise manner.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	2	3	3	2	3	3
CO2	2	2	3	2	2	3	-
CO3	2	-	3	2	2	3	1
CO4	2	2	3	1	1	2	2
CO5	2	2	2	1	2	2	-

SEMESTER-III

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY DEPARTMENT OF CHEMICAL SCIENCES				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL201-19**			
Subject Title:	**ORGANIC CHEMISTRY-II (CHEMISTRY OF FUNCTIONAL GROUPS-II)**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	4. To predict and account for the most commonly encountered reaction mechanisms (substitution, addition and elimination) in organic chemistry. 5. To impart knowledge regarding physical properties and chemical reactions of oxygen, nitrogen and sulphur containing functional groups. 6. To study the classifications and properties of biomolecules like carbohydrates, amino acids, proteins, peptides and nucleic acids.			

Details of the Course

Unit	Contents	Contact Hours
I	**Alcohols** Classification and nomenclature. Monohydric alcohol - nomenclature, methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding, Acidic nature. Reactions of alcohols. Dihydric alcohols - nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacol-pinacolone rearrangement. Trihydirc alcohols - nomenclature and methods of formation, chemical reactions of glycerol. **Phenols** Nomenclature, structure and bonding. Physical properties, Acidity of phenols and substituent effects, Comparative acidic strengths of alcohols and phenols, Resonance stabilization of phenoxide ion. Preparation and reactions of phenols - electrophilic aromatic substitution, acylation and carboxylation, Kolb-Schmitt reaction. Preparation of aryl ethers, Cleavage of aryl ethers by hydrogen halides, Claisen rearrangement of allyl aryl ethers, Oxidation of phenols. Gatterman synthesis, Hauben-Hoesch reaction, Laderer-Manasse reaction and Reimen-Tiemann reaction.	10

	Ethers and Epoxides Nomenclature of ethers, epoxides and sulphides. Structure and bonding in ethers and epoxides. Physical properties of ethers, Preparation of ethers. The Williamson ether synthesis, Acid catalyzed cleavage of ethers. Preparation of epoxides, Conversion of vicinal halohydrins to epoxides, Reactions of epoxides: Nucleophilic ring opening, acid-catalyzed ring opening.	
II	**Aldehydes and Ketones** Nomenclature and structure of the carbonyl groups. Physical properties, Sources of aldehydes and/or ketones from alkenes, alkynes, carboxylic acids, acid chlorides, nitriles and alcohols. Reaction of aldehydes with Grignard reagent to produce ketones. Hydroformylation, Synthesis of aldehydes and ketones using 1,3-dithianes. Reactions of aldehydes and ketones: Clemmensen, Wolff-Kishner, $LiAlH_4$, and $NaBH_4$ reductions. Addition of Grignard reagents and organolithium reagents to aldehydes and ketones. Principles of nucleophilic addition: hydration of aldehydes and ketones, cyanohydrin formation, acetal formation. Benzoin, aldol, Perkin and Knoevenagel condensations. Use of acetals as protecting groups. Reactions of aldehydes and ketones with ammonia, primary amines and secondary amines. Enamines and Wittig reaction, Stereoselective addition to carbonyl groups. Oxidation of aldehydes. Mannich reaction. BaeyerVilliger oxidation of ketones, Cannizzaro reaction. Meerwein-Ponndorf-Verley reaction, Halogenation of enolizable ketone. An introduction to α,β-unsaturated aldehydes and ketones. **Sulphur containing compounds** Preparation and reactions of thiols, thioethers and sulphonic acids. **Amines** Amine nomenclature, Structure and bonding, physical properties. Basicity of amines. Structural features effecting basicity of amines. tetraalkylammonium salts as Phase Transfer Catalysts. Preparation of primary, secondary and tertiary amines: Nucleophilic substitution by azide ion on alkyl halides, nitration of arenes, nucleophilic ring opening of epoxides by ammonia, nucleophilic addition of amines to aldehydes and ketones, nucleophilic substitution by ammonia on α-halo acids. Nucleophilic acyl substitution. Preparation of amines by alkylation of ammonia, The Gabriel synthesis of primary alkylamines, preparation of amines by reduction of azides, epoxides, nitriles, nitro and amides. Reductive amination, Reaction of amines with alkyl halides, The Hofmann elimination. Electrophilic aromatic substitution in arylamines, nitrosation of alkylamines and arylamines. Synthetic transformations of aryl diazonium salts, azo coupling.	12
III	**Carboxylic Acids**	12

	Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength . Dicarboxylic acids. Methods of formation and effect of heat and dehydrating agents. Preparation of carboxylic acids: carboxylation of Grignard reagents, oxidation of alkylbenzenes, oxidation of primary alcohols, aldehydes. Preparation and hydrolysis of nitriles. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation. Intramolecular ester formation. Hydroxy acids: malic, tartaric and citric acids. Methods of formation and chemical reactions of unstaturated monocarboxylic acids. **Carboxylic Acid Derivatives** Nomenclature and structure of acid chlorides, esters, amides, acid anhydrides and nitriles. Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution in acyl chlorides and acid anhydrides. Sources and physical properties of esters. Acid as well as base catalyzed ester hydrolysis. Reactions of esters with ammonia, amines, Grignard reagents and lithium aluminium hydride. Amides: hydrolysis of amides. Lactams. Preparation of nitriles, hydrolysis, addition of Grignard reagents to nitriles.	
IV	**Carbohydrates** Classification of carbohydrates, Fischer projections and D-, L-notations of glyceraldehyde, aldotetroses, aldopentoses and aldohexoses. Cyclic forms of carbohydrates: Furanoses and Pentoses. Mutarotation and mechanism. Introduction to ketoses, deoxy sugars, amino sugars and branched chain carbohydrates. Glycosides: The Fischer glycosidation, mechanism. examples of disaccharides and polysaccharides. Reactions of carbohydrates: Reduction of monosaccharides, oxidation of monosaccharides. Determination of ring size of monosaccharides. Cyanohydrin formation and chain extension. Kiliani-Fischer synthesis. Epimerization, isomerizaion and retrocleavage: Interconversion of glucose into mannose, fructose. Acylation and alkylation of carbohydrate hydroxyl group. Mechanism of osazone formation, An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination. **Amino Acids, Peptides, Proteins and Nucleic Acids** Classification, structure and stereochemistry of amino acids. Acid-base behaviour, isoelectric point and electrophoresis. Preparation and reactions of α-amino acids. Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, the Edman degradation. The strategy of	11

	peptide synthesis: amino and carboxyl group protection, peptide bond formation. Solid-phase peptide synthesis: The Merrifield method. Secondary structures of peptides and proteins. Introduction to tertiary and quaternary structures of proteins. Protein denaturation/renaturation. Nucleosides and nucleotides. secondary structure of DNA: The double helix. Tertiary structure of DNA: supercoils. Nucleic acids: Introduction. Constitutents of nucleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA.	

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	F.A. Carey	Organic Chemistry, 8th edition	McGraw Hill, Inc.
2	Morrison and Boyd	Organic Chemistry	Prentice Hall
3	G. Solomons	Fundamentals of Organic Chemistry	John Wiley, 2002
4	S.M. Mukherji, S.P. Singh and R.P. Kapoor	Organic Chemistry Vol. I, II & III	Wiley Eastern Ltd (New Age International).
5	Jerry March	Organic Reaction Mechanism	John Wiley Ed. 5, 2002
6	L. G. Jr. Wade	Organic Chemistry	Prentice-Hall,1990
7	Stritwieser, Heathcock and Kosover	Introduction to organic chemistry	Macmilan

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Learn the range of organic compounds containing various types of functional groups like oxygen, nitrogen and sulphur.

CO2. gain in-depth understanding of carbohydrates, amino acids, proteins and nucleotides and their roles in biological system.

CO3. To study the various known reactive intermediate in organic synthesis

CO4. To learn the fundamental and advanced concepts of reaction mechanisms along with the study of reaction mechanisms in various types of substitution addition and elimination reactions.

CO5. To predict the relationships between organic chemical structures and their reactivity.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	4	4	3	-	3	4	2
CO2	4	2	3	1	2	2	-
CO3	4	2	1	-	4	4	-

CO4	4	4	4	-	4	3	-
CO5	4	3	4	-	4	-	-

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL202-19**			
Subject Title:	**PHYSICAL CHEMISTRY-II (CHEMICAL THERMODYNAMICS)**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	This course will equip students with the necessary knowledge concerning the fundamentals in thermodynamics of chemical processes. The problem solving skills of students are expected to be enhanced through due weightage given to numerical problems in each unit.			

Details of the Course

Unit	Contents	Contact Hours
I	**Chemical 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. *Thermochemistry:* Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions.	12
II	**Chemical Thermodynamics:** *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:* Statement of third law, concept of residual entropy. *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.	10
III	**Chemical Equilibrium:**	11

	Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p , K_c and K_x. Le Chatelier's principle; equilibrium between ideal gases and a pure condensed phase.	
IV	**Solutions and Colligative Properties:** Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.	12

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	P.W. Atkins & J. de Paula	Atkin's Physical Chemistry	Oxford University Press (2006)
2	S.H. Maron & C.F. Prutton	Principles of Physical Chemistry, 1st edition	Oxford and IBH (1958)
3	G.W. Castellan	Physical Chemistry, 4th edition	Narosa (2004)
4	I .N. Levine	Physical Chemistry 6th Ed.,	Tata Mc Graw Hill (2010)
5	T. Engel & P. Reid	Physical Chemistry 3rd Ed.	Prentice-Hall (2012)
6	D. A. McQuarrie, & J. D. Simon	Molecular Thermodynamics	Viva Books Pvt. Ltd.: New Delhi (2004)
7	M. J. Assael, A. R. H. Goodwin, M. Stamatoudis, W. A. Wakeham, & S. Will	Commonly Asked Questions in Thermodynamics	CRC Press: NY (2011)

Course Outcomes and Mapping

At the end of the course, the student will be able to

- **CO1.** Understand the basic principles and theories pertaining to thermodynamics
- **CO2.** Solve various problems related to thermodynamics of different chemical processes
- **CO3.** Define the various laws of thermodynamics.
- **CO4.** Familiarise with the different colligative properties of solutions and the concept of abnormal molecular mass
- **CO5.** Understand thermodynamics of processes at equilibrium

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	1	1	-	2	1	1
CO2	3	2	3	-	1	-	1
CO3	2	2	1	-	2	1	1
CO4	3	2	2	-	2	1	1
CO5	3	2	2	-	1	-	1

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL203-19**			
Subject Title:	**SPECTROSCOPY**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	To teach the fundamental concepts of Spectroscopy and their applications.			

Details of the Course

Unit	Contents	Contact Hours
I	Introduction, interaction of electromagnetic radiation with molecules; various types of spectroscopy; absorption and emission spectroscopy; Born-Oppenheimer approximation. Vibrational and IR spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, Fundamental and non-fundamental molecular vibrations; concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.	12
II	IR absorption positions 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 in functional group analysis. Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution. Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.	11

III	Electronic spectroscopy and UV spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model. λ_{max}, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λ_{max} 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.	10
IV	Nuclear Magnetic Resonance (NMR) spectroscopy: General principle of NMR spectroscopy and Proton Magnetic Resonance Spectroscopy, Larmor precession, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant, different scales, low resolution spectra, high resolution spectra, anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpetation of NMR spectra of simple compounds. Applications of IR, UV and NMR for identification of simple organic molecules.	12

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	Banwell, C. N. & McCash, E. M.	Fundamentals of Molecular Spectroscopy 4th Ed.	Tata McGraw-Hill: New Delhi (2006).
2	Kakkar, R.	Atomic & Molecular Spectroscopy	Cambridge University Press (2015)
3	Kemp, W.	*Organic Spectroscopy*	Palgrave
4	Pavia, Lampman, Kriz, Vyvyan	Spectroscopy	Cengage Learning

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand the fundamental principles and theories of various spectroscopic techniques

CO2. Learn the interaction of various electromagnetic radiations with matter
CO3. Learn about the behaviour of different types of compounds towards different electromagnetic radiations
CO4. Understand the applications of interaction of light in their characterization
CO5. Learn about the role of different techniques in the characterization of different compounds

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	2	2	3	3	2	3
CO2	3	1	3	3	1	2	1
CO3	2	3	2	2	2	3	1
CO4	2	2	1	2	3	1	2
CO5	1	2	3	2	2	1	2

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**UC-BSHP-214-19**			
Subject Title:	**PHYSICS-III (ELEMENTS OF MODERN PHYSICS)**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	The objective of the course is to develop basic understanding concepts of modern physics, namely to special relativity and to the quantum nature of light and energy, emphasizing whenever possible, how classical concepts have shown up to be inadequate in explaining experiments, which will act as a strong background if he/she chooses to pursue science as a career.			

Details of the Course

Unit	Content	Hours
I	**Dual Nature of Waves and Particles:** Black body radiation, Planck's quantum, Planck's constant and light as a collection of photons; Photo Electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment, Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle.	**10**
II	**Quantum Mechanics:** Two slit interference experiment with photons, atoms & particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wavefunction, probabilities and normalization; Probability and probability current densities in one dimension. One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example.	**10**
III	**Atomic structure:** The nuclear atom, Electron orbits, Atomic spectra, The Bohr Model, Energy level and spectra, Correspondence principle, Nuclear motion, Atomic excitation, Many electron atoms, Exclusion Principle, electron spin, spin orbit coupling, X-ray spectra. Zeeman effect, Stern-Garlach experiment.	**10**

IV	**Special Theory of Relativity:** Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy- Momentum Four Vector.	**10**

Recommended Books:

1. Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill
2. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson,2009, PHI Learning
3. Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, 2003, McGraw Hill
4. Quantum Physics, Berkeley Physics, Vol.4. E.H. Wichman, 2008, Tata McGraw-Hill Co.
5. Modern Physics, R.A. Serway, C.J. Moses, and C.A.Moyer, 2005, Cengage Learning

Course Outcomes and Mapping

At the end of the course, the student will be able to	
CO1	gained a deep understanding on the motivations that have led in the past century to the relativistic and quantum revolution in physics
CO2	demonstrate ability to apply wave-particle duality and uncertainty principle to solve physics problems.
CO3	demonstrate ability to solve quantum mechanical eigenvalue equations for various operators and obtain expectation values of the corresponding observables.
CO4	demonstrate ability to solve 1-D quantum problems including the quantum particle in a box, a well, the simple harmonic oscillator, and the transmission and reflection of waves.
CO5	solve problems involving the quantization of mass, charge, light, and energy including Avogadro's number, black-body radiation, photoelectric effect, and other related issues.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	1	2	1	-	1	2
CO2	2	2	1	2	1	1	1
CO3	3	2	2	2	1	1	2
CO4	2	2	2	2	1	1	2
CO5	2	2	2	2	1	1	2

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL205-19**			
Subject Title:	**ENVIRONMENTAL SCIENCE**			
Contact Hours:	**L:2**	**T:0**	**P:0**	**Credits:2**
Examination Duration (hours)	**3**			
Objective(s):	This course will equip students with the necessary knowledge and make them aware about the environmental issues .			

Details of the Course

Unit	Contents	Contact Hours
I	**Introduction to Environmental Studies** Multidisciplinary nature of Environmental Studies: Scope & Importance, Need for Public Awareness **Ecosystems** Concept of an Ecosystem: Structure & functions of an ecosystem (Producers, Consumers & Decomposers) Energy Flow in an ecosystem: Food Chain, Food web and Ecological Pyramids, Characteristic features, structure & functions of following Ecosystems: Forest Ecosystem, Aquatic Ecosystem (Ponds, Lakes, River & Ocean)	7
II	**Natural Resources** Renewable & Non-renewable resources, Forest Resources: Their uses, functions & values (Biodiversity conservation, role in climate change, medicines) & threats (Overexploitation, Deforestation, Timber extraction, Agriculture Pressure), Forest Conservation Act Water Resources: Their uses (Agriculture, Domestic & Industrial), functions & values, Overexploitation and Pollution of Ground & Surface water resources (Case study of Punjab), Water Conservation, Rainwater Harvesting Land Resources: Land as a resource; Land degradation, soil erosion and desertification Energy Resources: Renewable & non-renewable energy resources, use of alternate energy resources (Solar, Wind, Biomass, Thermal), Urban problems related to Energy	8
III	**Biodiversity & its conservation** Types of Biodiversity: Species, Genetic & Ecosystem India as a mega biodiversity nation, Biodiversity hot spots and biogeographic regions of India Examples of Endangered & Endemic species of India, Red data book	7

IV	**Environmental Pollution & Social Issues** Types, Causes, Effects & Control of Air, Water, Soil & Noise Pollution, Nuclear hazards and accidents & Health risks, Global Climate Change: Global warming, Ozone depletion, Acid rain, Melting of Glaciers & Ice caps, Rising sea levels. Environmental disasters: Earthquakes, Floods, Cyclones, Landslides **Field Work** Visit to a National Park, Biosphere Reserve, Wildlife Sanctuary Documentation & preparation of a Biodiversity (flora & fauna) register of campus/river/forest Visit to a local polluted site : Urban/Rural/Industrial/Agricultural Identification & Photography of resident or migratory birds, insects (butterflies) Public hearing on environmental issues in a village	8

Reference Books

1. Bharucha, E. Text Book for Environmental Studies. University Grants Commission, New Delhi.
2. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
3. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)
4. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
5. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
6. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
7. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
8. Down to Earth, Centre for Science and Environment (R)
9. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press. 473p
10. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
11. Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p.
12. Jadhav, H & Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284 p.
13. Mckinney, M.L. & School, R.M. 1996. Environmental Science systems & Solutions, Web enhanced edition. 639p.
14. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB).
15. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
16. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
17. Rao M N. & Datta, A.K. 1987. Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd. 345p.

18. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut
19. Survey of the Environment, The Hindu (M)
20. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science.

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand environmental problems at local and national level through literature and general awareness.

CO2. Gain practical knowledge by visiting wildlife areas, environmental institutes and various personalities who have done practical work on various environmental Issues.

CO3. Apply interdisciplinary approach to understand key environmental issues and critically analyze them to explore the possibilities to mitigate these problems.

CO4. Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.

CO5. Become aware of the local, regional and global environmental problems.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	3	2	3	2	2
CO2	2	3	3	3	2	3	3
CO3	3	3	3	2	2	2	3
CO4	3	3	3	2	2	2	3
CO5	3	1	2	3	2	2	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCP206-19**			
Subject Title:	**ORGANIC CHEMISTRY LAB-II: (FUNCTIONAL GROUP TRANSFORMATIONS AND THEIR IDENTIFICATIONS)**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**
Examination Duration (hours)	**3**			
Objective(s):	The objective of this course is to provide practical knowledge and illustrative experiments regarding synthesis, separation and purification of organic compounds.			

Details of the Course

Unit	Contents
I	Functional group detection using spectroscopy techniques Application of IR and UV spectroscopy in functional groups characterization of various compounds containing different functional groups (20 compounds).
II	One step synthesis 1. Acetylation of the following compounds using conventional method or using green approach (a) amines (aniline, o-, p-toluidines) (b) phenols (β-naphthol, 2-amino phenol, salicylic acid) 2. Benzolyation of the following compounds (a) amines (aniline, o-, p- toluidines) (b) phenols (β-naphthol, resorcinol) by Schotten-Baumann reaction. 3. Oxidation of ethanol/ isopropanol (Iodoform reaction). 4. Bromination of any one of the following: (a) Acetanilide by conventional methods (b) Acetanilide using green approach (Bromate-bromide method) 5. Nitration of any one of the following: (a) Acetanilide/nitrobenzene by conventional method

	(b) Salicylic acid by green approach (using ceric ammonium nitrate). The above derivatives should be prepared using 0.5-1.0 g of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point and TLC.
III	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

S.No.	Author(s)	Title of the Book	Publisher
1	Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R.	Practical Organic Chemistry, 5th Ed.	Pearson (2012)
2	F.G. Mann and B. C. Saunders	Practical Organic Chemistry	Longman, New York
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 Outcomes and Mapping

At the end of the course, the students will be able

CO1. To synthesise organic compounds by conventional and greener approach.

CO2. To develop preparative skills for purification of organic compounds by crystallization method.

CO3. To separate the organic compound by thin layer chromatography technique.

CO4. To present their work with practical skills and the awareness of health and safety procedures.

CO5. To apply related experiments for their research work

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	1	2	-	3	2	-
CO2	2	-	3	-	3	3	-
CO3	3	3	4	-	3	3	-
CO4	3	4	3	4	4	5	4

CO5	2	3	4	2	4	4	4

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc.(Honours) Chemistry**			
Subject Code:	**BHCP207-19**			
Subject Title:	**PHYSICAL CHEMISTRY LAB-II**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**
Examination Duration (hours)	**4**			
Objective(s):	To provide students practical knowledge and skills about various topics taught in theory class of physical chemistry, which in turn will enhance their problem solving and analytical skills.			

Details of the Course

Contents
1. Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization). 2. Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide. 3. Calculation of the enthalpy of ionization of ethanoic acid. 4. Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts. 5. 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. 6. Determination of enthalpy of hydration of copper sulphate. 7. Study of the solubility of benzoic acid in water and determination of ΔH. 8. To Determine the Molecular Weight of given compound by Freezing Point Depression Method *Any other experiment related to thermochemistry carried out in the class.*

Reference Books

S.No.	Author(s)	Title of the Book	Publisher
1	J.B. Yadav	Practical Physical Chemistry	Krishna
2	B. D. Khosla, V. C. Garg, & A. Gulati,	Senior Practical Physical Chemistry	R. Chand & Co. New Delhi (2011)
3	V. D. Athawale, & P. Mathur,	Experimental Physical Chemistry	New Age International: New Delhi (2001)

Course Outcomes and Mapping

At the end of the course, the students will be able to

CO1. Understand the basic procedures for carrying out a physical chemistry practical like preparation and standardisation of solutions, handling the equipments and measuring with precision.

CO2. Correlate the theoretical and practical aspects and know about the limits of the experimental error.

CO3. Determine the various physical parameters for the various problems under study.

CO4. Verify various laws studied in the theory part.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	3	3	3	3	3	3
CO2	2	2	3	3	3	2	2
CO3	2	3	3	2	2	3	3
CO4	2	3	3	1	2	2	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**UC-BSHP-215-19**			
Subject Title:	**PHYSICS LAB-III (ELEMENTS OF MODERN PHYSICS LAB)**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**
Examination Duration (hours)	**3**			
Objective(s):	The aim and objective of the Physics Lab course is to introduce the students of B. Sc. (Hons.) Physics to the formal structure of wave and vibrations and mechanics so that they can use these as per their requirement.			

Details of the Course

Contents
Students are expected to perform about 8-10 experiments from the following list, selecting minimum of 6-7 from the Physical Lab and 2-3 from the Virtual lab 1. To determine value of Boltzmann constant using V-I characteristic of PN diode. 2. To show the tunneling effect in tunnel diode using I-V characteristics. 3. To determine work function of material of filament of directly heated vacuum diode 4. To determine value of Planck's constant using LEDs of at least 4 different colors. 5. Measurement of Planck's constant using black body radiation and photo-detector. 6. To determine work function of material of filament of directly heated vacuum diode. 7. To determine the ionization potential of mercury. 8. To determine the wavelength of H-alpha emission line of Hydrogen atom. 9. To determine the absorption lines in the rotational spectrum of Iodine vapour. 10. To study the diffraction patterns of single and double slits using laser source and measure its intensity variation using Photosensor and compare with incoherent source – Na light. 11. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light 12. To determine the value of e/m by magnetic focusing. 13. To experimentally demonstrate the concept of quantization of energy levels according to Bohr's model of atom using Franck-Hertz Apparatus. 14. To determine the wavelength of laser source using diffraction of single slit. 15. To determine the wavelength of laser source using diffraction of double slits. 16. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency.

Recommended Books:

1. Experimental Physics - M.A. Hippargi.

2. Experimental Physics – Gadad & Hiregoudar.
3. Practical Physics - C. L. Arora.
4. Advanced Practical Physics – Worsnop and Flint.
5. Practical Physics – Gupta & Kumar Vol I, Vol II
6. http://vlab.amrita.edu/?sub=1&brch=195

Course Outcomes and Mapping

At the end of the course, the student will be	
CO1	Able to understand the theoretical concepts learned in the theory course.
CO2	Trained in carrying out precise measurements and handling equipment.
CO3	Learn to draw conclusions from data and develop skills in experimental design.
CO4	Able to understand the principles of error analysis and develop skills in experimental design.
CO5	Able to document a technical report which communicates scientific information in a clear and concise manner.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	1	2
CO2	3	3	3	3	2	2	1
CO3	3	3	2	-	2	1	2
CO4	3	2	2	2	-	2	2
CO5	2	2	2	2	-	2	2

SEMESTER-IV

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL211-19**			
Subject Title:	**INORGANIC CHEMISTRY-III (Crystal field theory and transition elements)**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	To teach the fundamental concepts of Inorganic Chemistry and their applications.			

Details of the Course

Unit	Contents	Contact Hours
I	**Coordination Chemistry-II:** Valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.	13
II	**Transition Elements-I:** General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, 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.	10
III	**Transition Elements-II:** Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy). **Lanthanoids and Actinoids:**	10

	Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).	
IV	**Bioinorganic Chemistry:** Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the 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), reasons for toxicity, Use of chelating agents in medicine. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.	12

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	Purcell, K.F & Kotz, J.C.	Inorganic Chemistry	W.B. Saunders Co, 1977.
2	Huheey, J.E.	Inorganic Chemistry	Prentice Hall, 1993
3	Lippard, S.J. & Berg, J.M.	Principles of Bioinorganic Chemistry	Panima Publishing Company 1994
4	Cotton, F.A. & Wilkinson, G	Advanced Inorganic Chemistry	Wiley-VCH, 1999
5	Basolo, F, and Pearson, R.C.	Mechanisms of Inorganic Chemistry	John Wiley & Sons, NY, 1967
6	Greenwood, N.N. & Earnshaw A.	Chemistry of the Elements	Butterworth-Heinemann,1997

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand the fundamental concepts of various theories of coordination compounds

CO2. Learn the periodicity of the transition elements

CO3. Understand the chemistry involved in the different transition elements.

CO4. Learn about the role of metal ions in the biological systems.

CO5. Understand the effect of trace metals on the biological systems

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	3	3	2	1
CO2	2	3	2	3	1	3	2
CO3	2	2	3	2	2	2	3
CO4	1	2	2	2	2	1	2
CO5	2	1	2	2	1	3	2

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL212-19**			
Subject Title:	**PHYSICAL CHEMISTRY-III (Phase Equilibrium & Chemical Kinetics)**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	This course will equip students with the necessary knowledge concerning the fundamentals in physical chemistry concerning phase equilibria, chemical kinetics, catalysis and adsorption. The problem solving skills of students are expected to be enhanced through due weightage given to numerical problems in each unit.			

Details of the Course

Unit	Contents	Contact Hours
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. *Binary solutions:* Gibbs-Duhem-Margules equation, azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.	15
II	**Chemical Kinetics** Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (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, Numericals. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.	14

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, surface catalyzed unimolecular and bimolecular reactions. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.	8
IV	**Adsorption:** Physical adsorption, chemisorption, adsorption isotherms. nature of adsorbed state, derivation of Langmuir, Freundlich, and BET adsorption isotherms, estimation of surface area by BET equation, Types of Adsorption Isotherms, Gibb's Adsorption isotherm.	8

Reference Books

1. Peter Atkins & Julio De Paula, *Physical Chemistry 9th Ed.*, Oxford University Press (2010).
2. Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa (2004).
3. McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.: New Delhi (2004).
4. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall (2012).
5. Zundhal, S.S. *Chemistry concepts and applications* Cengage India (2011).
6. Ball, D. W. *Physical Chemistry* Cengage India (2012).
7. Mortimer, R. G. *Physical Chemistry 3rd Ed.*, Elsevier: NOIDA, UP (2009).
8. Levine, I. N. *Physical Chemistry 6th Ed.*, Tata McGraw-Hill (2011).
9. Metz, C. R. *Physical Chemistry 2nd Ed.*, Tata McGraw-Hill (2009).

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Describe various terms associated with phase equilibria, chemical kinetics, catalysis and adsorption.

CO2. Analyse and draw phase diagrams for single and two component systems

CO3. Define the various terms associated with catalysis.

CO4. Familiarise with the phenomenon of adsorption and its related theories.

CO5. Understand the factors affecting the kinetics of chemical processes.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	1	1	-	2	1	1
CO2	3	2	3	-	1	-	1
CO3	2	2	1	-	2	1	1
CO4	3	2	2	-	2	1	1
CO5	3	2	2	-	1	-	1

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL213-19**			
Subject Title:	**GREEN CHEMISTRY**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	To teach the fundamental concepts of Green Chemistry and its applications.			

Details of the Course (Atomic Structure and Chemical Bonding)

Unit	Contents	Contact Hours
I	**Introduction to Green Chemistry** What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry. **Principles of Green Chemistry and Designing a Chemical synthesis** Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/ minimization of hazardous/ toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups.	12
II	**Principles of Green Chemistry and Designing a Chemical synthesis** Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes. **Examples of Green Synthesis/ Reactions**	12

	1. Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, citral, ibuprofen, paracetamol. 2. Microwave assisted reactions in water: Hofmann Elimination, Oxidation of toluene	
III	Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Diels-Alder Reaction. Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, synthesis of nitriles from aldehydes. 3. Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction.	10
IV	**4.** Selective methylation of active methylene group using dimethylcarbonate, Free Radical Bromination; Biocatalysis in organic syntheses. **Future Trends in Green Chemistry** Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; oncovalent derivatization; Green chemistry in sustainable development	11

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	V.K. Ahluwalia & M.R. Kidwai	New Trends in Green Chemistry	Anamalaya Publishers (2005)
2	P.T. Anastas & J.K. Warner	Oxford Green Chemistry- Theory and Practical	University Press (1998)
3	A.S. Matlack	Introduction to Green Chemistry	Marcel Dekker (2001)
4	M.C. Cann & M.E. Connely	Real-World cases in Green Chemistry	American Chemical Society, Washington (2000)
5	M.A. Ryan & M. Tinnesand	Introduction to Green Chemistry	American Chemical Society, Washington (2002)

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand the fundamental concepts of green chemistry

CO2. Learn the use of these fundamental principles for the designing of various chemical reactions

CO3. Understand the various techniques available and their present applications in different green reactions
CO4. Learn about the various applications of the green chemistry
CO5. Understand the various expected future trends of the green chemistry

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	2	3	2	2	1	2
CO2	2	3	2	1	3	2	1
CO3	1	2	3	1	2	2	1
CO4	1	2	1	3	2	2	0
CO5	2	3	2	2	1	2	2

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL214-19**			
Subject Title:	**POLYMER CHEMISTRY**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	This course will equip students with the knowledge concerning the fundamentals in the basic areas of Polymer Chemistry.			

Details of the Course

Unit	Contents	Contact Hours
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. **Functionality and its importance:** Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems.	10
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.	12
III	**Determination of molecular weight of polymers** (M_n, M_w, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index. **Glass transition temperature (T_g) and determination of T_g** Free volume theory, WLF equation, Factors affecting glass transition temperature (T_g). **Polymer Solution** – Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy,	11

	and free energy change of mixing of polymers solutions, Flory-Huggins theory, Lower and Upper critical solution temperatures.	
IV	**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)].	12

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	G. Odian	Principles of Polymerization	John Wiley
2	F.W. Billmeyer	Text Book of Polymer Science	John Wiley
3	P. Ghosh	Polymer Science & Technology	Tata Mcgraw-Hill
4	R.W. Lenz:	Organic Chemistry of Synthetic High Polymers	-

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Study the nomenclature, classifications and bonding in polymers

CO2. Learn the criteria for the synthesis of polymers and mechanism involved in polymerization

CO3. Understand the morphology, kinetics and their structure property relationship

CO4. Learn the various techniques used for determining the molecular weight of polymeric compounds

CO5. Study the physical, thermal, Flow and Mechanical Properties of Polymers

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	4	4	3	-	3	4	2
CO2	4	2	3	1	2	2	-
CO3	4	2	1	-	4	4	-
CO4	4	4	4	-	4	3	-
CO5	4	3	4	-	4	-	-

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**UC-BSHM-408-19**			
Subject Title:	**Maths-III (MATRICES & ORDINARY DIFFERENTIAL EQUATIONS)**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	The objective of the course on **Matrices & Ordinary Differential Equations** is to equip the B.Sc. (Hons) students with the theoretical aspects of matrices. Their applications in system of equations and real-life engineering problems. Furthermore, students will be introduced to Ordinary Differential Equations.			

Details of the Course

Unit	Contents	Contact Hours
I	**Matrices**: Introduction to matrix, Different kinds of matrices, Addition, Multiplication, Symmetric and Skew symmetric matrix, Transpose of matrix, trace of a matrix**.** Determinants**:** Determinant of matrix, Properties of determinant, Singular and non**-**singular matrices, Adjoint and inverse of a matrix, Rank of a matrix.	12
II	**System of Equations:** Introduction to system of linear equations, Condition of Consistency of system of linear equations, Homogenous and Non-homogenous system of equations, Echelon form. Solving Linear system of Equations: Matrix inversion method, Gauss-Jordon method and Gauss Elimination method.	12
III	**ODE**: Introduction of differential coefficient, Ordinary differential equation, Order and degree of differential equation, Formation of differential equation, Difference between linear and non**-**linear differential equations**.**	10
IV	**Solving Ordinary Differential Equations:** Solution of Separable differential equations, linear differential equations of the first order, Exact differential equations, Solution of homogeneous differential equations, Bernoulli's equation and Riccati equation, The chemical application of these first order differential equations.	11

Reference Books

1. Mathematics 10+2, NCERT, New Delhi.
2. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition. Wiley Publications, 2005.

3. O'Neil, P.V., Advanced Engineering Mathematics 7th Edition. Cengage Learning Custom Publishing, 2011.
4. Jain, R.K. and Iyengar, S.K., Advanced Engineering Mathematics 5th Edition. New Delhi: Narosa Publication, 2011.

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Learn the basic concepts of Matrices.

CO2. Understand about operations on matrices, such as, addition, subtraction and multiplication. And, the concept of determinants.

CO3. Use matrices in solving system of equations using Gauss Elimination method, Gauss-Jordon method, Matrix inversion method etc.

CO4. Be acquainted with knowledge of ordinary differential equations and Linear differential equations.

CO5. Apply the learnt techniques in solving various problems related to differential equations.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	2	2	2	2	2	2
CO2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2
CO4	2	2	2	2	1	2	2
CO5	2	2	2	2	1	1	1

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL216-19**			
Subject Title:	**BASIC ANALYTICAL CHEMISTRY**			
Contact Hours:	**L:2**	**T:0**	**P:0**	**Credits:2**
Examination Duration (hours)	**3**			
Objective(s):	This is skill enhancement course to equip students with the necessary knowledge about basic techniques applied in analytical chemistry.			

Details of the Course

Unit	Contents	Contact Hours
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.	6
II	**Analysis of soil:** Composition of soil, humus and clay, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators **Analysis of water:** Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.	10
III	**Chromatography:** Definition, general introduction on principles of chromatography, paper chromatography, TLC etc. **Ion-exchange:** Column, ion-exchange chromatography etc.	7
IV	**Analysis of food products:** Nutritional value of foods, idea about food processing and food preservations and adulteration. **Analysis of cosmetics:** Major and minor constituents and their function	7

Reference Books

1. Willard, H. H. *Instrumental Methods of Analysis*, CBS Publishers.
2. Skoog & Lerry. *Instrumental Methods of Analysis*, Saunders College Publications, New York.
3. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.*, Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
5. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
7. Freifelder, D. Physical Biochemistry *2nd Ed.*, W.H. Freeman and Co., N.Y. USA (1982).
8. Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.*, Prentice Hall.
10. Vogel, A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Prentice Hall.

11. Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.,* Marcel Dekker, Inc., New York.

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand the basics of analytical chemistry.

CO2. Know about soil and water, their sampling, analysis & purification methods.

CO3. Familarise with the principles and techniques of chromatography.

CO4. Aware of the nutritional value of various food items and concept of food processing and adulteration.

CO5. Understand the functions of various constituents present in cosmetics.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	1	-	3	-	-
CO2	3	2	1	2	2	2	1
CO3	3	2	1	1	2	2	1
CO4	3	3	1	2	-	2	1
CO5	3	3	1	2	-	2	-

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCP217-19**			
Subject Title:	**INORGANIC CHEMISTRY LAB-III**			
Contact Hours:	**L:0**	**T:0**	**P:6**	**Credits:3**
Examination Duration (hours)	**3**			
Objective(s):	To understand the various concepts involved in the quantitative analysis of the metal ions through gravimetric analysis; learn to prepare the inorganic complexes and chromatographic separation techniques for the separation of different metal ions.			

Details of the Course

Unit	Contents
	Gravimetric Analysis: i. Estimation of nickel (II) using Dimethylglyoxime (DMG). ii. Estimation of copper as CuSCN iii. Estimation of iron as Fe_2O_3 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, $[Cu(NH_3)_4]SO_4.H_2O$ ii. *Cis* and *trans* $K[Cr(C_2O_4)_2.(H_2O)_2]$ 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)

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	Vogel, A.I.	Vogel's book on Quantitative Analysis	ELBS, 1986

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand the concept of qualntitative analysis.

CO2. Understand the various techniques/principles involved in the quantitative analysis for present metal ions.

CO3. Learn to synthesize various inorganic compounds

CO4. Understand the principles involved in chromatographic separations

CO5. Learn to estimate the cations present, through quantitative analysis

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	1	2	2	1	2
CO2	1	2	2	2	1	0	1
CO3	2	1	1	2	2	1	2
CO4	2	3	3	2	2	2	1
CO5	1	2	2	2	3	1	2

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc.(Honours) Chemistry**			
Subject Code:	**BHCP218-19**			
Subject Title:	**PHYSICAL CHEMISTRY LAB-III**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**
Examination Duration (hours)	**4**			
Objective(s):	To provide students practical knowledge and skills about various topics taught in theory class of physical chemistry, which in turn will enhance their problem solving and analytical skills.			

Details of the Course

Unit	Contents
	1. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it. 2. Determination of distribution coefficient of succinic acid between ether and water. 3. Distribution of benzoic acid between water and benzene and show that benzoic acid dimerises in benzene. 4. Determination of equilibrium constant of the reaction; $KI + I_2 \leftrightarrow KI_3$ by the distribution method. 5. Determination of formula of complex formed between the cupric ion and ammonia by distribution method. 6. Determination of rate constant of hydrolysis of methyl acetate catalyzed by acid and also the energy of activation. 7. Compare the relative strengths of the acids by studying kinetics of hydrolysis of methyl acetate. 8. Study the hydrolysis of methyl acetate catalyzed by HCl and equimolar urea hydrochloride, and hence the degree of hydrolysis of the salt. 9. Study the kinetics of the saponification of ethyl acetate. 10. Investigate the reaction between hydrogen peroxide and hydrogen iodide. 11. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Reference Books

S.No.	Author(s)	Title of the Book	Publisher
1	J.B. Yadav	Practical Physical Chemistry	Krishna
2	B. D. Khosla, V. C. Garg, & A. Gulati,	Senior Practical Physical Chemistry	R. Chand & Co. New Delhi (2011)
3	V. D. Athawale, & P. Mathur,	Experimental Physical Chemistry	New Age International: New Delhi (2001)

Course Outcomes and Mapping

At the end of the course, the students will be able to

CO1. Understand the basic procedures for carrying out a physical chemistry practical like preparation and standardisation of solutions, handling the equipments and measuring with precision.

CO2. Correlate the theoretical and practical aspects and know about the limits of the experimental error.

CO3. Determine the various physical parameters for the various problems under study.

CO4. Verify various laws studied in the theory part.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	3	3	3	3	3	3
CO2	2	2	3	3	3	2	2
CO3	2	3	3	2	2	3	3
CO4	2	3	3	1	2	2	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc.(Honours) Chemistry**			
Subject Code:	**BHCP219-19**			
Subject Title:	**BASIC ANALYTICAL CHEMISTRY LAB-III**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**
Examination Duration (hours)	**3**			
Objective(s):	To provide students practical knowledge and skills about various topics taught in theory class of basic analytical chemistry, which in turn will enhance their problem solving and analytical skills.			

Details of the Course

Unit	Contents
	1. Importance of significant figures and standard deviations 2. Determination of pH of soil samples. 3. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration. 4. Determination of pH, acidity and alkalinity of a water sample. 5. Determination of dissolved oxygen (DO) of a water sample. 6. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc. 7. Analysis of preservatives and colouring matter. 8. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}). 9. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate. 10. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets. 11. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Reference Books

1. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
2. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.

Course Outcomes and Mapping

At the end of the course, the students will be able to

CO1. Identify the adulterants in common food items.
CO2. Analyse samples of soil (pH) and water (pH, acidity, alkalinity etc)
CO3. Learn the paper chromatographic technique for separation of metal ions.
CO4. Learn the spectrpphotometric determination of compounds in commercial products.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	3	3	3	3	3	3
CO2	2	2	3	3	3	2	2
CO3	2	1	2	2	2	1	1
CO4	2	3	3	1	2	2	3

Semester V

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL301-19**			
Subject Title:	**Inorganic Chemistry-IV (Organometallic Chemistry)**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	To teach the fundamental concepts of Inorganic Chemistry and their applications.			

Details of the Course

Unit	Contents	Contact Hours
I	**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. π-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding	10
II	**Organometallic Compounds:** Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls. Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.	12
III	Metallocenes and sandwich complexes, Structure of the metallocenes , Redox properties of the sandwich metallocenes ,Metallocene synthesis, Chemical properties of Metallocenes, Triple- and multiple-decker sandwich complexes, Non-sandwich metallocenes derivatives, Metal-bis-arene sandwich complexes, Cylopentadienyl-metal-arene complexes. Preparations of Metal-carbene complexes, Metal-carbyne complexes, structures and reactions.	11
IV	**Reaction Kinetics and Mechanism:** Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans-effect, theories of trans effect, Mechanism of nucleophilic substitution	12

	in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.	

Reference Books

1. Vogel, A.I. Qualitative Inorganic Analysis, Longman, 1972.
2. Svehla, G. Vogel's Qualitative Inorganic Analysis, 7th Edition, Prentice Hall, 1996-03-07.
3. Cotton, F.A. G.; Wilkinson & Gaus, P.L. Basic Inorganic Chemistry 3rd Ed.; Wiley India.
4. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.
5. Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005
6. Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry3rd Ed., John Wiley and Sons, NY, 1994.
7. Greenwood, N.N. & Earnshaw, A. Chemistry of the Elements, Elsevier 2nd Ed, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
8. Lee, J.D. Concise Inorganic Chemistry 5th Ed., John Wiley and sons 2008.
9. Powell, P. Principles of Organometallic Chemistry, Chapman and Hall, 1988.
10. Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.
11. Basolo, F. & Person, R. Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed., John Wiley & Sons Inc; NY.
12. Purcell, K.F. & Kotz, J.C., Inorganic Chemistry, W.B. Saunders Co. 1977
13. Miessler, G. L. & Donald, A. Tarr, Inorganic Chemistry 4th Ed., Pearson, 2010.
14. Collman, James P. et al. Principles and Applications of Organotransition Metal Chemistry. Mill Valley, CA: University Science Books, 1987.
15. Crabtree, Robert H. The Organometallic Chemistry of the Transition Metals. j New York, NY: John Wiley, 2000.
16. Spessard, Gary O., &Gary L. Miessler. Organometallic Chemistry. Upper Saddle River, NJ: Prentice-Hall, 1996.

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand the fundamental concepts of various concepts involved in organometallic compounds
CO2. Learn different methods of preparations and various chemical reactions of organometallic compounds
CO3. Understand the kinetics involved in the different reactions.
CO4. Learn about the catalytic applications of organometallic compounds.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	2	3	2	3	1	2
CO2	2	3	3	3	2	3	2
CO3	3	2	3	2	2	2	2

CO4	3	2	3	2	3	2	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL302-19**			
Subject Title:	**Organic Chemistry-III (Heterocyclic Chemistry)**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	The objective of this course is to develop basic understanding of heterocyclic chemistry. Emphasis is given on the most important heterocyclic systems particularly five and six-membered heterocyclic systems, small ring heterocycles as well as fused heterocyclic systems.			

Details of the Course

Unit	Contents	Contact Hours
I	**Heterocyclic Nomenclature** Systematic (Hantzsch-Widman System), trivial and replacement nomenclature system for monocyclic, fused, spiro and bridged heterocycles **Aromatic Heterocycles** Aromaticity in heterocycles: relationship with carbocyclic aromatic compounds and structural criteria, structure of six-membered and five membered rings with one heteroatom. Structures of bicyclic heteroaromatic compounds and tautomerism in aromatic heterocycles. Synthesis and mechanism of substitution reactions of furan, pyrrole (Paal-Knorr, Knorr pyrrole and Hantzch synthesis), thiophene, pyridine (Hantzch synthesis), Pyrimidine, structure elucidation of indole, Fisher indole synthesis and Madelung synthesis. Synthesis and reactions of pyrylium salts and pyrones and their comparison with pyridinium & thiopyrylium salts and pyridones. Synthesis and reactions of quinolizinium and benzopyrylium salts, coumarins and chromones.	12
II	**Six-Membered Heterocycles with Two or More Heteroatoms** Synthesis and reactions of diazines, triazines, oxadiazoles and thiadiazoles **Purines: Synthesis and Reactions** Approaches for the construction of purine ring, reactions of purines with electrophilic reagents, with nucleophilic reagents, reactions with bases, reactions of C-metallated purines **Non-aromatic Heterocycles** Strain-bond angle and torsional strains and their consequences in small ring heterocycles. Conformation of six-membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion and 1,3-diaxial interaction.	13

	Stereo-electronic effect-anomeric and related effects. Attractive interactions-hydrogen bonding and intermolecular nucleophilic-electrophilic interactions	
III	**Heterocyclic Synthesis** Introduction, types of reactions and heterocyclic synthesis involving cyclization and cycloaddition reactions **Small Ring Heterocycles** Synthesis and reactions of three-membered heterocycles (aziridine, oxirane, thiirane) and four membered heterocycles (azetidine, oxetane and thietane)	10
IV	**Benzo-Fused Five-Membered Heterocycles** Synthesis and reactions (electrophilic, nucleophilic, oxidation, reduction and cycloaddition) of benzopyrroles, benzofurans and benzothiophenes **Meso-ionic Heterocycles** General classification, chemistry of meso-ionic heterocycles of type-A (1,3-oxazolium-4-olates, 1,3-oxazolium-5-olates, 1,3-oxathioliwn-4-olates, 1,3-oxathiolium-5-olates) and type-B (1,2-Diazoliwn-4-aminides, 1,2-Dithiolium-4-olates) and their applications.	10

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	J. A. Joule, K. Mills and G. F. Smith	Heterocyclic Chemistry, 3rd & 5th edition	A John Wiley & Sons, Ltd., Publication
2	T. L. Gilchrist	Heterocyclic Chemistry	Longman Scientific Technical
3	T. Eicher, S. Hauptmann, and A. Speicher	The chemistry of Heterocyclic Chemistry	Wiley-VCH
4	G. R. Newkome and W.W. Paudler,	Contemporary Heterocyclic Chemistry	Wiley-Inter Science
5	R. M. Acheson	An Introduction to Heterocyclic Compounds	John Wiley
6	A. Paquett	Heterocyclic Chemistry	-

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Know about the most important heterocyclic ring systems containing heteroatom and their systems of nomenclature and numbering.

CO2. Understand and discuss the reactivity and stability of hetero aromatic compounds.

CO3. Study the important synthetic routes and reactivity for five and six member hetero aromatic compounds.

CO4. Understand the important chemical properties of five and six member hetero aromatic compounds.

CO5. Learn the synthesis and chemical reactions of small ring and Benzo-fused heterocycles.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	4	1	3	-	1	3	1
CO2	4	1	3	-	2	3	-
CO3	3	3	2	-	3	2	1
CO4	3	3	2	-	3	2	1
CO5	2	3	3	-	2	3	-

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL303-19**			
Subject Title:	**QUANTUM CHEMISTRY**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	This course will equip students with the necessary knowledge concerning the quantum mechanical concepts in chemistry. The problem solving skills of students are expected to be enhanced through due weightage given to numerical problems in each unit.			

Details of the Course

Unit	Contents	Contact Hours
I	Classical Mechanics vs quantum mechanics, Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and particle-in-a-box, quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, 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 wavefunctions. Vibrational energy of diatomic molecules and zero-point energy.	13
II	Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution. Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression) Radial and angular parts of the hydrogen atomic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals. Significance of Quantum numbers.	10
III	Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H2. Bonding and antibonding orbitals. Qualitative extension to $H2^{+}$. Qualitative description of LCAO-MO treatment of diatomic molecules: Term symbols and Molecular orbital for homonuclear and heteronuclear (CO, HF, LiH) molecules. Comparison of LCAO-MO and VB treatments of H2 (only wavefunctions, detailed solution not required) and their limitations.	10

IV	**Photochemistry** Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.	12

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	G.M. Barrow	Physical Chemistry	Tata McGraw-Hill: New Delhi (2007)
2	A. K. Chandra	Introductory Quantum Chemistry	Tata McGraw-Hill (2001).
3	J. E. House	Fundamentals of Quantum Chemistry 2nd Ed.	Elsevier: USA (2004).
4	J. P. Lowe & K.Peterson,	Quantum Chemistry	Academic Press (2005).
5	G.W. Castellan	Physical Chemistry 4th Ed	Narosa (2004)

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. be able to explain how quantum mechanical systems differ from classical systems.

CO2. interpret the physical significance of the wave functions and energy levels derived by solving the time-independent Schrödinger equation.

CO3. understand and be able to explain the origin of quantized energy levels.

CO4. relate the energy levels obtained as solutions to the time-independent Schrödinger equation for different systems with spectroscopic techniques.

CO5. Understand the origin of theories used to describe the covalent bonding especially for diatomic molecules.

CO6. learn the various laws of photochemistry and explain the various processes behind photochemical reactions.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	1	1	-	2	1	1
CO2	3	2	3	-	1	-	1
CO3	2	2	1	-	2	1	1
CO4	3	2	2	-	2	1	1
CO5	3	2	2	-	1	-	1

CO6	2	2	1	-	2	1	1

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL304-19**			
Subject Title:	**ANALYTICAL CLINICAL BIOCHEMISTRY**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	**Basic understanding of the structures, properties and functions of carbohydrates, lipids and proteins and the analysis of biochemistry of diseases using Blood and Urine.**			

Details of the Course

Unit	Contents	Contact Hours
I	**Carbohydrates:** Classification, Types and Biological importance of Monosaccharides, Disaccharides, Polysaccharides and Glycosaminoglycans. Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle. Isolation and characterization of polysachharides.	10
II	**Proteins:** Classification, biological importance; Primary and secondary and tertiary structures of proteins- α-helix and β- pleated sheets, Isolation, characterization and denaturation of proteins. **Enzymes:** Nomenclature, classification, Characteristics (mention of Ribozymes), Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, effect of pH, temperature on enzyme activity, enzyme inhibition. Biocatalysis.	11
III	**Lipids:** Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications. **Lipoproteins:** Properties, functions and biochemical functions of steroid hormones. Biochemistry of peptide hormones. **Nucleic Acids:** Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.	11

IV	**Biochemistry of disease:** A diagnostic approach by blood/ urine analysis. **Blood:** Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin. Normal constituents of blood and their estimation and variation in pathological conditions - urea, uric acid, creatinine, glucose, bilirubin, total protein, albumin/globulin ratio. Lipid profile – cholesterol, triglycerides, lipoproteins - HDL and LDL. **Urine:** Collection and preservation of samples. Normal composition of urine – volume, pH, colour, specific gravity. Constituents-urea, uric acid, creatinine, pigment. Abnormal constituents – glucose, albumin, ketone bodies, variations in urea, creatinine, pigments and their clinical significance in brief. Uremia, hyperuricemia, porphyria and factors affecting nitrogen balance.	13

Reference Books

1. Lippincott's illustrated biochemistry – Champe and Harvey; 6th edition 2007.
2. D.Voet and J.G. Voet: Fundamentals of Biochemistry, John Wiley & Sons, USA 2004.
3. Albert L. Lehninger Principles of Biochemistry CBS Publishers & Distributors, New Delhi.
4. Nelson, D. L. & Cox, M. M. :Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.
5. Berg, J. M., Tymoczko, J. L. & Stryer, L. Biochemistry 7th Ed., W. H. Freeman.
6. O. Mikes, R.A. Chalmers: Laboratory Handbook of Chromatographic Methods.
7. M.N.Chatterjea and Ranashinde: Text book of Medical biochemistry. Jaypee Brothers Medical Publisher (P) Ltd.

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand the structure & functions of Biomolecules.
CO2. An advanced understanding and applied knowledge of the theory of clinical biochemistry.
CO3. A critical understanding of how biochemical investigations are employed to develop a clinical diagnosis.
CO4. To gain knowledge and understanding of clinical disorders.
CO5. To gain knowledge of biological samples and their collection procedures.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	3	2	2	3	2	2
CO2	2	3	3	3	2	3	3
CO3	3	2	3	3	2	2	3
CO4	3	2	3	2	3	2	3
CO5	3	2	2	3	2	3	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL305-19**			
Subject Title:	**INDUSTRIAL CHEMICALS AND ENVIRONMENT**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	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.			

Details of the Course

Unit	Contents	Contact Hours
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. *Industrial Metallurgy*: Preparation of ultrapure metals for semiconductor technology.	12

II	**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., Major sources of air pollution and Pollution by SO_2, CO_2, CO, NO_x, and H_2S gases. Methods of estimation of CO, NO_x, SO_x 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.	11
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.	10
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. E-waste and its Management **Biocatalysis** Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry.	12

Reference Books

1. Manahan, S.E. (2017),**Environmental Chemistry**, CRC Press.
2. Buchel, K.H.; Moretto, H.H.; Woditsch, P.(2003),**Industrial Inorganic Chemistry**, Wiley-VCH.

3. De, A.K.(2012), **Environmental Chemistry,** New Age International Pvt., Ltd.
4. Khopkar, S.M.(2010), **Environmental Pollution Analysis**, New Age International Publisher.
5. Rai, G.D., Non-Conventinal Energy Resources, Khanna Publications.

Course Outcomes and Mapping

At the end of the course, the student will be able to understand

CO1. different toxic gases and their toxicity hazards, Safe design systems for large scale production of Industrial gases.

CO2. manufacturing processes, handling and storage of inorganic chemicals and knowledge of Hazardous effects of the inorganic chemicals on human beings and vegetation.

CO3. the requirement of ultra-pure metals for the semiconducting technologies.

CO4. different sources, effects and control measures of air, water pollutants, water quality parameters, different methods of Treatment of effluents from different sources.

CO5. different sources of energy, source of nuclear waste and its disposal. Use of biocatalyst in chemical industries.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	4	2	3	1
CO2	2	3	4	5	3	3	3
CO3	3	3	3	2	2	2	2
CO4	2	3	3	5	4	3	3
CO5	3	2	4	5	3	4	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL306-19**			
Subject Title:	**LIGAND FIELD THEORY**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	To teach the concepts of ligand field theory and their applications.			

Details of the Course

Unit	Contents	Contact Hours
I	**Symmetry:** Symmetry elements, symmetry operations, point group determination, determination of reducible and irreducible representations, character tables, use of symmetry in obtaining symmetry of orbitals in molecules, use of character table to determine which metal orbitals are used in σ and π bond formation in octahedral, tetrahedral and square planar transition metal complexes, qualitative splitting of s, p, d, f orbitals in octahedral, tetrahedral and square planar fields using character tables and without the use of character tables. **Orbital Wave Functions:** Wave function and shapes of imaginary and real s, p, d and f orbital (cubic and general set in case of f orbitals), Z – component of orbital angular momentum, vector, imaginary and real d orbitals.	11
II	**Crystal Field Theory:** Evaluation of $V_{(x, y, z)}$, $V_{oct.}$, $V_{sq, pl.}$ and $V_{tetragonal}$, evaluation of $V_{oct.}$ in cartesian co- ordinates, effect of V_{oct} on d-orbital wave functions. **Interelectronic Repulsions:** Spin-spin, orbital-orbital and spin orbital coupling, L.S. and jj coupling schemes, determination of all the spectroscopic terms of p^n , d^n ions, determination of the ground state terms for p^n , d^n , f^n ions using L.S. scheme, determination of total degeneracy of terms, order of interelectronic repulsions and crystal field strength in various fields, two type of electron repulsion parameters, term wave functions, Bra and Ket notation, derivations of single electron wave functions and their linear combinations for getting the term wave functions of all spectroscopic terms of d^n system, spin orbit coupling parameters (λ) energy separation between different j states.	13
III	**Free Ions in Weak Crystal Field:** The effect of V_{oct} on S, P, D and F terms (with help of the character table and qualitatively), splitting patterns of and G, H and I terms. **Free Ions in Medium and Strong Crystal Fields**: Strong field configurations, transition from weak to strong crystal fields, evaluation of strong crystal field terms of d^2 and d^3 cases in octahedral and tetrahedral crystal fields (using group theory), construction of the	11

	correlation energy level diagrams of d^2 and d^3 configurations in octrahedral and tetrahedral fields, study of energy level diagrams for higher configurations, selection rules of elecronic transitions in transition metal complexes, their proof using group theory, relaxation of the selection rule in centrosymmetric and non centrosymmetric molecules, Orgel diagrams, Tanabe Sugano diagrams, interaction of T_{1g} (P) and T_{1g}(F) terms.	
IV	**Electronic Spectra of Transition Metal Complexes**: Variation of the Racah parameter, central field covalency, symmetry restricted covalency, differential radial expansion, intermediate coupling, nephlauxetic effect, spectrochemical series, band intensities, factors influencing band widths, variation of 10Dq, vibrational structure, spin orbit coupling, low symmetry components, Jahn-Teller effect, discussion of electronic spectra of octahedral and tetrahedral $d^1 – d^9$ metal ions, calculation of 10Dq and B with and without the use of Tanabe Sugano diagrams, low spin complexes of Mn^{3+}, Mn^{2+}, Fe^{3+}, Co^{3+}, Fe^{2+}, comment on the spectra of second and third transition series, spectra of K_3MoCl_6 and $[Rh(NH_3)_6]^{3+}$, spectra of cis and trans$[Co(en)_2X_2]^+$, $[Mn(H_2O)_6]^{2+}$, $CuSO_4.5H_2O$ and anhydrous complex, comparison of d – d band with f – f bands.	10

Reference Books

1. B.N. Figgis, Introduction to Ligand Field, Wiley Eastern.
2. A.B.P. Lever, Inorganic Electronic Spectroscopy, Elsevier.
3. A. Earnshaw, Introduction to Magnetochemistry, Academic Press.
4. J.E. Huheey, Inorganic Chemistry Principles of Structure and Reactivity, Harper Inter-Science.
5. R.S. Drago, Physical Method in Chemistry, W.B. Saunders Company.
6. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, Wiley Inter-science.
7. F.A. Cotton, Chemical Application of Group Theory, Wiley Eastern.

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand the fundamental concepts of various aspects of Ligand Field Theory
CO2. Learn the different aspects of crystal field theory
CO3. Understand the effect of weak , medium and strong crystal field on free ions
CO4. Learn about the electronic spectra of transition metal complexes
CO5. Understand the factors affecting the electronic spectra of the complexes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	2	2	2	3	3	2
CO2	2	3	3	3	2	3	3

CO3	2	3	2	2	1	2	3
CO4	2	3	3	2	2	2	2
CO5	3	2	2	3	3	2	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCP307-19**			
Subject Title:	**Inorganic Chemistry Lab-IV**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**
Examination Duration (hours)	**3**			
Objective(s):	To understand the various concepts involved in the quantitative analysis of the metal ions through different types of titrations.			

Details of the Course

Unit	Contents	Contact Hours
I	**Oxidation-Reduction Titrations-II** Ceric Sulphate Titrations: (i) Standardisation with Mohr's salt. (ii) Determination of Cu(II) (iii) Determination of oxalates. KIO_3 Titrations: (i) Determination of copper. (ii) Determination of hydrazine. **Precipitation Titrations** (i) AgNO3 – standardisation by Mohr's method / by using absorption indicator. (ii) Determination of chloride. (iii)Volhard's method for chloride determination. **Complexometric Titrations (EDTA)** (i) Standardisation of EDTA with $Pb(NO_3)_2$ / $ZnSO_4.7H_2O$ (ii) Determination of Mg^{2+} (iii) Determination of Ca^{2+} (by substitution method). (iv) Determination of total hardness of water (permanent and temporary (v) Determination of Cu^{2+} and Ni^{2+} by using masking reagent.	

Reference Books

1. Vogel, A.I. Quantitative Inorganic Analysis.

Course Outcomes and Mapping

At the end of the course, the student will be able to
CO1. Understand the concept of quantitative analysis.
CO2. Learn to estimate the present cations through quantitative analysis
CO3. Understand the various techniques/principles involved in the quantitative analysis present metal ions.
CO4. Learn to perform the volumetric analysis using different methods.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	2	3	2	3	2	2
CO2	2	2	3	3	3	3	2
CO3	3	3	3	2	2	2	2
CO4	2	3	1	3	2	2	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCP308-19**			
Subject Title:	**ORGANIC CHEMISTRY LAB-III: (Synthesis of organic compounds and their identifications)**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**
Examination Duration (hours)	**3**			
Objective(s):	The objective of this course is to provide practical knowledge and illustrative experiments regarding synthesis, separation, purification and characterization of organic compounds.			

Details of the Course

Contents
Organic Preparations **1.** Selective reduction of 1,3-dinitrobenzene to *m*-nitroaniline. **2.** Reduction of *p*-nitrobenzaldehyde by sodium borohydride. **3.** Hydrolysis of amides and esters. **4.** Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde. **5.** S-Benzylisothiouronium salt of one each of water-soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid). **6.** Aldol condensation using either conventional or green method. **7.** Benzil-Benzilic acid rearrangement. **8.** Solvent-free Cannizzaro reaction of benzaldehyde. **9.** Preparation of fluorescein from resorcinol and phthalic anhydride. **10.** Synthesis of 2-phenylindole using Fischer Indole synthesis reaction. 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 determination. All reactions in the following experiments are to be monitored by thin layer chromatography (TLC) and characteristic data (UV-visible/fluorescence, IR, NMR, MS) is to be explained.

Reference Books

S.No.	**Author(s)**	**Title of the Book**	**Publisher**

1	Furniss, B. S., Hannaford, A. J., Smith, P. W. G. & Tatchell, A. R.	Vogel's Textbook of Practical Organic Chemistry, 5th Ed.	Pearson (1989)
2	F. G. Mann and B. C. Saunders	Practical Organic Chemistry	Longman, New York
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 Outcomes and Mapping

At the end of the course, the students will be able

CO6. To synthesise organic compounds by various approach.

CO7. To develop preparative skills for purification of organic compounds by crystallization method.

CO8. To separate the organic compound by thin layer chromatography technique.

CO9. To present their work with practical skills and the awareness of health and safety procedures.

CO10. To apply related experiments for their research work

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	1	2	-	3	2	-
CO2	2	-	3	-	3	3	-
CO3	3	3	4	-	3	3	-
CO4	3	4	3	4	4	5	4
CO5	2	3	4	2	4	4	4

Semester VI

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL311-19**			
Subject Title:	**Organic Chemistry-IV (Natural Products and Biochemistry)**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	The objective of this course is to 1. impart knowledge of types, synthesis, isolation and physiological functions of alkaloids and terpenes 2. study the properties of lipids and enzymes and their importance in biological systems 3. understand the importance of high-energy compounds, electron transport chain and metabolic processes.			

Details of the Course

Unit	Contents	Contact Hours
I	**Alkaloids** Natural occurrence, General structural features, Isolation and their physiological action, Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine	12
II	**Terpenes** Occurrence, classification, isoprene rule; Elucidation of structure and synthesis of Citral, Neral and α-terpineol. **Lipids** 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	12
III	**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 stereo specificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition).	11
IV	**Concept of Energy in Biosystems** Cells obtain energy by the oxidation of foodstuff (organic molecules). Introduction to metabolism (catabolism, anabolism).	10

	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

S.No.	Author(s)	Title of the Book	Publisher/Year
1	Finar, I. L.	Organic Chemistry (Volume 2)	Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2	Singh, J.; Ali, S. M. & Singh, J.	Natural Product Chemistry, 2010	Prajati Parakashan
3	Agarwal O. P.	Natural Product (Volume 1)	Krishna Parakashan Publication
4	Berg, J. M., Tymoczko, J. L. and Stryer, L.	Biochemistry, VIth edition, 2006	W. H. Freeman and Co.
5	Nelson, D. L., Cox, M. M. and Lehninger, A. L.	Principles of Biochemistry, IVth edition, 2009	W. H. Freeman and Co.
6	Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W.	Harper's Illustrated Biochemistry, XXVIII edition, 2009	Lange Medical Books/ McGraw-Hill.

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO6. Learn the different types of alkaloids and terpenes and their chemistry and medicinal importance

CO7. Understand the importance of natural compounds as lead molecules for new drug discovery.

CO8. Elaborate general methods of structural elucidation of compounds of natural origin.

CO9. Understand the fundamentals of lipids and enzyme structure and function.

CO10. learn the metabolism of carbohydrates through various anabolic and catabolic pathways like glycolysis, Kreb's cycle, Glycogen metabolism etc.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	4	3	3	-	1	4	-
CO2	3	2	4	-	3	4	-
CO3	3	2	4	-	3	4	-
CO4	4	3	3	-	1	4	-
CO5	4	3	3	-	1	4	-

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL312-19**			
Subject Title:	**PHYSICAL CHEMISTRY-IV (ELECTROCHEMISTRY)**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	This course will equip students with the necessary knowledge concerning the fundamentals of electrochemistry with regard to various theories developed and their applicability for various systems under consideration. The problem solving skills of students are expected to be enhanced through due weightage given to numerical problems in each unit.			

Details of the Course

Unit	Contents	Contact Hours
I	**Conductance:** Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions and its applications. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. 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. Numericals	10
II	**Electrochemistry-I:** Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. 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.	12
III	**Electrochemistry-II:** Application of EMF measurements in determining free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values. Latimer and Frost diagrams. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).	12

IV	**Electrical & Magnetic Properties of Atoms and Molecules:** Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation.	11

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	P.W. Atkins & J. de Paula	Physical Chemistry 9th ed	Oxford University Press (2011)
2	S.H. Maron & C.F. Prutton	Principles of Physical Chemistry, 1st edition	Oxford and IBH (1958)
3	G.W. Castellan	Physical Chemistry, 4th edition	Narosa (2004)
4	I .N. Levine	Physical Chemistry 6th Ed.,	Tata Mc Graw Hill (2010)
5	T. Engel & P. Reid	Physical Chemistry 3rd Ed.	Prentice-Hall (2012)
6	D.W. Rogers	Concise Physical Chemistry	Wiley (2010)
7	M. J. Assael, A. R. H. Goodwin, M. Stamatoudis, W. A. Wakeham, & S. Will	Commonly Asked Questions in Thermodynamics	CRC Press: NY (2011)

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand and recognize the electrochemical processes

CO2. discuss electrode potentials and relate it to cell thermodynamics

CO3. explain potentiometric methods and explain the types of indicator electrodes

CO4. evaluate conductivity measurements and titration curves to develop corelation with the practical part

CO5. Understand the concept of dipole moment, magnetic behaviour in molecules

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	1	1	-	2	1	1
CO2	3	2	3	-	1	-	1
CO3	2	2	1	-	2	1	1
CO4	3	2	2	-	2	1	1
CO5	3	2	2	-	1	-	1

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL313-19**			
Subject Title:	**CATALYSIS**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	To teach the fundamental concepts of Catalysis and their applications.			

Details of the Course

Unit	Contents	Contact Hours
I	**Heterogeneous catalysis: -** Introduction, Concepts of heterogeneous catalysis, Important Reaction Types, Oxidative Addition and Reductive Elimination, Insertion Reactions, b-Hydride Elimination, Nucleophilic Attack on a Coordinated Ligand Transformation of hydrocarbons, Metathesis of alkanes, alkenes and alkynes, Oxidation of hydrocarbons, Alkene hydrogenation (Wilkinsons Catalyst), Hydroformylation (Co salts), Wacker Process, Synthetic gasoline (Fischer Tropsch reaction).	12
II	**Hydrogenation and hydroelementation of alkenes,** Hydrogenation of olefins, Asymmetric hydrogenation, Hydroboration of olefins, Hydrocyanation of olefins, Hydroamination of olefins and alkynes **Transformations of alkenes and alkynes**: Ziegler-Natta-type olefin polymerization, Metathesis of alkenes, alkynes and cycloalkenes, Olefin dimerization and oligomerization, Olefin isomerization	10
III	**Bio-catalysis** Introduction, Introduction to enzymes and enzyme catalysed reactions. Classification and mechanism of reaction. Purification and characterization of enzymes. Applications of enzymes in diagnostics, analysis, biosensors and other industrial processes and bio-transformations, Enzyme immobilization and concept of enzyme engineering. Nanobiocatalysis, **Bio-organometallic chemistry** Cobalamin: co-enzyme vitamin B12, Biological redox mediators, Examples of oxido-reductase enzymes: the mono-oxygenases, Nitrogen fixation by nitrogenase enzyme	11
IV	**Organometallic complexes in organic synthesis** **Examples of applications** Protection and stabilization of unsaturated organic derivatives and fragments.Nucleophilic and electrophilic reactions on hydrocarbon ligands, General methods of C-C bond formation using the oxidative addition of an organic halide or a related electrophile , Extension of palladium catalysis to the formation of C-O and C-N	12

	bonds, Oxidative coupling reactions of alkynes with other unsaturated fragments,for the formation of cyclic and heterocyclic compounds,Metal-carbene complexes in organic synthesis, Examples of asymmetric catalysis.	

Reference Books

10. Cotton, F.A. G.; Wilkinson & Gaus, P.L. Basic Inorganic Chemistry 3rd Ed.; Wiley India.
11. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.
12. Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005
13. Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry3rd Ed., John Wiley and Sons, NY, 1994.
14. Greenwood, N.N. & Earnshaw, A. Chemistry of the Elements, Elsevier 2nd Ed, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
15. Lee, J.D. Concise Inorganic Chemistry 5th Ed., John Wiley and sons 2008.
16. Powell, P. Principles of Organometallic Chemistry, Chapman and Hall, 1988.
8. Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.
9. Basolo, F. & Person, R. Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed., John Wiley & Sons Inc; NY.
10. Purcell, K.F. & Kotz, J.C., Inorganic Chemistry, W.B. Saunders Co. 1977
11. Miessler, G. L. & Donald, A. Tarr, Inorganic Chemistry 4th Ed., Pearson, 2010.
12. Collman, James P. et al. Principles and Applications of Organotransition Metal Chemistry. Mill Valley, CA: University Science Books, 1987.
13. Crabtree, Robert H. The Organometallic Chemistry of the Transition Metals. j New York, NY: John Wiley, 2000.
14. Spessard, Gary O., &Gary L. Miessler. Organometallic Chemistry. Upper Saddle River, NJ: Prentice-Hall, 1996.

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand the Organometallic chemistry
CO2. Understand the fundamental concepts of various concepts involved in catalysis.
CO3. Learn different application of catalysis in the synthesis of organic compounds.

CO4. To Understand role of catalysis in biological model

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	2	3	2	3	1	2
CO2	2	3	3	3	2	3	2
CO3	3	2	3	2	2	2	2
CO4	3	2	3	2	3	2	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL314-19**			
Subject Title:	**ANALYTICAL METHODS IN CHEMISTRY**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	This course will equip students with the necessary knowledge concerning various analytical techniques, their sampling and sources of error etc.			

Details of the Course

Unit	Contents	Contact Hours
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. **Thermal methods of analysis:** Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.	10
II	**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. *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.	13
III	**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.	10

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.	12

Reference Books

1. Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman .
2. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.

3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.

4. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.

5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.

7. Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.

8. Ditts, R.V. Analytical Chemistry – Methods of separation.

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. explain the fundamentals of analytical chemistry and steps of a characteristic analysis

CO2. estimate kinds of errors in chemical analysis.

CO3. identify quality of experimental measurements.

CO4. interpret the sources of random errors and effects of random errors on analytical results.

CO5. Familiarise with various analytical techniques and compare them.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	1	1	-	2	1	2
CO2	3	2	3	-	1	-	2
CO3	2	2	1	-	2	1	2
CO4	2	2	2	-	2	1	2
CO5	3	2	2	-	3	-	2

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL315-19**			
Subject Title:	**NANOCHEMISTRY**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	• To learn the basic concepts of Nanochemistry and changes of chemical and physical properties due size reduction. • To familiarize about the different chemical methods of synthesis, characterization, and different applications of nanomaterials			

Details of the Course

Unit	Contents	Contact Hours
I	Introduction to Nanomaterials: History-Feynman's hypothesis- scales of nanosystems- Moore's law, Classification of nanomaterials based on dimensions – one dimensional (1D), two dimensional (2D) and three dimensional (3D) nanomaterials, quantum dots, quantum wires, quantum core/shell structures, Different types of nanomaterials: Synthesis, properties and applications of fullerenes, carbon nanotubes and quantum dots, self-assembled monoayers, monolayer protected metal nanoparticles.	10
II	Chemical Routes for Synthesis of Nanomaterials: Chemical precipitation and co-precipitation; Sol-gel synthesis; Microemulsions or reverse micelles; Solvothermal synthesis; Thermolysis routes, Microwave heating synthesis; Sonochemical synthesis; Photochemical synthesis; Synthesis in supercritical fluids. Organic nanoparticles: Size and shape control of nanoparticles and their characterization; inorganic-organic hybrid nanoparticles; Nanopolymers: Preparation and characterization of diblock Copolymer based nanocomposites; Applications of Nanopolymers in Catalysis.	13
III	Optical characterization: Absorption and photoluminescence (PL & PLE) spectroscopies, steady-state vs. fast spectroscopy, dynamic light scattering, Structural characterization: XRD, SEM, STEM, TEM, AFM, Deviations between bulk and near-surface crystal structures.	12
IV	Chemistry of small surfaces: Curvature and neighboring-charge effects on chemical reactivity and equilibria (pKa's, redox potentials), Applications in structural materials, lighting, energy conversion (Solar Cells) and catalysis applications, Environmental, safety, and ethical aspects of nanotechnology.	10

Reference Books

1. C.N.R. Rao, H.C. Mult, A. Müller, A. K. Cheetham; The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Wiley, 2004, ISBN:9783527306862.
2. G.B. Sergeev, K.J. Klabunde, Nanochemistry, Elsevier, 2013.
3. Robert Kelsall, Ian W. Hamley , Mark Geoghegan, Nanoscale Science and Technology, Wiley.
4. C Brechignac, P Houdy, M Lahmani, Nanomaterials and Nanochemistry, 2011, Wiley.

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand the fundamental concepts of nanomaterials.
CO2. Learn the different methods of chemical synthesis of nanoparticles.
CO3. Understand the basic techniques about the organic nanoparticles.
CO4. Learn about the various characterization techniques.
CO5. Understand the various applications of nanomaterials.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	2	2	2	3	1	2
CO2	2	2	3	3	3	3	2
CO3	1	3	2	2	1	2	3
CO4	2	3	3	2	2	3	2
CO5	2	2	3	3	3	2	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCL316-19**			
Subject Title:	**MOLECULAR MODELLING AND DRUG DESIGN**			
Contact Hours:	**L:3**	**T:1**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	• To learn the basic concepts of molecular modelling and drug designing using the different energy minimization methods. • To understand the fundamentals of computer simulation.			

Details of the Course

Unit	Contents	Contact Hours
I	**Introduction to Molecular Modelling**: Introduction. Useful Concepts in Molecular Modelling: Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware and Software. The Molecular Modelling Literature. **Force Fields: Fields.** Bond Stretching. Angle Bending. Introduction to nonbonded interactions. Electrostatic interactions. Van-der Waals Interactions. Hydrogen bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water.	13
II	**Energy Minimization and Computer Simulation:** Minimization and related methods for exploring the energy surface. Non-derivative method, First and second order minimization methods. Computer simulation methods. Simple thermodynamic properties and Phase Space. Boundaries. Analyzing the results of a simulation and estimating Errors.	10
III	**Molecular Dynamics & Monte Carlo Simulation:** Molecular Dynamics Simulation Methods. Molecular Dynamics using simple models. Molecular Dynamics with continuous potentials. Molecular Dynamics at constant temperature and pressure. Metropolis method. Monte Carlo simulation of molecules. Models used in Monte Carlo simulations of polymers.	12
IV	**Structure Prediction and Drug Design:** Structure prediction - Introduction to comparative Modeling. Sequence alignment. Constructing and evaluating a comparative model. Predicting protein structures by 'Threading', Molecular docking. Structure based de novo ligand design, Drug Discovery – Chemoinformatics – QSAR.	10

Reference Books

1. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001.
2. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

Course Outcomes and Mapping

At the end of the course, the student will be able to

CO1. Understand the fundamental concepts of molecular modelling.
CO2. Learn the different methods of energy minimization and computer simulation.
CO3. Understand the basic concepts of molecular dyanamics.
CO4. Learn about the various concepts of drug designing and molecular modelling.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	2	2	2	3	3	2
CO2	2	2	2	3	3	2	2
CO3	2	3	2	2	3	2	2
CO4	2	3	3	1	2	3	3

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc. (Honours) Chemistry**			
Subject Code:	**BHCP318-19**			
Subject Title:	**ORGANIC CHEMISTRY LAB-IV**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**
Examination Duration (hours)	**3**			
Objective(s):	The objective of this course is to provide practical knowledge and illustrative experiments regarding study, estimation and isolation of bioorganic compounds.			

Details of the Course

S. No.	Contents
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. Synthesis of Nanoparticles and their applications (i) Green synthesis of silver nanoparticles using plant extract. (ii) Preparation of Chitosan Nanoparticles and characterization using FTIR. (iii) Synthesis of ZnO nanoparticles through non-aqueous route. (iv) Synthesis of copper nanoparticles. Application of synthesized nanoparticles in any two organic transformations / synthesis.

Reference Books

S.No.	Author(s)	Title of the Book	Publisher
1	Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.		
2	Arthur, I. V. Quantitative Organic Analysis, Pearson.		

Course Outcomes and Mapping

At the end of the course, the students will be able

CO11. To study about properties of amino acids/proteins/enzymes.

CO12. To estimate amino acids/proteins by various methods.

CO13. To understand the isolation and characterisation of DNA.

CO14. To present their work with practical skills and the awareness of health and safety procedures.

CO15. To apply related experiments for their research work

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	4	1	2	-	3	2	-
CO2	3	-	3	-	3	3	-
CO3	3	3	4	-	3	3	-
CO4	3	2	3	4	4	5	-
CO5	2	3	4	2	4	4	-

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**B.Sc.(Honours) Chemistry**			
Subject Code:	**BHCP319-19**			
Subject Title:	**PHYSICAL CHEMISTRY LAB-IV**			
Contact Hours:	**L:0**	**T:0**	**P:4**	**Credits:2**
Examination Duration (hours)	**4**			
Objective(s):	To provide students practical knowledge and skills about various topics taught in theory class of physical chemistry, which in turn will enhance their problem solving and analytical skills.			

Details of the Course

Unit	Contents
	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** 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 *Any other experiment related to electrochemistry carried out in the class.* **Introduction to Computational study / Molecular modeling** 1. To study the 3-dimensional structure of simple organic molecules such as alkanes, alkene and alkynes using physical as well as computer based modelling. 2. To study the relative stability of E and Z isomers of simple alkenes using molecular modelling.

	3. Determination of the molecular configuration of di (determine the interatomic distances) / triatomic (determine the interatomic distances and bond angles) / tetra atomic molecules (determine the interatomic distances and bond angles).

Reference Books

S.No.	Author(s)	Title of the Book	Publisher
1	J.B. Yadav	Practical Physical Chemistry	Krishna
2	B. D. Khosla, V. C. Garg, & A. Gulati,	Senior Practical Physical Chemistry	R. Chand & Co. New Delhi (2011)
3	V. D. Athawale, & P. Mathur,	Experimental Physical Chemistry	New Age International: New Delhi (2001)

Course Outcomes and Mapping

At the end of the course, the students will be able to

CO5. Understand the basic procedures for carrying out a physical chemistry practical like preparation and standardisation of solutions, handling the equipments and measuring with precision.

CO6. Correlate the theoretical and practical aspects and know about the limits of the experimental error.

CO7. Determine the various physical parameters for the various problems under study.

CO6. Verify various laws studied in the theory part.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	3	3	3	3	3	3
CO2	2	2	3	3	3	2	2
CO3	2	3	3	2	2	3	3
CO4	2	3	3	1	2	2	3