1.1.3

Supporting Documents-

Department of Chemical Sciences

Syllabus of Courses Highlighting the Focus on Employability/Entrepreneurship/Skill Development

1.1.3 & 1.2.1

Supporting Documents- Department of Chemical Science

Syllabus of courses highlighting the focus on employability/entrepreneurship/skill development

SCHEME OF THE PROGRAM:

Semester-I								
Sr. No	**Code**	**Theory Papers**	**Hours**	**L-T-P**	**Credits**	**Marks Distribution**		**Marks**
						Internal	External	
1.	CHL401-18	Inorganic Chemistry-I	45	4-0-0	4	30	70	100
2.	CHL402-18	Reactive Intermediates-I	45	4-0-0	4	30	70	100
3.	CHL403-18	Physical Chemistry-I	45	4-0-0	4	30	70	100
4.	CHL404-18	Spectroscopy - I	45	4-0-0	4	30	70	100
5.	CHL405-18	Environmental Chemistry	45	3-0-0	3	25	50	75
6.	CHL406A-18 CHL406B-18	Human Physiology * Or Numerical Methods for chemists*	45	3-0-0	3	25	50	75
7.	CHP407-18	Inorganic Chemistry Lab	60	0-0-6	3	50	25	75
8.	CHP408-18	Organic Synthesis Lab	60	0-0-6	3	50	25	75
		Total	**28 (Theory 22, Practical 6)**			**270**	**430**	**700**

Semester-II								
Sr. No.	**Code**	**Theory Papers**	**Hours**	**L-T-P**	**Credits**	**Marks Distribution**		**Marks**
						Internal	External	
1.	CHL411-18	Inorganic Chemistry-II	45	4-0-0	4	30	70	100
2.	CHL412-18	Reactive Intermediates-II	45	4-0-0	4	30	70	100
3.	CHL413-18	Physical Chemistry-II	45	4-0-0	4	30	70	100
4.	CHL414-18	Spectroscopy - II	45	4-0-0	4	30	70	100
5.	CHL415A-18 CHL415B-18	Chemistry of Materials Or Chemical Biology	45	4-0-0	4	30	70	100
6.	CHP416-18	Physical Chemistry Lab	60	0-0-6	3	50	25	75
7.	CHP417-18	Advanced Chemistry Lab-I	60	0-0-6	3	50	25	75
		Total	**26 (Theory 20, Practical 6)**			**250**	**400**	**650**

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

Semester-III								
Sr. No	**Code**	**Theory Papers**	**Hours**	**L-T-P**	**Credits**	**Marks Distribution**		**Marks**
						Internal	External	
1.	CHL501-18	Inorganic Chemistry-III	45	4-0-0	4	30	70	100
2.	CHL502-18	Advanced Organic Chemistry –I	45	4-0-0	4	30	70	100
3.	CHL503-18	Physical Chemistry-III	45	4-0-0	4	30	70	100
4.	CHL504-18	Advanced Characterization Techniques	45	4-0-0	4	30	70	100
5.	CHL505A-18 Or CHL505B-18 Or CHL505C-18	Biophysical chemistry Or Medicinal Chemistry Or Advanced Functional Materials	45	4-0-0	4	30	70	100
6.	CHP506-18	Advanced Chemistry Lab-II	60	0-0-6	3	50	25	75
7.	CHP507-18	Dissertation**		0-0-8	4	50	-	50
		Total	**27 (Theory 20, Practical 7)**			**250**	**375**	**625**

Semester-IV								
Sr. No	**Code**	**Theory Papers**	**Hours**	**L-T-P**	**Credits**	**Marks Distribution**		**Marks**
						Internal	External	
1.	CHL511-18	Advanced Organic Chemistry- II	45	4-0-0	4	30	70	100
2.	CHL512A-18 Or CHL512B-18 Or CHL512C-18 Or CHL512D-18 Or CHL512E-18 Or CHL512F-18	Advanced physical Chemistry Or Chemical Toxicology Or Supramolecular Chemistry Or Chemistry of Natural Products Or Green Chemistry Or Computational Chemistry	45	4-0-0	4	30	70	100
3.	CHP513-18	Research Seminar	30	….	3	50	-	50
4.	CHP514-18	Dissertation**		0-0-24	12	150	100	250
		Total	**23 (Theory 8, Practical 12, Seminar 3)**			**260**	**240**	**500**

* Human Physiology for students with mathematical background and Numerical methods for chemists for students with medical background.

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**M.Sc. Chemistry**			
Subject Code:	**CHL404-18**			
Subject Title:	**SPECTROSCOPY-I**			
Contact Hours:	**L:4**	**T:0**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	1. To learn various techniques of spectrometric identification of organic compounds 2. To characterize organic compounds by applying various techniques together			

Details of the Course

Unit	Contents	Contact Hours
I	**General Features of Spectroscopy:** Introduction to spectroscopy, Nature of radiation, Energies corresponding to various kinds of radiation, Experimental techniques, intensities of spectral lines, Selection rules and transition moments, Line widths, Broadening. **UV and Visible Spectroscopy of organic molecules:** Measurement techniques, Beer – Lambert's Law, molar extinction coefficient, oscillatorstrength and intensity of the electronic transition, Frank Condon Principle, Ground andfirst excited electronic states of diatomic molecules, relationship of potential energycurves to electronic spectra, Chromophores, auxochromes, blue shift, red shift, hypo andhyperchromic effect, σ-σ^*, π-π^*, n-π^* transitions in organic molecules, Woodward rulesfor conjugated dienes and α, β- unsaturated carbonyl groups, extended conjugation andaromatic sterically hindered systems, Quantitative applications.	10
II	**Infrared Spectroscopy:** Introduction, Principle of IR spectroscopy, modes of vibrations, Vibrational frequency, fundamental vibrations, Selection rules, factors affecting vibrational frequencies, IR spectrophotometer, sampling techniques, special features of different classes of organic compounds pertaining to IR spectroscopy (such as aliphatic and aromatic hydrocarbons, halogen compounds, alcohols and phenols, ethers, carbonyl compounds, acids and its derivatives, amines and amides, nitro and nitrides, nitrile compounds, heteroaromatic compounds etc.) and interpretation of IR spectrum, quantitative applications.	10
III	**Nuclear Magnetic Resonance Spectroscopy:** PMR: Natural abundance of ^{13}C, ^{19}F and ^{31}P nuclei; The spinning nucleus, effect of external magnetic field, precessional motion and frequency, Energy transitions, Chemical shift and its measurements. Factors influencing chemical shift, anisotropic effect; Integrals of protons, proton exchange, spin-spin coupling- splitting theory, one, two and three bond coupling, virtual, long range and allylic coupling, magnitude of coupling constant; factors affecting the coupling constant, Chemical and magnetic equivalence,	15

	First and second order spectra, A2, AB, AX, AB2, AX2, A2B2 and A2X2 spin systems, Simplification of complex spectra (solvent effect, field effect, double resonance and lanthanide shift reagents), CW and FT NMR, Relaxation processes, T1 and T2measurements, Applications of PMR in structural elucidation of simple and complex compounds. **13C-NMR**: Resolution and multiplicity of 13C NMR, 1H-decoupling, noise decoupling, broad band decoupling; Deuterium, fluorine and phosphorus coupling; NOE and origin of nuclear overhauser effect. off-resonance, proton decoupling, Structural applications of13C-NMR., pulse sequences, pulse widths, spins and magnetization vectors, DEPT,INEPT, Introduction to 2D-NMR, COSY, NOESY, HMBC and HSQC spectra.	
IV	**Mass Spectrometry:** Introduction, methods of ionization EI & CI, Brief description of LD, FAB, SIMS, FD etc., Ion analysis methods (in brief), isotope abundance, Metastable ions, general rules predicting the fragmentation patterns. Nitrogen rule, determination of molecular ion peak, index of H eficiency, fragmentation patterns for aliphatic compounds, alkyl halides, aryl halides, alcohols, amines, aldehydes, Ketones, esters, amides, nitriles, carboxylic acids, ethers, monocyclic aromatic compounds.	10

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	Donald L. Pavia, Gary M. Lampman, George S. Kriz & James R. Vyvyanz	Spectroscopy	Cengage learnings
2	Robert. M. Silverstein, Francis X. Webster, David J. Kiemle & David L. Bryce	Spectrometic Identification of Organic Compounds.	Wiley, 2007
3	W. Kemp	Organic Spectroscopy	Palgrave Macmillan
4	D.H. Williams, I. Fleming	Spectroscopic Methods in Organic Chemistry	New Age International
5	R. F. Barrow, Derek A. Long, D. J. Millen	Molecular Spectroscopy	Royal Society of Chemistry
6	C.N Banwell	Fundamentals of Molecular Spectroscopy	Tata Mc Graw Hill

Course Outcomes and Mapping

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

CO1. Solve structural problems based on UV-Vis, IR, ^{1}H-NMR, ^{13}C-NMR and mass spectral data.

CO2. Elucidate the structures of various organic compounds on the basis of spectral data.

CO3. Understand various involved processes responsible for NMR chemical shifts and splitting patterns and mass spectrometry.

CO4. Illustrate the mechanisms that give rise to the infrared and UV-Visible absorption bands and identify to which functional groups each correspond.

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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY DEPARTMENT OF CHEMICAL SCIENCES				
Course Name	**M.Sc. Chemistry**			
Subject Code:	**CHP407-18**			
Subject Title:	**INORGANIC CHEMISTRY LAB**			
Contact Hours:	**L:0**	**T:0**	**P:6**	**Credits:3**
Examination Duration (hours)	**6**			
Objective(s):	The objective of this course is to provide practical knowledge and illustrative experiments about synthesis and characterization of inorganic complexes and estimation of metal ions.			

Details of the Course

Unit	Contents
I	Synthesis and characterization of following complexes and estimation of metal ions: **1.** Synthesis of tris(ethylenediamine)nickel(II) dichloride, $[Ni(en)_3]Cl_2$, and estimation of Ni(II). Record and interpret its IR, UV-vis and magnetic susceptibilty. **2.** Synthesis of hexaaminenickel(II) dichloride $[Ni(NH_3)_6]Cl_2$ and estimation of Ni(II). Record and interpret its IR, UV-vis and magnetic susceptibilty. **3.** Synthesis of $[Cu(NH_3)_4]SO_4.H_2O$ and estimation of Copper. **4.** To prepare cis and trans copper glycine complexes. **5.** Preparation of $[VO(acac)_2]$. Record and interpret its IR, UV-vis and magnetic susceptibility. **6.** To prepare a pure sample of tris(acetylacetone)cobalt(III), $Co(acac)_3$. Record and interpret its IR, UV-vis spectrum. **7.** Preparation of tris(nitro-acetylacetonato)cobalt(III), $Co(acac\text{-}NO_2)_3$, record and interpret its proton NMR spectrum. **8.** To prepare $[Fe(NO)(S_2CNEt_2)_2]$. Record and interpret its IR and UV-vis spectrum, Magnetic Susceptibility and Analysis of Fe(II).
II	Gravimetric Analysis **1.** Determination of Ba^{2+} as its chromate. **2.** Estimation of lead as its lead molybdate. **3.** Estimation of chromium (III) as its lead chromate. **4.** Estimation of Cu^{2+} using Ammonium/Sodium thiocyanate

Reference Books

S.No.	Author(s)	Title of the Book
1	J.R. Barrante G. Marr and B.W. Rockett	Practical Inorganic Chemistry
2	Vogel	Inorganic Quantitative Analysis

Course Outcomes and Mapping

At the end of the course, the students will learn

CO1. Preparation of different inorganic complexes.

CO2. Purification and crystallisation of inorganic compounds.

CO3. Interpretation of compounds using UV-Vis, FT-IR techniques.

CO4. Measurement of various physical properties such as magnetic moment of complexes.

CO5. Gravimetric analysis of various cations.

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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY **DEPARTMENT OF CHEMICAL SCIENCES**				
Course Name	**M.Sc. Chemistry**			
Subject Code:	**CHP408-18**			
Subject Title:	**ORGANIC SYNTHESIS LAB**			
Contact Hours:	**L:0**	**T:0**	**P:6**	**Credits:3**
Examination Duration (hours)	**6**			
Objective(s):	1. To learn various practical techniques for synthesis, identification, isolation, purification and characterization of organic compounds. 2. To carry out hand on experience the various methods of organic synthesis.			

Details of the Course

Unit	Contents
I	**Techniques**: (At least One Practical of Each Technique) Crystallization, Purification by Sublimation, Distillation, Fractional Distillation, Steam Distillation, Vacuum Distillation, Preparative chromatography, Column Chromatography, TLC stains preparation and Thin Layer Chromatography. (Purity is to be checked by m.p. and mixed m.p.)
II	**Preparation of Derivatives:** (Each Derivative of at least one Compound) Oxime, 2,4-DNP, Acetyl, Benzoyl, Semicarbazone, Anilide, Amide, Aryloxyacetic acid.
III	**Preparations**: (a) At least eight single stage preparations from the following should be carried out. The preparations should be carried out on micro scale. i) Cyclohexanone to Adipic acid ii) Benzophenone to Benzhydral iii) Anthracene to Anthraquinone iv) Chlorobenzene to 2,4-Dinitrochlorobenzene v) 2,4-Dinitrochlorobenzene to 2,4-Dinitrophenol vi) Acetoacetic ester to 1-Phenyl-3-methyl-5 pyrazolone vii) Benzaldehyde to Cinnamic acid viii) 4-Chlorobenzaldehyde to 4-Chlorobenzoic acid and 4-Chlorobenzyl alcohol ix) Benzene to β-Benzoyl propionic acid x) Benzaldehyde to Dibenzylidene acetone xi) p-Aminobenzoic acid to p-Chlorobenzoic acid xii) N,N-Dimethylaniline to 4-Formyl-N, N-dimethyl aniline xiii) Benzophenone to Benzpinacol xiv) p-Nitrotoluene to p-Nitro benzoic acid xv) Anisole to 2,4-Dinitroanisole xvi) Phthalic anhydride to phthalimide xvii) Phthalimide to Anthranilic acid xviii) Acetanilide to p-Bromoacetanide xix) p-Bromoacetanide to p-Bromoaniline xx) m-Dinitrobenzene to m-Nitroaniline (b) Minimum 2 two stage and 2 three stage preparations to reveal how to develop a synthetic sequence. (c) Interpretation of NMR, IR and Mass Spectra of about 10 compounds.

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	John Leonard, Barry Lygo and Garry Procter	Advanced Practical Organic Chemistry, Third Edition	CRC Press, London
4	J.T. Sharp	Practical Organic Chemistry: A student handbook of techniques	Springer
5	Philippa B. Cranwell, Laurence M. Harwood and Cristopher J. Moody	Experimental Organic Chemistry, 3rd Edition	Wiley
6	Robert. M. Silverstein, Francis X. Webster, David J. Kiemle & David L. Bryce	Spectrometric Identification of Organic Compounds.	Wiley, 2007

Course Outcomes and Mapping

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

CO1. Apply various methods techniques in organic synthesis to build organic molecules.

CO2. Understand the fundamental mechanistic pathways of organic synthesis involving various practical lab techniques together.

CO3. Apply the spectroscopic techniques for the determination of molecular structures of organic molecules.

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

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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY DEPARTMENT OF CHEMICAL SCIENCES				
Course Name	**M.Sc. Chemistry**			
Subject Code:	**CHL414-18**			
Subject Title:	**SPECTROSCOPY-II**			
Contact Hours:	**L:4**	**T:0**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	To provide knowledge of advanced spectroscopic techniques for identification and elucidation of structures of molecules			

Details of the Course

Unit	Contents	Contact Hours
I	**Microwave spectroscopy:** Rigid and non-rigid rotator, Intensities of spectral lines, isotopic substitution effects, polyatomic linear and symmetric top molecules, Stark effect **Vibrational Spectroscopy:** Types of vibrations, overtones, combination and difference bands, Fermi resonance, group vibrations, Harmonic and anharmonic oscillators, absorptions of radiation by molecular vibrations, selection rules, force constant, frequency of vibrational transitions of HCl, vibrations in a polyatomic molecule, 3N-6 and 3N-5 rules, Applications	12
II	**Raman Spectroscopy:** Introduction, vibrational-rotational Raman Spectra, selection rules, mutual exclusion principle, anisotropic polarizabilty, Stokes, anti-Stokes lines, vibrational Raman spectra of CO_2 and H_2O, polarised and depolarised Raman Lines. **Mössbauer Spectroscopy:** Basic principles, Spectral parameters and display, simple spin states (I 1/2, 3/2), higher spin states (I > 3/2), magnetic splitting, quadruple splitting, additive model application to ^{57}Fe, ^{119}Sn	10
III	**Nuclear Quadruple Resonance Spectroscopy:** Introduction, experimental considerations, fundamentals of NOR spectroscopy, origin of EFG, measurement of energy differences between two nuclear spin states, the asymmetry parameter, effects of the magnetic field, interpretation of the spectra, application of NQR spectroscopy **Photoelectron Spectroscopy-I:** Introduction, photoelectron spectroscopy, chemical shift, X-ray photoelectron spectroscopy, molecular orbital diagrams of nitrogen and oxygen and their XPS spectra-ESCA.	11
IV	**Photoelectron Spectroscopy-II:** Ultraviolet photoelectron spectroscopy (UPS), PES spectrum of nitrogen sample, vibrational structure in the N2 UPS spectrum, chemical shifts in XPS, exchange splitting and shake up process. **Electron Paramagnetic Resonance Spectroscopy:** Principle, Spectral display, hyperfine splitting in isotropic systems involving more than one nucleus, Factors affecting magnitude of g values,	12

	zero field splitting and Krammer's degeneracy, Spectrum of benzene radical anion, methyl radical, CH_2OH, cyclopentedienyl, cycloheptatrienyl radical, pyrazine anion, pyrazine anion, Spectra of triplet states.	

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1	R.S. Drago	Physical Methods in inorganic Chemistry	Affiliated East-West Press (Section 1& 2) 2nd Edition, Reinhold New York (1968)
2	C. N. Banwell	Fundamentals of Molecular Spectroscopy	McGraw-Hill, 1966
3	R. V. Parish	NMR, NQR, EPR & Mossbauer spectroscopy in Inorganic Chemistry	Ellis Horwood, London, 1990
4	G. M. Barrow	Introduction to Molecular Spectroscopy	McGraw-Hill
5	E. A. Ebsworth, S.Craddock and D.W. H. Rankin	Structural methods in Inorganic Chemistry	Blackwell Scientific Publications (1991)
6	C.N.R. Rao and J.R. Ferraro	Spectroscopy in Organic Chemistry	Vol. I, Academic Press, 1971

Course Outcomes and Mapping

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

CO1. Learn the fundamental and advanced concepts of Microwave, Infrared-Vibration-rotation Raman and infra-red Spectroscopy and their applications for chemical analysis

CO2. Understand Electronic spectroscopy of different elements and simple molecules.

CO3. Study the concepts and principles of Mössbauer Spectroscopy and its application.

CO4. Apply Nuclear Quadruple Resonance and Electron Spin Resonance Spectroscopy for organic compounds analysis.

CO5. Solve structural problems based on these techniques.

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

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY DEPARTMENT OF CHEMICAL SCIENCES				
Course Name	**M.Sc. Chemistry**			
Subject Code:	**CHP416-18**			
Subject Title:	**PHYSICAL CHEMISTRY LAB**			
Contact Hours:	**L:0**	**T:0**	**P:6**	**Credits:3**
Examination Hours:	**6**			
Objective(s):	To provide students practical knowledge and skills about various topics taught in theory class of physical chemistry			

Details of the Course

Any fifteen experiments to be performed out of the following:

1. Find graphically the equivalent conductance at infinite dilution of weak electrolyte and hence determine the thermodynamic dissociation constant of the weak acid.
2. Determine the equivalent conductance of a strong electrolyte at several concentrations and verify the Onsagar's equation.
3. Determine the equivalent conductance of a weak electrolyte at infinite dilution using Kohlraush law.
4. To determine relative strength of two acids by conductance measurements.
5. Determine the solubility of a sparingly soluble salt in water using conductance measurements.
6. Determine the end point of some typical titrations by conductometric method.
7. Determine the composition of a mixture of acetic acid and hydrochloric acid by conductometric titration.
8. Study the kinetics of saponification of ethyl acetate by sodium hydroxide and hence determine the activation energy of the reaction.
9. Investigate the reaction between acetone and iodine.
10. Determine the relative strength of two acids studying the hydrolysis of an ester.
11. Study the kinetics of decomposition of the complex formed between sodium sulphide and sodium nitroprusside spectrophotometrically and find the rate constant and order of the reaction.
12. Investigate the inversion of cane sugar in presence of an acid.
13. Obtain a calibration curve for a given compound and verify Beer-Lambert law.
14. Study the complex formation between Fe (III) and salicylic acid, and find the formula and the stability of the complex.
15. Determine the concentration of Nickel in solution by spectrophotometric titration.
16. Determination of specific and molar refraction of a liquid by Abbe refractometer.
17. Determine the refraction equivalents of C, H, and Cl atoms.
18. Determine the composition of mixture of two liquids by refractive index measurements.
19. Determination of surface tension of given liquid by a) drop number method and b) drop weight method using stalagmometer.
20. Determine the critical micellar concentration of soap (sodium or potassium lauryl sulphate) by surface tension measurements.
21. Determine the parachor of the mixture using surface tension measurements.
22. Compare the cleansing power of two samples of detergent.

23. Determination of transition temperature of given substance by thermometric or dilatometric method.
24. Find water equivalent and heat of neutralization of strong acid vs strong base, weak base vs. strong acid using Dewar's flask.

Reference Books

1. Advanced Practical Physical Chemistry by J.B. Yadav.
2. Findlay's Practical Physical Chemistry.

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 which in turn will enhance their problem solving and analytical skills.

CO4. Verify various laws studied in the theory part.

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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY DEPARTMENT OF CHEMICAL SCIENCES				
Course Name	**M.Sc. Chemistry**			
Subject Code:	**CHP417-18**			
Subject Title:	**ADVANCED CHEMISTRY LAB-I**			
Contact Hours:	**L:0**	**T:0**	**P:6**	**Credits:3**
Examination Hours:	**6**			
Objective(s):	To provide illustrative experiments to support the material taught in the theory courses and to give the students practical experience in techniques used in the synthesis, isolation, characterization and structure determination of inorganic compounds.			

Details of the Course

S.No.	Contents
I	**Inorganic Practicals** 1. Preparation of Octahedral and Tetrahedral Complexes of dichlorodipyridylcobalt(II), Differentiate them using IR, UV and Magnetic Properties. Estimate Co(II) from one of them. 2. Preparation of cis-and trans-potassium Dioxalato Diaquochromate (III). Interpretation of IR, UV and Magnetic Properties. Estimation of Chromium. 3. Preparation of Salicylamide complexes of Copper(II). IR, UV, magnetic data and analysis of Cu(II). 4. To separate the mixture of metal ions (Cr^{3+}, Ni^{+2},Cu^{+2}, Zn^{+2}, Fe^{+2}) using thin layer and column chromatography. 5. To perform the solvent extraction for the recovery of metal ions (Cr^{3+}, Ni^{+2}, Cu^{+2}, Zn^{+2}, Fe^{+2}) from aqueous medium.
II	**Organic Practicals** 1. Synthesize (a) 2,4-dinitro-1-chlorobenzene from chlorobenzene, (b) mixture of *o*- and *p*-nitrophenols from phenol and (c) *p*-nitroacetanilide from acetanilide and make comparison of the reactivity of various substrates and reaction conditions used for performing nitration in each experiment. (Book 2, pp 978-979, 919-20) 2. Synthesis of benzalacetophenone by condensation of benzaldehyde with acetophenone and study its bromination and subsequent de-bromination. (Book 1, pp 242-247, Book 3 pp 361-365) 3. Synthesis of 2-chloro-4-bromo-6-iodoaniline from aniline. (Book 1, pp 292-299). 4. The epoxidation of benzalacetophenone to its epoxide and study its reactivity towards hydroxyl ion. (Book 3, pp 363-364). 5. Michael addition of aniline to benzalacetophenone. (Book 1, p 247).

	6. Conversion of benzalacetophenone to its oxime and its transformation to amideand oxazole derivatives. (Book 1, pp 242-247, Book 3 pp 361-365)

Reference Books

S.No.	Author(s)	Title of the Book	Publisher
1	R.M. Roberts, Gilbert, L. B. Rodewald and A.S. Wingrove. Holt,	An Introduction to Modern Experimental Organic Chemistry,	Ranehart and Winston Inc., J. C New York 1969.
2	Arthur Israel Vogel (Author)	Vogel's Text Book of Practical Organic Chemistry, 5th Edition.	Longman, 1961 .
3	R. Adams, J.R. Johnson	Laboratory Experiments in Organic Chemistry	Macmillan; 7th edition (1979)
4	G. Marr and B.W. Rockett	Practical Inorganic Chemistry	
5	W.L. Jolly	The Synthesis and Characterization of Inorganic Compounds	

Course Outcomes and Mapping

The students will learn

CO1. Preparation of different inorganic complexes.
CO2. Purification and crystallisation of inorganic compounds.
CO3. Interpretation of compounds using UV-Vis, FT-IR techniques.
CO4. Measurement of various physical properties such as magnetic moment of complexes.
CO5. Applying related experiments for their research work.

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

SEMESTER-III

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY

Subject Code:	**CHL504-18**			
Subject Title:	**ADVANCED CHARACTERIZATION TECHNIQUES**			
Contact Hours:	**L:4**	**T:0**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	This course will introduce the students to different techniques for characterisation of organic and inorganic materials. The emphasis will be on understanding crystal structure, morphology, microstructure, different types of phases present in a material, purity of the material.			

Details of the Course

Unit	Contents	Contact Hours
I.	**X-Ray diffraction:** Single crystal XRD and powder XRD, Bragg's diffraction law, Unit cell, space group, element of space group, particle size analysis using Scherer formula. **Thermo-Analytical Methods:** Theory, instrumental requirements and methodology for thermo gravimetric analysis (TGA), differential thermal analysis (DTA) and differential scanning calorimetry (DSC), applications.	12
II.	**Scanning electron microscopy:** Principle, Specimen Preparation, Replicas Various-application of SEM. **Transmission electron microscopy** : Instrumentation, Principle, Advantage, Difference between SEM and TEM.	10
III.	**Chromatographic Methods:** Classification of chromatographic methods according to separation and development procedure, Stationary phase, mobile phase, retention time. **Gas chromatography**: Physical components, Types of column and detector, Carrier gas, Applications, Inverse Gas chromatography, GC-MS: construction and working.	13
IV.	**High performance liquid chromatography**: Construction and working, Partition chromatography, Normal and reverse phase chromatography, Ion exchange chromatography, Isocratic and gradient elution. Gel permeation chromatography. Electrophoresis and electrochromatography.	10

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1.	J.Goldstein, D. E. Newbury, D.C. Joy, and C.E. Lym	Scanning Electron Microscopy and X-ray Microanalysis	2003
2.	S.L. Flegler, J.W. Heckman and K.L. Klomparens	Scanning and Transmission Electron Microscopy: A Introduction	WH Freeman & Co, 1993.
3.	P.J.Goodhew, J.Humphreys, R.Beanland	Electron Microscopy and Analysis	
4.	Willard, Merritt, Dean and	Instrumental Methods of	CBS Publisher and

	Settle	Analysis	Distributors.,1986
5.	W. W. Wendlandt and L. W. Collins, Dowden Hutechin and Ross	Thermal Analysis	
6.	K. Tyagi, Mainak Roy, S. K. Kulshreshtha and S. Banerjee	Advanced Techniques for Materials Characterization	

Course Outcomes and Mapping

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

CO1. Understand the topography, morphology, composition, relationship between composition and material properties.

CO2. Learn the functioning of the X-ray diffractometer, about its components and would be able to determine the crystal structure of a material, find impurity in the material, different phases present in the mixture of compound qualitative as well as functionalities

CO3. Understand the instrumentation of TGA and also to calculate the weight loss with temperature, types of changes occurring in the material/substances during thermal breading, enthalpy changes during heat treatment of a compound.

CO4. Apply the knowledge of various characterization techniques in material industries, metallurgy industries, electronic industries, civil Engineering.

CO5. Apply the quantitative and qualitative separation techniques in purification and its applications in food industry, pharmaceutical industry, purification, removal of pollutants, medicinal chemistry and essential oils.

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

Subject Title:	**ADVANCED CHEMISTRY LAB-II**			
Contact Hours:	**L:0**	**T:0**	**P:6**	**Credits:3**
Examination Hours:	**6**			
Objective(s):	To provide students practical knowledge and skills about various topics taught in theory class of physical chemistry			

Details of the Course

Unit	Contents
I	Any 10 experiments to be performed out of the following: 1. Preparation and study of Hardy – Schulze's rule for arsenious sulphide / Ferric hydroxide sols. 2. Verify the Freundlich adsorption isotherm for adsorption of CH_3COOH from its aqueous solution by activated charcoal. 3. Composing a phase diagram for three component system. 4. Determination of distribution coefficient of I_2 between CCl_4 and H_2O. 5. To show that benzoic acid dimerises in benzene by distribution method. 6. Determination of degree of hydrolysis of aniline hydrochloride at room temperature and hence hydrolysis constant of the salt. 7. Determination of pH of various mixtures of sodium acetate and acetic acid in aqueous solutions and hence determine the dissociation constant of the acid. 8. Determination of equilibrium constant of a reaction potentiometrically. 9. To construct a calibration curve for quinhydrone electrode and thus determine its standard reduction potential. 10. Determination of dissociation constant of a dibasic acid potentiometrically. 11. Determination of composition of KCl-KBr mixtures by potentiometric titration against silver nitrate solution. 12. Determination of acid and basic dissociation constants of an amino acid and hence the iso- electric point of the acid. 13. Titration of a mixture of Chloride and Iodide with $AgNO_3$ potentiometrically. 14. Titration of Phosphoric acid solution with NaOH using quinhydrone electrode. 15. Determination of Solute species in a phosphate mixture potentiometrically.
II	Any 5 experiments to be performed out of the following: 1. Separation of a mixture of amino acids using thin layer chromatography. 2. Isolation and quantitation of DNA from onion. 3. Separation of DNA using gel electrophoresis (agarose). 4. Isolation, detection, and quantitation of protein (casein) from milk. 5. Osmosis and diffusion through semipermeable membrane. 6. Estimation of DNA quantity using UV-Vis spectrophotometer. 7. DNA/ligand interaction (Scatchard plot) using UV-Vis spectrophotometer.

	8. Serum albumin/ligand interaction using UV-Vis spectrophotometer

Reference Books

1. Advanced Practical Physical Chemistry by J.B. Yadav.
2. Findlay's Practical Physical Chemistry.
3. Safety-Scale Laboratory Experiments for Chemistry for Today, S L Seager and M R Slabaugh, Brooks/Cole Laboratory Series for General, Organic, and Biochemistry, VII edition, Brooks/Cole, 2010

Course Outcomes and Mapping

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

CO1. Emphasize the importance of different techniques used for titration viz. potentiometery, pHmetry and amperometry .

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 which in turn will enhance their problem solving and analytical skills.

CO4. Verify various laws studied in the theory part.

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

SEMESTER-IV

Course Name	**M.Sc. Chemistry**			
Subject Code:	**CHL 512A-18**			
Subject Title:	**ADVANCED PHYSICAL CHEMISTRY**			
Contact Hours:	**L:4**	**T:0**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	The objective of this course is to provide an introduction to few advanced topics in physical chemistry like the chemistry of colloids, macromolecules and the latest electroanalytical techniques, focussing especially on their application part.			

Details of the Course

Unit	Contents	Contact Hours
I.	**Colloidal State:** Classification of colloids, charge and stability of colloidal dispersions, Hardy-Schulze Law, gold number, electrical properties of colloids, zeta-potential, electrophoresis and electroosmosis, emulsions and their classification, gels and their classification, thixotropy. Micelles, Surface active agents, Classification of surface active agents, Micellization, Hydrophobic interaction, Critical micellar concentration (cmc), Factors affecting the concentration of surfactants, Counter-ion binding of micelle, Thermodynamics of micellization, Applications.	11
II.	**Polymers:** Types of polymers, regular and irregular polymers, electrically conducting polymers, synthesis of polymers by chain and step reaction polymerization, physical properties of solid polymers (crystallinity, plasticity & elasticity) vulcanization of rubbers, molecular mass determination by osmometry, viscometry, light scattering and ultracertrifuge methods, number and mass average molecular masses, polymer solutions, factors affecting the solubility of polymers.	12
III.	**Voltammetric Techniques-I:** Linear sweep voltammetry; voltammetric electrodes, voltammograms. Hydrodynamic Voltammetry; concentration profiles at electrode surfaces, voltammetric currents, current voltage relationships, voltammograms for mixtures, Applications; voltammetric detectors, amperometric sensors, amperometric titrations. Differential pulse voltammetry.	10
IV.	**Voltammetric Techniques-II:** Polarography: principle, instrumentation and Applications, advantages and disadvantages of DME. Cyclic Voltammetry: Electrode used in cyclic voltametry, electrochemical mechanism, Eads mechanism (Adsorption mechanism), Butler-volmer equation, Reversible one electron transfer.	12

Reference Books

S.No.	Author(s)	Title of the Book	Publisher/Year
1.	R.J. Young and P.A.Lovell	Introduction to Polymers	Chapman and Hall London, 2nd ed., New Delhi (2004)
2.	F.W. Jr. Billmeyer	Text book of polymers science	Wiley-Interscience, 3rd ed. (1984)
3.	D. Myers	Surfactant Science and Technology	VCH Publishers (1988)
4.	P.J. Flory	Priciples of polymer chemistry	Cornell Univ. Press, Ithace (Indian Print 2006)
5.	M.J. Rosen	Surfactants and Interfacial Phenomena	John Wiley & Sons (1989)
6.	P.H. Reiger	Electrochemistry	Prentice-Hall,New Jersey (1994)
7.	D.R. Crow	Principles and Applications of Electro-chemistry	Blackie academic,Glasgow (1988)
8.	Bard &. Faulkner	Electrochemical Methods: Fundamentals and Applications	
9.	C.M.A. Brett and A.M.O. Brett	Electrochemistry: Principles, Methods and Applications	Oxford Uni. Press (1993)

Course Outcomes and Mapping

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

CO1. Understand major aspects of chemical terminology related to surface science, polymers and electrode processes.

CO2. Develop insights in the micelle formation process and emphasize its application in daily life.

CO3. Know about polymers in detail.

CO4. Correlate various types of voltammetric techniques and their importance in sensing field.

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

DEPARTMENT OF CHEMICAL SCIENCES				
Course Name	**M.Sc. Chemistry**			
Subject Code:	**CHL512E-18**			
Subject Title:	**GREEN CHEMISTRY**			
Contact Hours:	**L:4**	**T:0**	**P:0**	**Credits:4**
Examination Duration (hours)	**3**			
Objective(s):	1. To introduce the students of Master class about various concepts of green chemistry and its technologies. 2. The emphasis is on the synthesis of various entities using benign methods of green chemistry (their role and advantages).			

Details of the Course

Unit	Contents	Contact Hours
I.	Introduction to the Green Chemistry; Historical context: The Greening of Chemistry; Waste: Production, Problems, Prevention; Measuring and Controlling Environmental Performance; planning for the future for reducing carbon in the atmosphere; Emergence of Green chemistry and its environmental impact.	10
II.	Twelve Principles of green chemistry, concepts, importance and their applications with special emphasis on the use of alternative renewable feedstock (bio-fuels, biomass and their applications in green synthesis of various compounds); Use of innocuous reagents in natural processes; Alternative solvents; Design of the safer chemicals; Designing alternative reaction methodology; Minimizing energy consumption. Sustainable Polymers: The case of polylactide, using CO_2 and other feedstock.	10
III.	Green reactions (Role, advantages and applications): Aqueous phase organic synthesis, Solvent less organic synthesis, Photochemical organic synthesis, PTC catalysed reactions, Microwave induced reactions, Enzymatic transformations, Sonication reactions & reactions in Ionic liquids.	13
IV.	Green reactions (Role & mechanism): Aldol condensation reaction (solid phase and Ionic liquid synthesis), Baeyer-Villiger oxidation (aqueous phase and solid phase synthesis), Baylis-Hillman Reaction (Microwave synthesis and Ionic liquid synthesis), Biginelli Reaction under Microwave irradiation, Cannizaro Reaction under sonication, Dakin reaction under ultrasonication, Darzen reaction in PTC, Dieckmann condensation (Polymer supported synthesis), Diels-Alder reaction (in water, ionic liquid, MW and sonication), Photo-Fries rearrangement, Stille coupling in water and SC-CO_2, Ullmann reaction under sonication and in aqueous medium, Sonogashira reaction.	12

Reference Books

S.No.	Author(s)	Title of the Book	Publisher
1	Lancaster, M.	Green Chemistry an Introductory Text	Royal Society of Chemistry, Cambridge, UK 2002. ISBM 0-85404-620-8.
2	Cann, M.C.; Connelly, M.E.,	Real World Cases in Green Chemistry	American Chemical Society: Washington DC. 2000. ISBN 0-8412-3733-6.
3	Anastas, P. T.; Warner, J. C.	Green Chemistry: Theory and Practice	Oxford University Press: New York, 1998.

Course Outcomes and Mapping

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

CO1. Conceptualize the various syntheses using novel and greener methods.

CO2. Predict the relationships between organic chemical structures and their reactivity in different greener and benign conditions.

CO3. Learn the fundamental and advanced concepts of green chemistry in reaction mechanisms.

CO4. Apply the new methodologies for altering the reactivity patterns of substrates

CO5. Synthesize various molecules using combinations of reactive species in novel conditions.

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

M.Sc. Applied Chemistry (*Under Credit Based Continuous Evaluation Grading System*)

Semester-I				
Sr. No.	**Code**	**Theory Papers**	**Hours**	**credits**
1	CHL401	Basic Inorganic Chemistry	45	3-0-0
2	CHL402	Reactive Intermediates-I	45	3-0-0
3	CHL403	Physical Chemistry-I (Thermodynamics and Electrochemistry)	45	3-0-0
4.	CHL404	Organic Spectroscopy	45	3-0-0
5.	CHL405	Human Physiology(CHL-405H)-for non-medical Background /Mathematics (CHL-405M)-For Medical background	45	3-0-0
6.	CHL406	Environmental Sciences	30	2-0-0
6	CHP407	Inorganic Chemistry	90	0-0-3
7.	CHP408	Organic Synthesis	90	0-0-3
Theory 17 credits; Practical 6 credits				

Semester-II				
Sr. No.	**Code**	**Theory Papers**	**Hours**	**credits**
1	CHL411	Advanced Inorganic Chemistry	45	3-0-0
2	CHL412	Reactive Intermediates-II	45	3-0-0
3	CHL413	Physical Chemistry-II (quantum and statistical Chemistry)	45	3-0-0
4.	CHL414	Advanced Characterization Techniques	45	3-0-0
5.	CHL415	Electrochemical Techniques	45	3-0-0
6.	CHL416	Chemistry of Materials (416-A)/ Pharmacology (416-B)	45	3-0-0
7.	CHP417	Analytical and Electrochemical Techniques	90	0-0-3
8	CHP418	Physical Chemistry	90	0-0-3
Theory 18 credits; Practical 6 credits				

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

Semester-III				
Sr. No.	**Code**	**Theory Papers**	**Hours**	**credits**
1	CHL501	Photochemistry and Pericyclic Reactions	45	3-0-0
2	CHL502	Biophysical Chemistry	45	3-0-0
3	CHL503	Self- Assembled Materials (503A)/ Medicinal Chemistry-I(503B)	45	3-0-0
4.	CHL504	Connection and Disconnection Approach in Organic Synthesis	45	3-0-0
5.	CHL505	Chromatography and Separation Techniques	45	3-0-0
6.	CHL506	Computer for chemist	30	1-0-1
7.	CHP 507	BioPhysical Chemistry	90	0-0-3
8	CHP 508	Multi-step Organic Syntheses	90	0-0-3
Theory 16 credits; Practical 7credits				

Semester-IV				
Sr. No.	**Code**	Theory Papers	**Hours**	**credits**
1	CHL511	Advanced Organic Chemistry	45	3-0-0
2	CHL512	Functional Materials(512-A)/ Medicinal Chemistry-II (512-B)	45	3-0-0
4.	CHP513	Dissertation		0-0-18
Theory 6 credits; Practical 18 credits				

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

CHL404

Organic Spectroscopy

Credits: 3-0-0

SECTION-I

General Features of Spectroscopy

Introduction to spectroscopy, Nature of radiation, Energies corresponding to various kinds of radiation, Experimental techniques, intensities of spectral lines, Selection rules and transition moments, Line widths, Broadening

Nuclear Magnetic Resonance Spectroscopy:

PMR: Natural abundance of 13C, 19F and 31P nuclei; The spinning nucleus, effect ofexternal magnetic field, precessional motion and frequency, Energy transitions, Chemicalshift and its measurements. Factors influencing chemical shift, anisotropic effect;Integrals of protons, proton exchange, spin-spin coupling- splitting theory, one, two andthree bond coupling, virtual, long range and allylic coupling, magnitude of coupling constant; factors affecting the coupling constant, Chemical and magnetic equivalence,First and second order spectra, A2, AB, AX, AB2, AX2, A2B2 and A2X2 spin systems, Simplification of complex spectra (solvent effect, field effect, double resonance andlanthanide shift reagents).

SECTION-II

Nuclear Magnetic Resonance Spectroscopy:

CW and FT NMR, Relaxation processes, T1 and T2measurements, Applications of PMR in structural elucidation of simple and complex compounds.

13C-NMR: Resolution and multiplicity of 13C NMR, 1H-decoupling, noise decoupling, broad band decoupling; Deuterium, fluorine and phosphorus coupling; NOE and originof nuclear overhauser effect. off-resonance, proton decoupling, Structural applications of13C-NMR., pulse sequences, pulse widths, spins and magnetization vectors, DEPT,INEPT, Introduction to 2D-NMR, COSY, NOESY, HMBC and HSQC spectra

Mass Spectroscopy:

Introduction, methods of ionization EI & CI, Brief description of LD, FAB, SIMS, FD etc., Ion analysis methods (in brief), isotope abundance, Metastable ions, general rules predicting the fragmentation patterns.

SECTION-III

Mass Spectroscopy:

Nitrogen rule, determination of molecular ion peak, index of H eficiency, fragmentation patterns for aliphatic compounds, amines, aldehydes, Ketons, esters, amides, nitriles, carboxylic acids ethers, aromatic compoundsetc.

UV and Visible Spectroscopy of organic molecules:

Measurement techniques, Beer – Lambert's Law, molar extinction coefficient, oscillatorstrength and intensity of the electronic transition, Frank Condon Principle, Ground andfirst excited electronic states of diatomic molecules, relationship of potential energycurves to electronic spectra, Chromophores, auxochromes, blue shift, red shift, hypo andhyperchromic effect, σ-σ^*, π-π^*, n-π^* transitions in organic molecules, Woodward rulesfor conjugated dienes and α, β- unsaturated carbonyl groups, extended conjugation andaromatic sterically hindered systems, Quantitative applications.

Books Recommended:

1. Pavia, Lampman & Kriz, Introduction to Spectroscopy.
2. C.N Banwell "Fundamentals of Molecular Spectroscopy".
3. R. M. Silverstein, G.C.Bassler, T.C. Morrill, "Spectrometic Identification of Organic Compounds.
4. W. Kemp, "Organic Spectroscopy".
5. D.H. Williams, I. Fleming, "Spectroscopic Methods in Organic Chemistry".
6. D.H. Williams, I. Fleming, "Spectroscopic Problems in Organic Chemistry", 1967.
7. R.C. Banks, E.R. Matjeka, G. Mercer, "Introductory Problems in Spectroscopy", 1980.
8. G.M. Barrow "Introduction to Molecular Spectroscopy".

CHP-407
Inorganic Chemistry

Inorganic Synthesis

1. Synthesis of Tris(Ethylenediamine)Nickel(II) Chloride and estimation of Ni(II).
2. Synthesis of Potassium Trisoxalatoferrate(III) Trihydrate $K_3[Fe(C_2O_4)_3].3H_2O$ and estimation of anion.

Materials Synthesis

3. Synthesis of metal nanoparticles and studies of their photophysical properties.
4. Ligand directed synthesis of Quantum Dots and studies on the influence of surface directing agents.

Separation Techniques

5. To separate the mixture of metal ions using thin layer chromatography.
6. To perform the solvent extraction for the recovery of metal ions from aqueous medium.

Coordination Chemistry

7. Verification of relative position of ligands in spectrochemical series.
8. Calculation of 10Dq for the given metal complexes and assignment of transitions.

Inorganic Spectroscopy

9. Quantative determination of Cu(II) using spectroscopy.
10. Determination of stoichiometry of metal complex using Job plot method.
11. Determination of stoichiometry of metal complex using mole ratio method.
12. Determination of molar extinction coefficient of metal picrates.

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

CHP-408

Organic Synthesis

Techniques: (At least One Practical of Each Technique)

Crystallization, purification by Sublimation, Distillation, Fractional Distillation , Steam Distillation, Vacuum Distillation, Preparative chromatography Column Chromatography, TLC stains preparation and Thin Layer Chromatography

(Purity would be checked by m. p. and mixed m. p.).

2. Preparation of Derivatives: (Each Derivative of two Compounds) Oxime, 2, 4-DNP, Acetyl, Benzoyl, Semicarbazone, Anilide, Amide, Aryloxyacetic acid.

3. Preparations: Single Stage (Any 15)

i) Cyclohexanone to Adipic acid
ii) Benzophenone to Benzhydral
iii) Anthracene to Anthraquinone
iv) Chlorobenzene to 2,4-Dinitrochlorobenzene
v) 2,4-Dinitrochlorobenzene to 2,4-Dinitrophenol
vi) Acetoacetic ester to 1-Phenyl-3-methyl-5 pyrazolone
vii) Benzaldehyde to Cinnamic acid
viii) 4-Chlorobenzaldehyde to 4-Chlorobenzoic acid + 4-Chlorobenzyl alcohol
ix) Benzene to β-Benzoyl propionic acid
x) Benzaldehyde to Dibenzylidene acetone
xi) p-Aminobenzoic acid to p-Chlorobenzoic acid
xii) N,N-Dimethylaniline to 4-Formyl-N, N-dimethyl aniline
xiii) Benzophenone to Benzpinacol xiv) p-Nitrotoluene to p-Nitrobenzoic acid
xv) Anisole to 2,4-Dinitroanisole
xvi) Phthalic anhydride to phthalimide
xvii) Phthalimide to Anthranilic acid
xviii) Acetanilide to p-Bromoacetanide
xix) p-Bromoacetanide to p-Bromoaniline
xx) m-Dinitrobenzene to m-Nitroaniline

Pattern of Practical Examination

Q - 1. Techniques: Distillation or Column or TLC	25 marks
Q - 2. Preparation / Derivative	25 marks
Q - 3. Interpretation of spectrum	10 marks
Q - 4. Lab Journal	05 marks
Q - 5. Oral	10 marks

References: Vogel's, Practical Organic chemistry.

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

CHL414

Advanced Characterization Techniques

Credits: 3-0-0

SECTION-I

1. Modern Methods of Surfaces Analysis **5Hrs**

Scanning electron microscopy: Principle, Specimen Preparation, Replicas Various-application of SEM

2. Transmission electron microscopy **6Hrs**

Instrumentation, Principle, Advantage, Difference between SEM and TEM.

SECTION-II

3. Atomic Force Microscopy **10Hrs**

Principle, Instrumentation, Advantage and disadvantage, scanning force microscopy, shear forces microscopy, lateral force microscopy and magnetic force microscopy.

4. X-Ray diffraction **7Hrs**

Single crystal XRD and powder XRD, Bragg's diffraction law, Unit cell, space group, element of space group, particle size analysis using Scherer formula.

SECTION-III

5. Atomic Absorption Spectroscopy **7Hrs**

General principles, Instrumentation, Hollow cathode lamp, Line width effect in atomic absorption, Cold vapor atomic absorption spectroscopy.

6. Thermo-Analytical Method **10Hrs**

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

Reference

1. J.Goldstein, D. E. Newbury, D.C. Joy, and C.E. Lym, "Scanning Electron Microscopy and X-ray Microanalysis", 2003.
2. S.L. Flegler, J.W. Heckman and K.L. Klomparens, "Scanning and Transmission Electron Microscopy: A Introduction", WH Freeman & Co, 1993.
3. P.J.Goodhew, J.Humphreys, R.Beanland, "Electron Microscopy and Analysis",
4. Instrumental Methods of Analysis, Willard, Merritt, Dean and Settle, CBS Publisher and Distributors.,1986.
5. Thermal Analysis, W. W. Wendlandt and L. W. Collins, Dowden Hutechin and Ross

CHL415

Electrochemical Techniques

Credits: 3-0-0

SECTION-I

1. Introduction to electrochemistry **15Hrs**

Electrode potential, electrochemical cell and its types, Oxidation reduction reaction in electrochemical cell, Half-cell potential, standard hydrogen electrode, calculation of cell potential from electrode potential, Standard Weston cell, The Nernst equation, disproportion and comproportionation. Latimer diagram, Frost diagram, Oxidation reduction titrations

SECTION-II

2. Cyclic voltametry **15Hrs**

Electrode used in cyclic voltametry, electrochemical mechanism, E_{ads} mechanism (Adsorbtion mechanism), Butler-volmer equation, Reversible one electron transfer. Linear sweep voltametry, differential pulse voltammetry, Application, Polarography: principle and Application of polarography.

SECTION-III

3. Conductometry **8Hrs**

Electrolytic conductance, Measeurement of conductance, Conductometric titration, Application, Oscillometry.

4. Potentiometric methods **7Hrs**

Indicator electrode, Instrument for cell potential measurement, Application of potentiometric titration.

References

1. Fundamental of analytical chemistry, Skoog, West, Holler, Crouch, Eighth edition book, 2001.
2. Principles of Instrumental Analysis, Skoog, Holler, Nieman, Fifth edition Thomson Books ,1998.
3. Electrochemical Methods: Fundamentals and Applications, Bard, Allen J.; Larry R. Faulkner, Sencond edition, 2000 Wiley.
4. Handbook of Electrochemistry. Elsevier Science. ISBN 0-444-51958-0. Zoski, Cynthia G. 2007.

CHP417

Analytical and Electrochemical Techniques

Credits: 0-0-3

A. Conductometry

1. Find graphically the equivalent conductance at infinite dilution of weak acid (benzoic acid, succinic acid, acetic acid) and hence determine the thermodynamic dissociation constant of the weak acid.
2. Determine the equivalent conductance of strong electrolytes (KNO_3, KCl) at several concentrations of its aqueous solution and verify the Onsagar's equation.
3. Determine the equivalent conductance at infinite dilution of weak electrolytes (CH_3COOH, NH_4OH) in their aqueous solutions using Kohlraush law.
4. To determine relative strength of monochloroacetic and acetic acid by conductance measurements.

B. Potentiometry and *p*Hmetry

5. To determine the dissociation constant of a dibasic acid (malonic acid)
6. The potentiometric titration of a mixture of Chloride and Iodide with $AgNO_3$.
7. To determine the degree of hydrolysis of aniline hydrochloride and hence hydrolysis constant of the salt.
8. Determination of acid and basic dissociation constants of an amino acid and hence the iso-electric point of the acid.
9. Titration of Phosphoric acid solution with NaOH using quinhydrone electrode.
10. The Potentiometric Determination of Solute Species in a Phosphate Mixture
11. The Potentiometric Titration of Copper with EDTA.

C. Electrogravimetry and Coulometric titrations

12. Determination of Copper and Lead in a given sample of Brass Electrogravimetrically.
13. Determine coulometrically the concentration of Nickel and Cobalt from a given mixture.
14. The coulometric titration of cyclohexene.

D. Polarography and Stripping methods

15. The polarographic Determination of Copper and Zinc in the given sample of Brass.
16. Study the polarographic waves produced by dissolved oxygen.
17. Determine the half wave potential of Cd^{2+}, and Zn^{2+} ions in 0.1 M KCl solution.
18. Plot a polarogram for a mixture of Cd^{2+}, Zn^{2+}, and Mn^{2+}, ions.
19. Determine of formula and the stability constant of complex formation of a metal ion complex.
20. Determine the amount of Copper and Zinc in tap water using DPP.

21. Apply stripping methods to determine the concentration of lead in tap water.

Amperometric titrations:

22. Amperomertic titration of lead solution with potassium dichromate.
23. Amperometric titration of potassium sulphate solution with Lead nitrate solution.
24. Amperometric titration of nickel in solution with dimethyl glyoxime.
25. Determine transport number of silver and nitrate ions by Hittorf's method.

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

CHP418

Physical Chemistry Lab

- **Error analysis and statistical error analysis**

Errors, types of errors, minimization and distribution of errors; precision, accuracy, and combination; statistical treatment of error analysis; student 't' test; null hypothesis; linear regression analysis; and curve fitting

- **Adsorption**

Adsorption isotherm; and surface tension-concentration relationship for solutions

- **Phase equilibria**

Congruent composition and temperature of a binary system; phase diagram of a three component system; and oscillating reaction

- **Chemical kinetics**

Rate and order of reaction (ester hydrolysis in homogeneous/heterogeneous media and oxidation of iodine with hydrogen peroxide/iodine clock); influence of temperature, concentration of reactant and catalyst, and ionic strength of the media on rate constant; primary salt effect on the kinetic of ionic reaction

- **Solutions**

Molecular weight and activity coefficient of non-volatile and non-electrolyte/electrolyte; degree of dissociation of weak electrolyte (deviation from strong electrolyte); and surface tension and viscosity

- **Polymers**

Viscosity and molecular weight of polymers

- **UV-Vis and fluorescence spectroscopy**

UV-Vis spectra of compounds and λmax; effect of solvents (hypochromic, hyperchromic, hypsochromic, and bathochromic shifts); estimation of molecular extinction coefficients; emission and excitation spectra, effect of solvent; and estimation of quantum yields

- **Electrochemistry**

(a) Conductometry: velocity constant, order of reaction and energy of activation; strength of strong and weak acid; effect of solvent on conductance; activity coefficients of ions (Debye Huckel's limiting law); and solubility product of sparingly soluble salt

(b) Potentiometry:formation constant and stochiometry of a complex potentiometrically; strength of strong and weak acids (potentiometer/pH meter); temperature dependence of EMF of a cell; acid-base titration in non aqueous media (pH meter); activity and activity coefficients of an electrolyte; dissociation constant of acid in organic solvents (DMSO, DMF); and thermodynamic constant G, S, and H for the reaction by emf method

(c) Polarimetry:rate constant and enzyme kinetics for hydrolysis/inversion of sugar

Recommended books

1. *Practical Physical Chemistry*, A M James and F E Prichard, Longman

2. *Findley's Practical Physical Chemistry*, B P Levitt, Longman

2. Experimental Physical Chemistry, R C Das and B Behera, Tata McGraw Hill

CHL505

Chromatography and separation methods

Credits: 3-0-0

SECTION-I

1. Introduction to analytical separation, Principles of Adsorption Chromatography

2. Chromatographic Methods:

Classification of chromatographic methods according to separation and development procedure, Stationary phase, mobile phase, retention time.

SECTION-II

3. Gas chromatography:

Physical components, Types of column and detector, Carrier gas, Applications, Inverse Gas chromatography, GC-MS: construction and working.

SECTION-III

4. High performance liquid chromatography:

Construction and working, Partition chromatography, Normal and reverse phase chromatography, Ion exchange chromatography, Isocratic and gradient elution. Supercritical fluid chromatography: Mobile phase, Sample preparation, Drawback, Electrophoresis and electrochromatography

5. Gel permeation chromatography:

Working, Choice of Column: Organic column and aqueous column, Application, polydispersity index, Mark–Houwink equation.

6. Modern flash chromatography:

Advantage, comparison of column and flash chromatography

Reference

1. Chromatographic Methods, A. Braithwaite and F. J. Smith, 5th edn. Blackie Academic and rofessional, London, 1996.
2. Preparative chromatography, Henner Schmidt Traub, Wiely, 2005.
3. Principles of Instrumental Analysis, Skoog, Holler, Nieman, Fifth edition Thomson Books ,1998.

CHP507
Biophysical Chemistry Lab

- Separation of a mixture of amino acids using thin layer chromatography
- Isolation and quantitation of DNA from onion
- Separation of proteins/DNA using size-exclusion chromatography (SEC)
- Separation of DNA using gel electrophoresis (agarose)
- Isolation, detection, and quantitation of protein (casein) from milk
- Separation of proteinsusingpolyacrylamide gel electrophoresis (SDS-PAGE)
- Osmosis and diffusion through semipermeable membrane
- Estimation of DNA quantity using UV-Vis spectrophotometer
- DNA/ligand interaction (Scatchard plot) using UV-Vis spectrophotometer
- Melting curves of DNA using UV-Vis spectrophotometer
- Serum albumin/ligand interaction using UV-Vis spectrophotometer
- Study of DNA conformation using circular dichroism spectroscopy
- Thermal stability and conformation of proteins using circular dichroism spectroscopy

Books recommended

- *Safety-Scale Laboratory Experiments for Chemistry for Today*, S L Seager and M R Slabaugh, Brooks/Cole Laboratory Series for General, Organic, and Biochemistry, VII edition, Brooks/Cole, 2010

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

CHP 508

Multi-step Organic Synthesis

The use of multi-step approach in organic synthesis and applications of spectroscopic techniques to determine the structures of the compounds prepared.

EXPERIMENTS

1. Synthesize (a) 2,4-dinitro-1-chlorobenzene from chlorobenzene, (b) mixture of *o*- and *p*-nitrophenols from phenol and (c) *p*-nitroacetanilide from acetanilide and make comparison of the reactivity of various substrates and reaction conditions used for performing nitration in each experiment. (Book 2, pp 978-979, 919-20)
2. Synthesis of 2-chloro-4-bromo-6-iodoaniline from aniline. (Book 1, pp 292-299)
3. Synthesis of benzalacetophenone by condensation of benzaldehyde with acetophenone and study its bromination and subsequent de-bromination. (Book 1, pp 242-247, Book 3 pp 361-365)
4. The epoxidation of benzalacetophenone to its epoxide and study its reactivity towards hydroxyl ion. (Book 3, pp 363-364).
5. Michael addition of aniline to benzalacetophenone. (Book 1, p 247)
6. Conversion of benzalacetophenone to its oxime and its transformation to amideand oxazole derivatives. (Book 1, pp 242-247, Book 3 pp 361-365)
7. Synthesis of anthranilic acid from phthalimide. (Book 2, pp 898-899)
8. Synthesis of *p*-aminobenzenesulfonamide. (Book 1, pp 275-289)
9. Synthesis of Methyl n-pentyl ketone from ethyl acetoacetate. (Book 2, pp 620-621)
10. Synthesis of triphenylcarbinol from bromobenzene. (Book 2, pp 540-541)

Books:

1. An Introduction to Modern Experimental Organic Chemistry, R.M. Roberts, Gilbert, L. B. Rodewaldand A.S. Wingrove. Holt, Ranehart and Winston Inc., J. C New York 1969.

2. Vogel's Text Book of Practical Organic Chemistry, 5th Edition.

3. Laboratory Experiments in Organic Chemistry, R. Adams, J.R. Johnson

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	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	40	0-0-4	2	30	20	50
		Total		**14-4-12**	**24**			**600**

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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	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	0-0-2	2	30	20	50
		Total		**14-4-10**	**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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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°, Benzoic acid 121.5-122°, Urea 132.5-133°, Succinic acid 184.5-185°, Cinnamic acid 132.5-133°, Salicylic acid 157.5-158°, Acetanilide 113.5-114°, m-Dinitrobenzene 90°, p-Dichlorobenzene 52°, Aspirin 135° **Determination of boiling point** Ethanol 78°, Cyclohexane 81.4°, Toluene 110.6°, Benzene 80°
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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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:** Summary Paraphrasing; Analysis and Interpretation; Translation (from Hindi/Punjabi to English and vice-versa) Close Reading; Comprehension;	04

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:	**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).**

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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:	**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,	10

	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.	
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:	**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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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.

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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	-

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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)

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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** 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	12
	Microwave assisted reactions in organic solvents: Esterification,	10

III	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.	
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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

CO3	1	2	3	1	2	2	1
CO4	1	2	1	3	2	2	0
CO5	2	3	2	2	1	2	2

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.	11
IV	**Properties of Polymers (Physical, thermal, Flow & Mechanical**	12

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

	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)].	

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	-	-

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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. &	Vogel's Textbook of Practical Organic Chemistry, 5th Ed.	Pearson (1989)

	Tatchell, A. R.		
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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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	12

	electrophile , Extension of palladium catalysis to the formation of C-O and C-N 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	10

	correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.	
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

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

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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	-

Head
Department of Chemical Sciences
IKG Punjab Technical University
Kapurthala - 144603 Punjab (INDIA)

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

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY

Estd. Under Punjab Technical University Act, 1996
(Punjab Act No. 1 of 1997)

Ref. No. : IKGPTU/Reg/N/ *Dated :*

NOTIFICATION

Sub: **Regarding Pre-Ph.D Course work.**

This is for information of all concerned that Pre-Ph.D course work from 2016-17 will be conducted in the IKGPTU main campus Kapurthala in regular mode. The PhD course work will consists of minimum 15 credits. The structure of the course work is as under.

Sr. No.	Nature of course	Name of course	Credits	Remarks
1.	Core	1.Research Methodology	4	The syllabus of RM should be formulated faculty wise such as Engineering, Science, Management/ Humanities and Life sciences
		2.Subject related theory paper	4	Discipline specific related to advancements in theoretical methods for research
		3. Presentation	3	Discipline specific
2.	Interdisciplinary	4. Elective	4	From list of subjects from allied fields
	Total Minimum credits		**15**	

-Sd-
Registrar

Endorsement No: IKGPTU/REG/N/ 4244-4251 Dated: 22.08.2016

1. Secretary to Vice Chancellor: For kind information of Vice Chancellor
2. Dean (P&D)
3. Dean (RIC)
4. Dean (Academics)
5. Finance Officer
6. Controller of Examination
7. DR (Computers): For uploading on website
8. File Copy

Registrar 22/8/16

I. K. Gujral Punjab Technical University, Jalandhar
Jalandhar Kapurthala Highway, Near Pushpa Gujral Science City, Kapurthala - 144 603
Ph. No. 01822 - 662521. 662501 Fax No. : 01822-255506. 662526. Email : registrar@ptu.ac.in

RESEARCH METHODOLOGY

Course code	L	T	P	C
PHAS - 901	3	1	0	4

1. **Introduction to Research:-** Notes + Books.

   Objectives of research, motivation in research, types of research, significance of research, research methods vs methodology, research process in flow chart, criteria of good research, problems encountered by researchers in India.

2. **Thinking Processes:** Notes.

   Role of thinking in research, levels and styles of thinking; common-sense and scientific thinking; examples.

3. **Problem solving:** ?

   Problem solving strategies – reformulation or rephrasing, techniques of representation, logical thinking, division into sub- problems, verbalization, awareness of scale; importance of graphical representation; examples

4. **Experimental and modeling skills:**

   Census and sample survey, sampling procedure, important scaling techniques, methods of data collection, estimation and reduction of random errors; detection and elimination of systematic errors; guidelines for constructing questionnaire, Scientific method; role of hypothesis in experiment, hypothesis testing; F test, t test, Chi Square test, use of ANOVA; Types of models, the art of making approximations, problem representation; logical reasoning; mathematical skills; techniques of numerical simulation.

5. **Problem finding and literature survey:** → Notes (Research Design Kothari)

   Information gathering – reading, searching and documentation; types, attributes and sources of research problems; problem formulation, relative

importance of various forms of publications, choice of journal and reviewing process. Difference between publishing and patenting.

6. Chemdraw and documentation

Difference between TEX and LATEX, basics of using latex, latex input files, input file structures, layout of the document, titles, chapter and sections, cross references, foot note, environments, typesetting, building blocks of a mathematical formula, matrices, tables, including encapsulated postscript graphics, bibliography, downloading and working of CHEMDRAW software

7. Data And its Presentation

Introduction to origin, basics of importing and exporting data, working with Microsoft excel, graphing, statistics in origin, hypothesis testing, power and sample size, basic linear regression and curve fitting.

8. Statistical Analysis of Data

Error Analysis and Basic Statistics Measuring errors, uncertainties, parent and sample distributions, mean and standard deviation of distribution, types of probability distribution, instrumental and statistical uncertainties, propagation of errors, specific error formulas, method of least square fitting.

9. Multivariate analysis:

Multiple regression, multiple discriminant analysis, multipleanalysis of variance, canonical correlation analysis, Factor analysis cluster analysis, path analysis. Computational techniques.

10. Stress management, Time management, Interpersonal skills, professional ethics:

Psychological phases of a PhD process; stress points, Managing self; teamwork; sense of humor; Plagiarism and research ethics

Course structure

- The course comprises of six modules listed in table below. Each module has 4-5 units.

Modules	Unit title	Teaching hours
Theory		
RPE 01	Philosophy and Ethics	4
RPE 02	Scientific Conduct	4
RPE 03	Publication Ethics	7
Practice		
RPE 04	Open Access Publishing	4
RPE 05	Publication Misconduct	4
RPE 06	Databases and Research Metrics	7
	Total	**30**

Syllabus in detail

THEORY

- **RPE 01: PHILOSOPHY AND ETHICS (3 hrs.)**

1. Introduction to philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral philosophy, nature of moral judgements and reactions

- **RPE 02: SCIENTIFICCONDUCT (5hrs.)**

1. Ethics with respect to science and research
2. Intellectual honesty and research integrity
3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
4. Redundant publications: duplicate and overlapping publications, salami slicing
5. Selective reporting and misrepresentation of data

- **RPE 03: PUBLICATION ETHICS (7 hrs.)**

1. Publication ethics: definition, introduction and importance
2. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest
4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
5. Violation of publication ethics, authorship and contributorship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

PRACTICE

- **RPE 04: OPEN ACCESS PUBLISHING(4 hrs.)**

1. Open access publications and initiatives
2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
3. Software tool to identify predatory publications developed by SPPU
4. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

- **RPE 05: PUBLICATION MISCONDUCT (4hrs.)**

A. Group Discussions (2 hrs.)

1. Subject specific ethical issues, FFP, authorship
2. Conflicts of interest
3. Complaints and appeals: examples and fraud from India and abroad

B. Software tools (2 hrs.)

Use of plagiarism software like Turnitin, Urkund and other open source software tools

- **RPE 06: DATABASES AND RESEARCH METRICS (7hrs.)**

A. Databases (4 hrs.)

1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.

B. Research Metrics (3 hrs.)

1. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score
2. Metrics: h-index, g index, i10 index, altmetrics

References

Bird, A. (2006). *Philosophy of Science*. Routledge.

MacIntyre, Alasdair (1967) *A Short History of Ethics*. London.

P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978-9387480865

National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). *On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition*. National Academies Press.

Resnik, D. B. (2011). What is ethics in research & why is it important. *National Institute of Environmental Health Sciences*, 1–10. Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm

Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179–179. https://doi.org/10.1038/489179a

Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance(2019), ISBN:978-81-939482-1-7. http://www.insaindia.res.in/pdf/Ethics_Book.pdf

Annexure-A

01- Advanced Organic Chemistry

LTP-3-0-0

Total Hours: 45

1. **Pericyclic Reactions**
Molecular orbital symmetry, Frontier orbital of ethylene, 1, 3- butadiene, 1, 3, 5- hexatriene and allyl system. Classification of pericyclic reactions. Woodward-Hoffmann diagrams. FMO and PMO approach. Electrocyclic reactions, 4n, 4n+2 and allyl systems. Cycloadddition – antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions. Sigmatropic rearrangements–suprafacial and antarafacial shifts of Hydrogen, sigmatropic shifts involoving carbon moieties, 3, 3- and – sigmatropic rearrangements. Claisen, Cope and aza-Cope rearreangements, ene reaction.

2. **Metal Salt Catalysis**
(a). Fundamental reaction steps of transition metal catalysed reaction.
oxidative-addition reactions, elimination reactions, cleavage of C-H bonds, migration reaction, insertion reaction.
(b). Homo/heterogeneous catalysis by transition metal complexes.
Hydrogenation reaction, alkene isomerization, hydrosilylation and hydroboration reaction, alkene hydrogenation, reaction of CO and hydrogen, hydroformylation of unsaturated compounds, carbonylation reactions, C-C cross coupling and related reaction, reaction of conjugated dienes, reaction of alkynes, , alkene and alkyne metathesis, phase transfer catalysis,
(c). C-H activation using metal salts, Suzuki reaction, Heck reaction, Negishi coupling, Stille reaction, Sonogashira coupling reactions.

3. **Cycloaddition reaction in Organic Synthesis**
Cycloaddition reactions:- Brief introduction, types of cycloaddition reactions, diene , dienophiles, intra and inter-molecular Diels Alder reaction (Lewis acid catalysed and uncatalysed), , brief introduction to diene and heterodiene and their cycloaddition reaction (2+2 and 4+2) with dienophiles, regiochemistry and stereochemistry in Diels alder reaction, povarov reaction, aza-diels alder reactions, normal and inverse electron demand cycloaddition reactions, heterodienophiles, Hetero Diels alder reactions (general introduction), 1,3-dipolar cycloaddition reactions

4. **Multicomponent cycloaddition reactions,** brief introduction to transition metal salts catalysed reactions, brief introduction to (m+o), (m+n+o) type reactions with emphasis on 3+2; 4+3, 2+2, 4+2, 5+2, 2+2+2,3+2+2, 5+2+1 types of reactions.

Books

1. Advanced Inorganic Chemistry F.A Cotton 6th addition chapter 21 and 22, p. 1167-1294.
2. Cycloaddition reactions in organic synthesis by W. Carruthers in the Tetrahedron Organic Chemistry Series, edited by J. E. Baldwin and P. D. Magnus, Pergamon Press, Oxford, **1990**.
3. S.M. *Mukherji* and S. P. *Singh*, Reaction Mechanism in *Organic* Chemistry.
4. Inorganic Chemistry:Principles of Structure and Reactivity by James E. Huheey, Ellen A. Keiter, Richard L. Keiter
5. Some Modern Methods of Organic Synthesis by W Carruthers, Cambridge University Press.
6. Smith M B , March J March's Organic Chemistry 5th ed (2001)(2103s), Wiley, New York.

Annexure-B

02 Medicinal Chemistry

Total Hours: 45

No. of Lectures LTP-3-0-0

Structure, stereochemistry, nomenclature, mode of action, specific clinical applications and structure activity relationships of following classes of drugs and synthesis/commercial routes to specified drugs.

1. **CNS Active Drugs: CNS Depressants: Hypnotics and sedatives**: Barbiturates, Non-barbiturates, Amides and Imides, Glutethimide, Benzodiazepines, Aldehydes and derivatives, Methaqualone and other miscellaneous agents. **Anticonvulsants**: Barbiturates, Hydanatoins, Oxazolidinediones. Succinimides, Bezodiazepines, Thenacemide, Glutethimide. **CNS-stimulants & Psychoactive drugs**: Analeptics, Purines, Psychomotor stimulants, Sympathomimetics, Monamine oxidase inhibitors, Tricyclic antidepressants, Miscellaneous psychomotor stimulants. Hallucinogens **(Psychodelics, Psychomimetics)**: Indolethylamines, R-phenylethylamines, Butyrophenones and other miscellaneous drugs.
2. **Commercial Synthetic routes to:** Thioridazine, Haloperidol, Chloropromazine, Phenytoin, Phenobarital, Carbamazipine valproic acid, Methaquolane, Nitrazepam, Oxazepam, Diazepam, Cholridazepoxide

3. **Antibacterial and Antiviral Agents:** History of Antibacterial Drugs, Types, Classifications, Structural Activity Relationship, Fluoroquinolones, Mechanism of Action Of Antibacterial, ß-lactams, Bacterial Resistance against Antibacerial Drugs,
   Target for Anti HIV Drugs. Anti HIV Agents: HIV-Protease inhibitors, Amprenavir, Foseprenavir, Alazanavir etc. Anti-HIV Nucleosides: Lamivudine, Retrovir, Videx, Hivid, Zlarit, Viread, Carbovir, Delavirdine, Ziduvidine, Etavirenz, Calanolide, Capravine, Nevirapine. DNA Polymerase inhibitors: Acyclovir, Ganciclovir, Penciclovir, Famicilovir, Valaciclovir, Valomaciclovir, Codofvir.

4. **Antineoplastic agents:** Alkylating agents (Nitrogen mustards, Aziridines, Sulfonic acid Esters, Epoxides, Nitrosoureas, Triazenes, Phosphamides, Mitomycin, Comparative activity of alkalyting agents). **Antimetaboilities:** Antifolates (Methotrexate), Mercaptopurine, Thioguanine, Flourouracil, Floxuridine, Cytarabine, Azathioprine, Antitumor, antibiotics, Dactinomycin, Daunorubricin, Aclacinomycin, Mithramycin, Bleomycin, **Miscellaneous compounds:** Cisplatin, Taxol, Gunazole, Pipobromin. **Antitumor alkaloids:** Vincristine, Vinblastine. **Hormones agonist and antiagonists:** Steroids, Tamoxifen, Mitotane, Dromastanolone propionate, Testalactone, Megestrol acetate Immunotherapy.

Books Recommended:

1. Wilson and Gisvolds Textbook of Organic Medicinal and Pharmaceuticals Chemistry, 8th edition, edited by R.F. Deorge, J.B. Lippincott Company, Philadelphia, 1982.
2. Pharmaceutical Chemicals in Perspective. B.G. Reuben and H.A. Wittcoff, John Wiley & Sons, New York, 1989.
3. W.O. Foye, T.L. Lamke, D.A. Williams, Principles of Medicinal Chemistry, 5th edition, Lippencott Williams and Wilkins, 2002.

Annexure-D LABORATORY PRACTICES
ESL964

Credits 3-0-0

Total Hrs 45

1. **Introduction to chemical analysis:** Nature of analytical chemistry, general directions of chemical analysis: Cleanliness in the laboratory, Recording and planning data. Data quality: Bias, Precision, Uncertainty, Method detection limit, Checking correctness of analysis, Expression of results, Significant figures, Collection and preservation of sample,
2. **Laboratory hazards**: Chemical, Fire, Careless habits, Handling of compressed gases, Stockroom safety rules, Laboratory safety rules. Quality assurance of chemical measurements: Quality assurance, quality control, Quality assessment, Sampling, Sampling custody, Sample preparation, Analytical methodology with case studies, Calibrations, Detection limits, Statistics in chemical analysis, Quality control charts.
3. **Laboratory apparatus and glassware**: Labware materials, soft vs. heat resistant glassware, plastic, porcelain, platinum, nickel labware. Volumetric flask, pipette, burette, cleaning of volumetric glassware. Types of balances: Analytical balances, Desiccators.
4. **Chemical reagents and standards:** Grade and purity of chemicals, Proper storage of chemicals and standards, Laboratory pure water, Preparation of reagent grade water, Reagent water quality.
5. **Reagents and solutions**. Stock standardization solutions, Preparation and standardization of common standard solutions,
6. **Filtration:** Gravity, Vacuum, Centrifugation, Distillation: Simple, Fractional, Vacuum, Refluxing, Ion exchange, Drying and washing sample, Liquid-liquid extraction by separating funnel, Soxhlet extraction.
7. Software's for stock room management, Role of computers in Laboratory occupational health and safety, Waste minimization and disposal.

References:

1. Csuros, M., Environmental Sampling and Analysis, Lewis Publications.
2. Standard methods for the examination of water

Annexure-D

LABORATORY PRACTICES AND SEAFTY

ESL964

	L	P	T	C
Total Hrs 45	3	0	0	3

1. **Introduction to chemical analysis:**

   Nature of analytical chemistry, General directions of chemical analysis: Cleanliness in the laboratory, Recording and planning data. Data quality: Bias, Precision, Uncertainty, Method detection limit, Checking correctness of analysis, Expression of results, Significant figures, Collection and preservation of sample.

2. **Data Analysis:**

   Uncertainties, Errors, calibrations, Mean, Standard Deviation, Least square fit.

3. **Laboratory apparatus and glassware:**

   Lab wares, soft Vs heat resistant glasswares, lab ware's of plastic, porcelain, platinum and nickel. Volumetric flasks, Pipette, burette, Cleaning of volumetric glassware. Calibrations of Glass wares ,Types of balances: Analytical balances, Desiccators.

4. **Chemical reagents and standards:**

   Grade and purity of chemicals, Proper storage of chemicals and standards, Laboratory pure water, Preparation of reagent grade water, Reagent water quality.

   Quality assurance of chemical measurements: Quality assurance, quality control, Quality assessment, Sampling, Sampling custody, Sample preparation, Analytical methodology with case studies, Calibrations, Detection limits, Statistics in chemical analysis, Quality control charts.

5. **Reagents and solutions.**

   Stock standardization solutions. Preparation and standardization of common standard solutions.

6. **Common Laboratory techniques:**

Gravity, Vacuum, Centrifugation, Distillation: Simple, Fractional, Vacuum, Refluxing, Ion exchange, Drying and washing sample, Liquid-liquid extraction by separating funnel, Soxhlet extraction and filtration.

7. **Inventory Management:**

Software's for stock room management, Role of computers in Laboratory occupational health and safety, Waste minimization and disposal.

8. **Laboratory hazards and safety:**

Lab design, Fume hoods, Chemical safety aspects, Fire, Careless habits, Safe Storage, Handling of Chemicals, Handling of compressed gases, Stockroom safety rules, and Laboratory safety rules. , Protection of Environment, Disposal of Chemicals, Bio safety, chemical and electrical safety, Fire safety, Radiation safety, Eyewash and safety shows, Routine mock drills for lab safety.

References:

1. Environmental Sampling and Analysis by Csuros, M.,Lewis Publications.
2. Standard methods for the examination of water Author /publisher missing ?????
3. Laboratory Safety for Chemistry Students, by Robert H. Hill Jr. (Author), David C. Finster (Author), Wiley(second Edition)
4. Good Laboratory Practice Regulations, Fourth Edition. by Sandy Weinberg,CRC press