St. Xavier's College (Autonomous), Ahmedabad-09

Syllabus under Autonomous system for M.Sc. Semester I and II for M Sc Analytical Chemistry (Self Finance Course) (2018-2020)

January 26, 2018

St. Xavier's College- Ahmedabad 09 (Autonomous)
Department of Chemistry
Proposed Syllabus for M Sc Sem I and II Chemistry for
M.Sc. Analytical Chemistry (Self finance)
(Tobe approved by the board of studies in the Chemistry Department)

M Sc Chemistry Sem I Overview

Sub. code	Course	Instruction Hrs/week	Internal Assessment Marks	Max Marks Semester Exams	Duration of Semester Exam (Hrs)	Credit
THEORY						
PCH 1801	Inorganic Chemistry	4	30	70	3	4
PCH 1802	Organic Chemistry	4	30	70	3	4
PCH 1803	Physical Chemistry	4	30	70	3	4
PCH 1804	Analytical techniques	4	30	70	3	4
PRACTICALS						
PCH 1805L	Inorganic Chemistry Lab-I	3	30	70	3	4
	Organic Chemistry Lab-I	3			3	
PCH 1806L	Physical Chemistry Lab-I	3	30	70	3	4
	Analytical Chemistry Lab-I	3			3	
	Total	**28**	**180**	**420**		**24**

Note:- Semester -I and Semester-II syllabus is common for all specializations to be selected by the students for final year i.e. Inorganic, Organic, Physical and Analytical. At present St. Xavier's College offers only Organic Chemistry as a specialization in the final year of M Sc Chemistry.

M Sc Semester I

CORE Paper: Inorganic Chemistry (Theory)
Course Code: PCH 1801
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)

I. Course Overview & Course Objectives

Unit IC 01: Quantum theory and Atomic Structure

Unit IC 02: Symmetry and Group Theory

Unit IC 03: Magneto chemistry

Unit IC 04: Bio-inorganic Chemistry

The main objective of the course will be to enhance the understanding and knowledge of Inorganic Chemistry, for students studying, any branch of chemistry.

By the end of the paper, a student will be able to:

(a)Understand the important aspects of Quantum theory and Atomic Structure

(b)Know and study the Symmetry and Group Theory

(c) Understand the important aspects of Magneto chemistry

(d) Know and study Bio-inorganic Chemistry

Thus, the knowledge from the course can help in the following:
(a) Finally, all students, of all branches whether organic or inorganic will be able to incorporate this knowledge, in their pursuit of research in their different fields.

II. Course Content

Unit 1 -Quantum theory and Atomic Structure (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Quantum theory and Atomic Structure]

Postulates of quantum mechanics, setting up of different observables, commutation relations, step-up and step-down operators. Simple harmonic oscillator. Angular momentum of inner quantum number j.

Approximationmethods:VariationmethodandapplicationtoHatom.Perturbation theory (first order and non-degenerate), application to the Heliumatom.

Unit 2- Symmetry and Group Theory (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Symmetry and Group Theory]

Representation of groups –some properties of matrices & vectors, representation of groups, the Great orthogonality theorem and its consequences, character table, wave functions as basis for irreducible representations, direct product, identifying non- zero matrix elements.

Unit 3- Magneto Chemistry (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Magneto chemistry]

Magnetic susceptibility and basic derivation of diamagnetic susceptibility, pascal constant and its utility, Curie law and Curie-Weiss law, antiferromagnetism and ferromagnetism. Types of ant ferromagnetism, antiferromagnetic exchange pathway: Direct –metal- metal interaction and Indirect-atom exchange i.e. super exchange mechanism.

Unit 4- Bio-inorganic Chemistry (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Bio-inorganic Chemistry]

Metalloporphyrins (enzymes) definition, hemoglobin and myoglobin, cytochrome, vitamin B_{12}(cyanocobalamin), zinc metallo enzymes, nitrogen fixation, essential and trace elements in biological system, biochemistry of non metals K, Na pump (action of bath ions), toxic metals and their toxicity.

Co-ordination compounds in medicine

Chelation therapy, gold compounds and rheumatoid arthritis, anticancer drugs –platinum complexes, gold complexes, metallocenes etc, antimicrobial agents, metal complexes as radio diagnostic agents, magnetic resonance imaging.

III. Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

M Sc Semester I

IV. Reference Books: PCH 1801: Inorganic Chemistry (Theory)

(1) Introduction to Quantum Chemistry, A. K. Chandra, Tata MacGraw Hill
(2) Quantum Chemistry, Ira N. Levine, Prentice Hall

(3) Quantum Chemistry by R. K. Prasad, New Age International Publishers (1985)
(4) Elementary Quantum Chemistry by D. L. Pilar, McGraw Hill Book Co, New York (1968)
(5) D. A. McQuarrie Quantum Chemistry, OUP 1983
(6) M. W. Hanna, Quantum Mechanics in Chemistry, The Benjamin Pub.
(7) Molecular Quantum Mechanics, Third Edition, P. W. Atkins and R.S. Friedman
(8) Group theory and symmetry in chemistry, L. H. Hall(McGraw Hill)
(9) F. A. Cotton, Chemical Applications of Group theory, Wiley Eastern 2nd Edn.1992
(10) V. Ramkrishnan& M. S. Gopinadhan, Group theory in Chemistry Vishal Pub.1996.
(11) Inorganic Chemistry, Third Edition, Alan G. Sharpe
(12) Theoretical Inorganic Chemistry, M. C. Day, J. Shellin
(13) Chemistry, Fifth Edition, John E. McMurry, Robert C. Fay
(14) Hermann Dugas, Bioorganic Chemistry, A Chemical Approach to Enzyme Action, Springer International Edition
(15) An Introduction to Theoretical Chemistry, Jack Simons, Cambridge
(16) Progress in inorganic Chemistry, Vols 18 and 38 ed. J. J. Lippard, Wiley
(17) Inorganic Reaction Mechanisms, M. L. Tobe, Nelson Pub
(18) Inorganic Chemistry, K. F. Purcell and J. C. Kotz.
(19) Principles of Bioinorganic Chemistry, S. J. Lippard and J. M. Bers
(20) Bioinorganic Chemistry, I. Bertini, H. B. Gray and S. J. Lippard
(21) Principals of Biooganic Chemistry, S. J. Lippard and J. M. Berg, University Science Books.
(22) Bioinorganic Chemistry, I. Bertini, H. B. Gray, S. J. Lippard and J. S. Valentine, University Science Books.
(23) Inorganic Biochemistry vols I and II ed. G. L. Eichhorn, Elsevier
(24) Introduction to Magnetochemistry, Alan Earnshaw, 1968
(25) Elements of Magnetochemistry, Dutta and Syamal, 1993

M Sc Semester I

Paper: PCH 1802: Organic Chemistry (Theory)

CORE Paper: Organic Chemistry (Theory)
Course Code: PCH 1802
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)

I. Course Overview & Course Objectives

Unit OC 01: (A) Elimination Reaction
(B) Nucleophilic Substitution Reaction
Unit OC 02: Molecular rearrangements:
Unit OC 03: (A) Reactive intermediates
(B) Aromaticity
Unit OC 04: Stereo Chemistry

The main objective of the course will be to enhance the understanding and knowledge of organic chemistry

By the end of the paper, a student will be able to :

(a) understand the details of Elimination Reaction and Nucleophilic Substitution Reaction

(b) the chemistry of various types of Molecular rearrangement reactions.
(c) understand the important aspects of Reactive intermediates and Aromaticity

(d)understand the details of various aspects of Stereo Chemistry.

Thus, the knowledge from the course can help in the following:
This content can help students to increase their conceptual base and understanding in these topics which will be needed by students in their pursuit of research in other allied branches of chemistry.

II. Course Content

Unit-1 **(15L)[14Marks]**

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Elimination Reaction and Nucleophilic Substitution Reaction]

(A) Elimination Reaction

The E1, E2 and E1CB reaction mechanism. reactivity- effects of substrate structures, attacking base, leaving group and medium. Regiochemistry of E1 and E2 elimination reactions.Stereochemistry of E2eliminations in cycloalkane and related systems.Mechanism and

orientation in Pyrolytic eliminations in (1) Acyclic systems (ii) Alicyclic systems (iii) Cope eliminations. Thermal decomposition without rearrangement. - The chugaev reaction.

(B) Nucleophilic Substitution Reaction

Mixed S_N1, S_N2 and SET mechanism. Nucleophilic substitution at (i) Allylic carbon (Allylic rearrangements)(ii) An Aliphatic trigonal carbon (the tetrahedral mechanism) and at (iii) A Vinyl carbon. Participation of Neighboring groups in Nucleophilic substitution by (a) Carboxylate anion (b) Halogen atoms (c) Hydroxyl groups (d) Acetoxyl group (e) Phenyl group (f) RS group (g) Participation by π-bond.

Unit-2 Molecular rearrangements (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Molecular rearrangements]

Introduction: Definition and classification.

(I) Rearrangements Induced by Cationic or Electron Deficient Sites

Molecular rearrangements involving electron deficient carbon:

(i) Wagner- Meerwein
(ii) Pinacol- Pinacolone rearrangement
(iii) Tiffeneau-Demjanov Rearrangement

Rearrangements to Electron Deficient Heteroatoms

Electron deficient Nitrogen:

(i) Lossen rearrangement
(ii) Curtius rearrangement
(iii) Schmidt rearrangement

Electron deficient Oxygen:

(i) Baeyer-Villager Rearrangement

(II) Rearrangements Induced by Bases or Electron Rich Sites

(i) The Favorskii Rearrangement
(ii) Wittig and Stevens Rearrangement
(iii) Benzylic acid rearrangement
(iv) The Sommelet-Hauser rearrangement

Unit – 3 (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to reactive intermediates and aromaticity]

(A) Reactive intermediates

Carbocations (classical and non classical), Carbanion, Carbines, Free radicals and Nitrenes: their stability, structure, generation and fate.

(B) Aromaticity

Aromaticity, aromatic character, Frost circle diagram for cyclobutadiene, benzene and others. Resonance and chemical stabilization-aromatic character based on NMR criteria, Huckels molecular orbital(HMO) method, MO of simple organic systems such as ethene, allyl and butadiene. Aromaticity in benzenoid and non-benzenoid compounds and charged rings, annulenes, fulvenes, azulenes, antiaromaticity and homoaromaticity.

Unit –4 Stereo Chemistry (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Stereo Chemistry]

Planar and helical Chirality: Configurational nomenclature: Planar chiral ANSA compounds and trans- cyclooctene. Helical chiral compounds. Enantio selective Synthesis – Epoxidation of allyl alcohols (Sharplessep oxidation), Enantio selectivity through Hydroboration-Oxidation, Enantio selectivity through use of Phase transfer catalysts, Reduction of ketones with chiral hydride donors. Asymmetric resolution: Dynamic resolution, Dynamic kinetic resolution and Dynamic Thermodynamic resolution.

III. Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

M Sc Semester I

IV. Reference Books: PCH 1802: Organic Chemistry:(Theory)

(1) Advanced Organic Chemistry, Reactions Mechanisms and Structure, J. March, 6thEdition, John Wiley.

(2) Carbenes, nitrenes and arynes, T.L. Gilchrist and C.W. Rees.

(3) Guidebook to Mechanism in Organic Chemistry by Peter Sykes, 6th Edition, Prentice Hall.

(4) Advanced Organic Chemistry Part A: Structure and Mechanism and Part B:Reaction and synthesis ,Francis A. Carey, Richard J. Sundberg, 5th Edition, Springer .

(5) Advanced Organic Chemistry Part B: Structure and Mechanism and Part B:Reaction and synthesis ,Francis A. Carey, Richard J. Sundberg, 5th Edition, Springer

(6) Organic Chemistry, Jonathan Clayden, Nick Geeves, Stuart Warren, 1st Edition, Oxford University Press.

(7) Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, 3rd Edition, Blackie Academic and Professional.

(8) Stereo Chemistry, P.S. Kalsi , New Age Publications.
(9) Reagents in Organic Synthesis- Fieser and Fieser, John Wiley.
(10) Stereochemistry of Organic Compounds, Ernest L. Eliel, Samuel H. Wilen, Wiley-Blackwell
(11) Organic Chemistry, T.W. Graham Solomons and Graig B. Frymes, John Wiley and Sons.
(12) Organic Chemistry, F. A. Carey, McGraw Hill Edition.
(13) Dynamic Stereochemistry of Chiral Compounds: Principles and Applications, Christian Wolf, RSC publishing.
(14) Organic Chemistry Vol 1-2 I.L.Finar 5th edition,ELBS.
(15) Organic Reaction mechanism, Third edition, V. K. Ahluwalia, RakeshkumarParashar, Narosa Publishing house New Delhi

M Sc Semester I

CORE Paper: Physical Chemistry (Theory)
Course Code: PCH 1803
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)

I. Course Overview & Course Objectives

Unit PC 01- Chemical thermodynamics
Unit PC 02- Chemical Kinetics
Unit PC 03-Solid state chemistry
Unit PC 04- Surface chemistry

The main objective of the course will be to enhance the understanding and knowledge of Physical Chemistry without an obscuring mathematical screen.

By the end of the paper, a student will be able to:

(a) understand the details and utility of the entire topics in physical chemistry, separately as well as in context to one another.

(b) the long major areas of study such as thermodynamics and kinetics are so taught ,such that students are able to move on to more advanced studies.

Thus, the knowledge from the course can help in the following:
The other topics, like Solid State and Surface Chemistry are so decided upon so that students can increase their conceptual base in this subject which will be needed by students in their pursuit of research in other allied branches of chemistry.

II. Course Content

Unit -1 Chemical thermodynamics (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Chemical thermodynamics]

Experimental verification of third law of thermodynamics, entropy correction for real gases, partial molar quantities and their determination, Gibbs-Duhem equation, chemical potential, chemical potential of idea gases and solutions, Raoult's law, real solutions, free energy and solutions, activity and activity coefficients, fugacity of gases and liquids and methods of its determination. Non equilibrium thermodynamics-basic concepts.

Unit -2 Chemical Kinetics (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Chemical Kinetics]

Unimolecular reactions, chain reactions and branched chain reactions, explosion limits, chain reaction between hydrogen and bromine, theory of absolute reaction rates, Kinetics of fast

reaction and some experimental techniques for studying fast reactions like NMR, Mass Spectoscopy, Gas chromatography, Flow method and Flash photolysis method.

Unit -3Solid state chemistry (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Solid state chemistry]

Bonding in solids and electronic structure in solids, bond theory-metals, semiconductors and insulators, defects in crystals, calculation of schottly and Frenkel defects using statistical method, non-stoichiometry –FeO (wustite), solid electrolytes, diffusion in solids- Fick's laws, mechanism of diffusion, electrical conductivity in solids, super conductivity, perovskites.

Unit -4 Surface chemistry (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Surface chemistry]

Physical and chemical adsorption, BET equation, heat of adsorption and its measurement by Calorimetric and Clausius Clapeyron equation methods, determination of surface area of adsorbents by BET method , surface tension and adsorption from solutions, Gibb's adsorption equation, micellisation and critical micellar concentration (cmc).

III. Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

M.Sc. Semester I

IV. Reference books: PCH1803: Physical Chemistry (Theory)

(1) Physical chemistry by W.J.Moore, 5th edition, orient longman private ltd.
(2) Textbook of physical chemistry by S. Glasstone, D. Van Nostrand company, inc., 1946.
(3) Textbook of physical chemistry by Peter Atkins Julio de and Paula, 9th edition, oxford press.
(4) Advanced physical chemistry by Gurdeep Raj 35th revised edition, Goel publishing house.
(5) Advanced physical chemistry by J. N. Gurtu, A.Gurtu, 11th edition , Pragati prakashan.
(6) Thermodynamics for chemists by S. Glasstone, Read Books, 2007.
(7) Physical chemistry by S. Castellan, 3rd edition, Pearson Custom Publishing.
(8) Thermodynamics of non equilibrium processes- Karapitianeh
(9) Chemical Kinetics by Laidler, 3rd edition, Pearson Education India.
(10) Chemical Kinetics – Frost and Pearson
(11) Principles of the Solid State by H.V. Keer, 2nd edition ,New Age International (P) Ltd.

(12) Solid state chemistry by Hannay,Prentice-hall,1967.
(13) Introduction to Solids by L. Azaroff, 1st edition, McGraw Hill Education India Pvt Ltd.
(14) Physical Chemistry of Surfaces by A.W.Adamson,6th edtition, Wiley-Interscience.
(15) Surface chemistry – Osipov
(16) Solid State Chemistry and its Applications by Anthony R West, 2nd edtiton 2014,Wiley.
(17) Chemical Thermodynamics: Classical, Statistical and Irreversible by Rajaram & Kuriakose, S Chand, 2nd edition.

M Sc Semester I

CORE Paper: Analytical Chemistry (Theory)
Course Code: PCH 1804
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)

I. Course Overview & Course Objectives

Unit -AC 01 Analytical objectives, sampling and calibration methods
Unit-AC 02 Fundamentals of spectrophotometry
Unit-AC 03 Applications of spectrophotometry
Unit-AC 04 Thermal methods of analysis

The main objective of the course will be to enhance the understanding and knowledge of Analytical Chemistry, for students studying , any branch of chemistry .

By the end of the paper, a student will be able to:

(a) Understand the very important role of an analytical chemist in all branches of chemistry.

(b) Know and study the work-up required by all samples before they can be subjected to analysis and also learn about the various types of analysis.

(c) will study about the most widely employed technique i.e. spectrophotometry and its application.in analytical chemistry and other branches of chemistry.

(d) will study about thermal methods of analysis which is able to provide valuable analytical data.Thus, the knowledge from the course can help in the following:

All students, of all branches whether organic or inorganic will be able to incorporate this knowledge, in their pursuit of research in their different fields.

II. Course Content

Unit -1Analytical objectives, sampling and calibration methods (15L)[14 Marks]
[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Analytical objectives, sampling and calibration methods]

Scope of analytical science and its literature, sampling and sample preparation, general steps in chemical analysis, calibration and classification of glassware, validation of analytical methods, finding the best straight line-least square regression ,correlation coefficient, calibration curves, standard addition technique internal standard method. Numericals based on chemical concentrations.

Unit-2 Fundamentals of spectrophotometry (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Fundamentals of spectrophotometry]

Properties of light, absorption of light, interaction of light with matter and origin of spectra, spectrophotometer-instrumentation of single and double beam, Beers Law-its use, limitation and numericals, photometric accuracy.

Unit-3 Applications of spectrophotometry (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Applications of spectrophotometry]

Analysis of mixture ,measurement of equilibrium constant, Scatchard Plot, Stoichiometry determination-method of continuous variation-Jobbs Plot , Photometric titrations.

Unit-4 Thermal methods of analysis (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Thermal methods of analysis]

Principle ,instrumentation and applications of Thermo Gravimetric Analysis (TGA), Differential thermal analysis(DTA) and Differential Scanning Calorimetry (DSC).

III. Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

M Sc Semester I

IV. Reference books: PCH1804: Analytical Chemistry (Theory)

(1) Quantitative Chemical Analysis, by Daniel C. Harris, 5th Edition, W.H. Freeman and Company, New York.

(2) Analytical Chemistry, by Gary D. Christian, 6th Edition, John Wiley and Sons Inc. New Jersey.

(3) Principles of Instrumental Analysis, by Douglas A. Skoog, 3rd Edition, Holt- Saunders International Edition.

(4) Instrumental Methods of Chemical Analysis, by Galen W. Ewing, 4thEdition, International Student Edition.

M Sc Semester I

Paper: Inorganic Chemistry and Organic Chemistry (Practicals)
Course Code: PCH 1805L
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)

I. Course: PCH 1805L (A) Advanced Inorganic Chemistry (Practicals)
II. Course Content

(1) Solid phase synthesis of trans-bis glycinato copper (II)
(2) Non-metal complex: Synthesis and characterization of bispyridine iodide nitrate.
(3) Nano-chemistry: Preparation of manganese dioxide nanoparticles.
(4) Synthesis of hexaammine cobalt (III) chloride.
(5) Determine the presence of F, As, Zn, Cd, Pb, Cu in drinking water and heavy metal in food samples.
(6) Determination of the half wave-potential for Cd (II) or Cu (II) or Zn (II) ion in 0.1 M KCl solution.
(7) Study the kinetics of dissociation of tris-O-phenanthroline Fe (II), Ni (II) complex by spectrophotometric method.
(8) Catalytic reduction activity of silver nano particle for p-nitrophenol and other derivatives.

Projects:

(1) Just like heavy metal detection in waste water, in chocolate and toys with the help of nano-particles.
(2) Bio chemical sensing with nano-particles.

III. Teaching methodologies: Practical work, problem solving, and group discussion etc.

M. Sc. Semester I

IV. References books: PCH1805L (A): Advanced Inorganic Chemistry (Practicals)

(1) Vogel's Qualitative Inorganic Analysis, Revised by G Svehla, Sixth Edition, Longman, 1987.
(2) Monograph on Green Chemistry Laboratory Experiments, Green Chemistry Task Force Committee, DST.

I. Course: PCH 1805L (B) Organic Chemistry (Practicals)

II. Course Content

(a)Preparation of organic compounds: Single Stage Preparations:

(1) Preparation of 1-Phenyl-3-methyl-5 pyrazolone from acetoacetic ester.

(2)Preparation of Dibenzylidene acetone from Benzaldehyde.

(3) Preparation of o-Chlorobenzoic acid from o-amino benzoic acid.

(4) Preparation of 2,4-Dinitroanisole from Anisole

(5) Preparation of Phthalimide from phthalic acid.

(6) Preparation of Para Red

(7) Preparation of methyl Orange.

(8) Preparation of Benzo triazole from o-Phenylene diamine

(9) Preparation of 1,2,3,4 tetrahydrocarbazole from phenyl hydrazine. (Fisher Indole synthesis)

(10) Preparation of p-Bromo acetanilide from acetanilide (Green route)

(b) Quantitative Estimations:

(1) Estimation of ester + acid

(2) Estimation of Formaldehyde

(3) Estimation of glycine

(4) Estimation of amide + acid

III. Teaching methodologies: Practical work, problem solving, and group discussion etc.

M. Sc. Semester I

IV. References books: PCH1805L (B): Organic Chemistry (Practicals)

(1) A text book of practical organic chemistry – A. I. Vogel

(2) Practical organic Chemistry – Mann and Saunders

(3) A handbook of quantitative and qualitative analysis – H. T. Clarke

(4) Comprehensive Practical Organic Chemistry : Qualitative Analysis V K Ahluwalia& S. Dhingra.

(5) Comprehensive Practical Organic Chemistry : Preparations and Quantitative Analysis V K Ahluwalia& R. Aggarwal Universities Press.

(6) An Advance Course in practical Chemistry, A K. Nad, B. Mahapatra and A. Ghoshal.

M. Sc. Semester I

Paper: Physical Chemistry and Analytical Chemistry (Practicals)
Course Code: PCH 1806L
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)

I. Course: PCH 1806L (A) Physical Chemistry (Practicals)
II. Course Content

(1). Conductometry

(a) To determine of centration of HCl and NH_4Cl in a given solution conductometrically (requirements: 0.05N HCl, 0.5 N NH_4Cl, 0.5 N NaOH)

(b) Estimate the concentration of H_2SO_4, CH_3COOH and C_USO_4 5 H_2O in a given solution conductometrically. (0.005M all against 0.05N NaOH)

(2) Potentiometry

(a) To construct the calibration curve for quinhydrone electrode and hence the standard oxidation potential of quinhydrone electrode. (0.2N CH_3COONa, 0.2NCH_3COOH)

(b) Solubility product of silver halides.

(3) pH metry

(a) To determine the amount of Aspirin in a given solution.(aspirin,0.1N alcoholic KOH, glass and calomel electrodes)

(b) Titration of mixture of bases (Na_2CO_3& $NaHCO_3$) with standard HCl and find the concentration of bases.

(4) Adsorption and kinetics

(a) To study the rate of acid catalysed ionization of acetone in presence of excess acid and acetone at room temp. (requirement: acetone, iodine, sulfuric acid sodium acetate, 0.01sodium thiosulphate, starch)

(b) To determine the autocatalytic reaction between $KMnO_4$ and oxalic acid. (Requirements:0.1M $H_2C_2O_4$, 10%KI , 0.01M $Na_2S_2O_3$, 0.02M $KMnO_4$,0.2M $MnSO_4$, 1% starch, 1.0 M H_2SO_4)

(5) Distribution method

(a) Distribution of HAC between H_2O and $CHCl_3$ / CCl_4.

(b) Distribution of I_2 between H_2O and CCl_4.

III. Teaching methodologies: Practical work, problem solving, and group discussion etc.

M. Sc. Semester I

IV. References books: PCH 1806 L (A): Physical Chemistry (Practicals)

(1) Advanced Practical Physical Chemisty By J. B. Yadav, 32nd edtion Krishna publication**.**

(2) Practicals in physical chemistry by P. S. Sindhu, Macmillan 2005.

(3) Experimental physical chemistry by R. C. Das, B. BeheraTata McGraw-Hill, 1983.

(4) Experimental Physical Chemistry by Athwale , Mathur and Parul, 1st edition reprint 2011,New Age International (P) Ltd.

M. Sc. Semester I

I. Course: PCH 1806L (B) Analytical Chemistry (Practicals)

II. Course Content

(1) Calibration of glass wares and balance.

(2) Determination of %age purity of given sample of Isoniacid.

(3) Determination of %age of Asprin in the given tablet.

(4) Determination of available chlorine in bleaching powder.

(5) Determination of vitamin C in orange juice/amla.

(6) Determination of acetic acid in vinegar.

(7) Determination of sodium carbonate and sodium bicarbonate in washing soda.

(8) Determination of ascorbic acid in vitamin C tablets.

(9) Determination of %age purity of given sample of Analgin tablet.

(10) Determination of calcium and magnesium in water sample.

(11) Determination of sulphate in water sample.

(12) Determination of chloride in water sample.

III. Teaching methodologies: Practical work, problem solving, and group discussion etc.

M. Sc. Semester I

IV. References books:PCH1806L (B): Analytical Chemistry (Practicals)

(1) Analytical Chemistry Practice, John H. Kennedy, Saunders College Publishing, Second Edition 1990.

(2) Vogels Textbook of Quantitative Chemical Analysis, 6th Edition, 2002.

M Sc Chemistry Sem II Overview

Sub. code	Course	Instruction Hrs/week	Internal Assessment Marks	Max Marks Semester Exams	Duration of Semester Exam (Hrs)	Credit
THEORY						
PCH 2801	Inorganic Chemistry	4	30	70	3	4
PCH 2802	Organic Chemistry	4	30	70	3	4
PCH 2803	Physical Chemistry	4	30	70	3	4
PCH 2804	Analytical techniques	4	30	70	3	4
PRACTICALS						
PCH 2805L	Inorganic Chemistry Lab-I	3	30	70	3	4
	Organic Chemistry Lab-I	3			3	
PCH 2806L	Physical Chemistry Lab-I	3	30	70	3	4
	Analytical Chemistry Lab-I	3			3	
	Total	**28**	**180**	**420**		**24**

Note:- Semester -I and Semester-II syllabus is common for all specializations to be selected by the students for final year i.e. Inorganic, Organic, Physical and Analytical. At present St. Xavier's College offers only Organic Chemistry as a specialization in the final year of M Sc Chemistry.

St. Xavier's College (Autonomous), Ahmedbad-09

Syllabus: M Sc Chemistry Semester II

M. Sc. Semester II

CORE Paper: Inorganic Chemistry (Theory)
Course Code: PCH 2801
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)

I. Course Overview & Course Objectives

Unit IC 01- Chemical Bonding

Unit IC 02- Application of symmetry

Unit IC 03- Organometallic Compounds

Unit IC 04 – Reaction Mechanism

The main objective of the course will be to enhance the understanding and knowledge of Inorganic Chemistry, for students studying, any branch of chemistry.
By the end of the paper, a student will be able to:

(a) understand the important aspects of Chemical Bonding and Atomic Structure

(b) know and study the applications Symmetry and Group Theory

(c) understand the important aspects of Organometallic Compounds

(d) know and study Reaction Mechanism in inorganic chemistry

Thus, the knowledge from the course can help in the following:
(a) Finally, all students, of all branches whether organic or inorganic will be able to incorporate this knowledge, in their pursuit of research in their different fields.

II. Course Content

Unit 1- Chemical Bonding **(15L)[14Marks]**

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to VSEPR theory and Chemical Bonding]

VSEPR, Walsh diagrams(tri atomic molecules), Bent rule and Simple Huckel theory of linear conjugated systems, simple Huckel theory of the cyclic conjugated system and aromaticity, self-consistent filed method, valence state ionization potentials,

Band theory of solids, Fermi level, electrical properties, insulators, semiconductors and superconductors (properties).

Unit 2- Application of symmetry **(15L)[14Marks]**

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to symmetry and IR and Raman spectra]

Application of symmetry to hybrid orbital, molecular orbitals, hybridization schemes for σorbitals, π bonding and molecular orbital for ABn type of molecules.

Application of symmetry to molecular vibrations, interpretation of IR and Raman spectral data.

Unit 3-Organometallic Compounds (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Organometallic Compounds]

Organometallic compounds of transition elements, stability of metal carbon bond in complexes. Synthesis, uses and structure of organometallic compounds of π bonding organic ligands, 2-electron ligands, olifinic and acetylinic complexes, compound with 3 electron ligand – allylic complexes, compounds. With 4- electron ligands butadiene complexes, n4 complexes of cyclopentadiene, compounds with 5 electron ligands – cyclopantadionyl, compounds with 6 electron ligands, n6 complexes of benzene and its derivatives. Role of organometallic compounds in catalytic reaction.

Unit 4 – Reaction Mechanism (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Inorganic Reaction Mechanism]

Mechanism of substitution reaction in square planar complexes. Kinetics of substitution reaction of platinum (II) complexes.

Effect of leaving group, effect of charge, steric effect, solvent effect, effect of nucleophile, effect of temperature and other effects.

Oxidation-Reduction reaction, electron transfer, tunneling effect, Marcus –Hush theory, one and two electron transfer inner sphere and outer sphere, effect of ions on rate, electron transfer through extended bridges, unstable oxidation states, hydrated electron.

III. Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

M. Sc. Semester –II

IV. References books: PCH2801: Inorganic Chemistry(Theory)

(1) Introduction to Quantum Chemistry, A. K. Chandra, Tata MacGraw Hill
(2) Quantum Chemistry, Ira N. Levine, Prentice Hall
(3) Quantum Chemistry by R. K. Prasad, New Age International Publishers (1985)
(4) D. A. Mc Quarrie Quantum Chemistry, OUP 1983
(5) M. W. Hanna, Quantum Mechanics in Chemistry, The Benjamin Pub.
(6) Lectures on Chemical Bonding and Quantum Chemistry, S. N. Datta, A Prism Book
(7) Group theory and symmetry in chemistry, L. H. Hall(McGraw Hill)

(8) Coulson's Valence, R. Mc Weeny, ELBS
(9) F. A. Cotton, Chemical Applications of Group theory, Wiley Eastern 2nd Edn.1992
(10) V. Ramkrishnan & M. S. Gopinadhan, Group theory in Chemistry Vishal Pub.1996.
(11) Inorganic Chemistry, Third Edition, Alan G. Sharpe
(12) Theoretical Inorganic Chemistry, M. C. Day, J. Shellin
(13) Chemistry, Fifth Edition, John E. McMurry, Robert C. Fay
(14) An Introduction to Theoretical Chemistry, Jack Simons, Cambridge
(15) Progress in inorganic Chemistry, Vols 18 and 38 ed. J. J. Lippard, Wiley
(16) Mechanism of Inorganic Reactions, F. Basolo and R. G. Persons, Wiley Pub
(17) Reaction Mechanism of Coordination Compounds, C. H. Langford and H. B. Gray
(18) Inorganic Reaction Mechanisms, M. L. Tobe, Nelson Pub
(19) Inorganic Chemistry, K. F. Purcell and J. C. Kotz.
(20) Principles of Bioinorganic Chemistry, S. J. Lippard and J. M. Bers
(21) Mehrotra R. C. and Singh A. Organo Metallic Chemistry, Willey Eastern Ltd., New Delhi
(22) Coates G. E. Green MIH Wade, K and Aylett B. J. Organo Metallic Comounds Chapman and Hall, London

M. Sc. Semester –II

CORE Paper: Organic Chemistry (Theory)
Course Code: PCH 2802
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)

I. Course Overview & Course Objectives

Unit OC 01: Application Redox and reagents in organic synthesis.
Unit OC 02:(A)Photochemistry
(B)Chemistry of Heterocycles
Unit OC 03: Organic Name reactions
Unit OC 04: Reagents in organic synthesis
The main objective of the course will be to enhance the understanding and knowledge of organic chemistry

By the end of the paper, a student will be able to:

(a) understand the details of Application Redox and reagents in organic synthesis
(b) the chemistry of Photochemistry and Heterocyclic compounds
(c) understand the importance of Organic Name reactions
(d) understand the details of various aspects of Reagents in organic synthesis.

Thus, the knowledge from the course can help in the following:
This content can help students to increase their conceptual base and understanding in these topics which will be needed by students in their pursuit of research in other allied branches of chemistry.

II. Course Content

Unit - 1: Application Redox and reagents in organic synthesis. (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Oxidation and reduction]

(A) Oxidizing agents, Reducing agents and Mechanistic explanation of oxidation and reduction with example.
Oxidation with Manganese, $KMnO_4$,Chromium, Peracid, Peroxide, Dimethyl dioxarane SeO_2,NBS,DDQ,Chloranil and Oppenauer oxidation.

(B) Reduction:
(i) Reduction with Hydride transfer reagents like $LiAlH_4$,$NaBH_4$,Diborane.
(ii)Reduction by Dissolving metals Zn, Li, Na.
(iii)Birch reduction and catalytic reduction.

Unit – 2 **(15L)[14Marks]**

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Photochemistry and Heterocyclic compounds]

(A) Photochemistry:

(1)Photochemical reactions: Principles of energy transfer, electronic excitation and molecular orbital view of excitation, excited states and excitation and molecular orbital view of excitation, excited states and fate of excited molecules (modified Jablonski diagram), Photosensitization.

(2)Photochemistry of carbonyl compounds: Representation of excited states of ketones, photo reduction Norrish type I& Π reactions, Reactions of cyclic Ketone, oxetane formation (Paterno-Buchi reaction)

(3)Di-π methane rearrangement, Dienone photochemistry, cis-trans isomerisation and photochemistry of conjugated olefins.

(B) Chemistry of Heterocycles

(1)Nomenclature of heterocycles: Few examples of systematic nomenclature (Hantzsch-Widman system) for monocyclic, fused and bridged heterocycles.
General chemical behavior of following aromatic heterocycles: their synthesis and important applications. (Three examples each)
(2)Five-membered and benzo fused five member heterocycles : Oxazole, Isoxazole, Thiazole, Pyrazole, Imidazole, Benzothiazole and Benzimidazole.
(3)Six membered and benzofused six membered heterocycles :Pyrazine, Pyridazine, Pyrimidine, Cinnoline, Quinazoline, Quinoxaline, Phenoxaline.

Unit – 3 Name reactions: **(15L)[14Marks]**

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Name reactions]

General nature, method, mechanism and synthetic applications of thefollowing named organic reactions:

(i)	Suzuki reaction	(ii)	Buchwald Hartwing reaction (cross coupling)
(iii)	Sonogarshira coupling	(iv)	Vilsmeier-Haack reaction
(iv)	Mitsunobu reaction	(vi)	Stobbe condensation
(vii)	Jones oxidation	(viii)	Swern oxidation reaction
(ix)	Michael addition	(x)	Dickmann reaction
(xi)	Knoevanagel reaction	(xii)	Darzen'sglycidic ester synthesis
(xi)	Mannich reaction	(xiv)	Witting reaction

Unit-4 Reagents in organic synthesis: **(15L)[14Marks]**

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Reagents in organic synthesis]

Mechanism selectivity and utility of following reagents:

(i) Gilman's reagent-Lithium dimethylcuprate (ii) Lithium diisopropylamide (LDA)

(iii) Dicyclohexylcarbodiimide (DCC) (iv) 1,3 – Dithiane (Umpolung reagent)

(v) Dess- Martin periodinane (vi) Bakers yeast

(vii) Diisobutylauminiumhydride(DIBAL –H)

(viii) Sodium cyanoborohydride($NaBH_3(CN)$) (ix) Grignard reagents

(x) Sodium borohydride (xi) DDQ (xii) n-Butyl lithium

(xiii) Phase transfer catalysis : Quaternary ammonium and phosphonium salts, crown ethers.

III. Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

M. Sc. Semester –II

IV. References books: PCH2802: Organic Chemistry (Theory)

(1) Modern Synthetic Reactions, H.O. House, W.A. Benjamin.
(2) Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, 3rd Edition, Blackie Academic and Proffessional.
(3) Introductory Photochemistry, A. Cox and T. Camp, McGraw Hill.
(4) Photochemistry, R.P. Kundall and A. Gilbert, Thomson Nelson.
(5) Organic Photochemistry, J. Coxon and B. Halton, 2nd Edition , Cambridge University Press.
(6) Strategic Applications of Named Reactions in Organic Synthesis, Laszlo Kurti and Barbara Czak, 1st Edition , Acedemic Press.
(7) Name Reactions and Reagents in Organic Synthesis, Bradford P. Mundy, Michael G. Ellerd, Frank G. Favaloro, 2nd Edition, Wiley – Interscience.
(8) Name Reactions. A Collection of Detailed Reaction Mechanisms.,Jie Jack Li, 3rd Edition Springer.
(9) Heterocyclic Chemistry, volume 1-3, R.R. Gupta, M. Kumar and V. Gupta, Springer-Verlag.
(10) Heterocyclic Chemistry, J.A. Joule, K.Mills, and G.F. Smith, 3rd Edition, Chapman and Hall.
(11) Heterocyclic Chemistry, T.L. Gilchrist, Longman Scientific Technical.
(12) Contemporary Heterocyclic Chemistry, G.R. Nikome and W.W. Poudler, Wiley.

(13) Comprehensive Heterocyclic Chemistry, A.R. Kartizky, and C.W. Rees.
(14) Encyclopedia of Reagents for Organic Synthesis, Leo A. Paquette, David Crich and Phillip L. Fuchs, John Wiley and Sons Inc.
(15) Organic Chemistry, T.W. Graham Solomons and Graig B. Frymes, John Wiley and Sons.
(16) General Organic Chemistry Sachin Kumar Ghose, New Central book agency.
(17) Guidebook to Mechanism in Organic Chemistry by Peter Sykes, 6th Edition, Prentice Hall.
(18) Advanced Organic Chemistry Part A: Structure and Mechanism and Part B:Reaction and synthesis ,Francis A. Carey, Richard J. Sundberg, 5th Edition, Springer .
(19) Organic Chemistry Vol 1-2 I. L. Finar 5th edition, ELBS.
(20) Advance organic chemistry by Jerry March
(21) Advance organic chemistry by Carey and Sundberg,
(22) Advance organic chemistry by Francis A. Carey.

M. Sc. Semester –II

CORE Paper: Physical Chemistry (Theory)
Course Code: PCH 2803
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)

I. Course Overview & Course Objectives

Unit-PC 01 Statistical thermodynamics

Unit-PC 02 Nuclear chemistry

Unit-PC 03 Polymer chemistry

Unit-PC 04 Electrochemistry

The main objective of the course will be to enhance the understanding and knowledge of Physical Chemistry without an obscuring mathematical screen.

By the end of the paper, a student will be able to :

(a) understand the details and utility of the entire topics in physical chemistry, separately as well as in context to one another.

(b) The long major areas of study such as Statistical thermodynamics and Nuclear chemistry are so taught, such that students are able to move on to more advanced studies.

Thus, the knowledge from the course can help in the following:
The other topics, like Polymer chemistry and Electrochemistry are so decided upon so that students can increase their conceptual base in this subject which will be needed by students in their pursuit of research in other allied branches of chemistry.

II. Course Content

Unit-1 Statistical thermodynamics (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Statistical thermodynamics]

Concepts of distribution of molecules, microstate and macrostate. Ensemble averaging, Canonical, grand canonical and microcanonical ensembles, Maxwell-Boltzman distribution laws (using Lagrange's method of undetermined multipliers). Fermi-Dirac statistics – distribution law and Bose-Einstein statistics – distribution law.

Partition functions – translational, rotational, vibrational and electronic partition

Unit-2 Nuclear chemistry (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Nuclear chemistry]

Nuclear properties-nuclear radius, coulombic and nuclear potential radius, nuclear spin and angular momentum, magnetic moment, nuclear binding energy, nuclear models-shell model, liquid drop model, Fermi gas model, collective model, radioactive decay, nuclear reactions, evaporation, spallation, fragmentation, fission and fusion reactions, accelerators, reaction cross section, use of radioisotopes as tracers.

Unit-3 Polymer chemistry (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Polymer chemistry]

Kinetics and mechanism of polymer processes, criteria of polymer solubility, thermodynamics of polymer solutions, polymer characterization, molecular weight of polymer (number average and weight average), methods of molecular weight determination, properties of polymers and applications.

Unit-4 Electro chemistry (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Electrochemistry]

Sign convention-American, European and IUPAC; Polarization ,demonstration of polarization , elimination of polarization ,Decomposition Potential-Factors ,applications and measurement of Decomposition potential and Overvoltage and factors affecting overvoltage, basic principle of polarography, origin of different types of current; Ilkovic equation. polarographic wave equation, Importance of E1/2 in polarography ,Dependence of E1/2 on pH and complexing agents(derivation),Pilot ion method and standard addition method to determine concentration.

III. Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

M. Sc. Semester –II

IV. Reference books: PCH2803: Physical Chemistry (Theory)

(1) Physical chemistry by W. J. Moore, 5th edition, orient longman private ltd.
(2) Textbook of physical chemistry by S. Glasstone, D. Van Nostrand company, inc., 1946.
(3) Textbook of physical chemistry by Peter Atkins Julio de and Paula, 9th edition, oxford press.
(4) Advanced physical chemistry by Gurdeep Raj 35th revised edition, Goel publishing house.

(5) Advanced physical chemistry by J. N. Gurtu, A.Gurtu, 11th edition , Pragati prakashan.
(6) Statistical thermodynamics by M.C.Gupta ,revised 2nd edition, New Age International publishers
(7) Thermodynamics, statistical thermodynamics and kinetics by T.Engle and P.Reid, Pearson India.
(8) Thermodynamics: A core course , by Srivastava, Saha and jain, 3rd edition, Prentice-hall of India
(7) Polymer science by Gowariker, New Age International, reprint 1986.
(8) Textbook of Polymer Science By Fred W. Billmeyer Jr., 3rd Edition edition (2 May 1984), Wiley-Blackwell.
(9) Principles of Polymer Science, 2nd edition by Bahadur & Sastry, Alpha Science.
(10) Polymer science & technology by Fried, 3rd edition, Printece-Hall.
(11) Polymer Chemistry: An Introduction by Malcolm P. Stevens, 3rd edition, Addison-Wesley Publishing Company.
(12) Essentials of Nuclear Chemistry by Arnikar, New Age Internation
(13) Nuclear and radio chemistry by J.W. Kannedy, G. Friedlander, 3rd edition, Wiley.
(14) Modern Electrochemistry by Bockris and Reddy

M. Sc. Semester –II

CORE Paper: Analytical Chemistry (Theory)
Course Code: PCH 2804
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)

I. Course Overview & Course Objectives

Unit-AC 01 Sample Preparation Techniques

Unit-AC 02 Basic Principles of chromatography

Unit-AC 03 Specialized chromatographic techniques

Unit-AC 04 Electro-Analytical Chemistry

The main objective of the course will be to enhance the understanding and knowledge of Analytical Chemistry, for students studying, any branch of chemistry.
By the end of the paper, a student will be able to:

(a) understand the very important role of an analytical chemist in all branches of chemistry.
(b) know and study the work-up required by all samples before they can be subjected to analysis and also learn about the various types of analysis.
(c) will study about the most widely employed technique i.e. Principles of chromatography and its applicationin analytical chemistry and other branches of chemistry.
(d) will study about Electro-Analytical methods of analysis which is able to provide valuable analytical data. Thus, the knowledge from the course can help in the following:

All students, of all branches whether organic or inorganic will be able to incorporate this knowledge, in their pursuit of research in their different fields.

II. Course Content

Unit-1Sample Preparation Techniques (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Sample Preparation Techniques]

Liquid-liquid extraction/solvent extraction-partition coefficient, distribution ratio and percent extraction.Solvent extraction of metal ions-ion association complexes and metal chelates, multiple batch extraction, Craig's counter-current distribution. Accelerated and Microwave assisted extraction, protein precipitation and solid phase extraction (SPE).

Unit -2 Basic Principles of chromatography (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Basic Principles of chromatography]

Chromatographic Methods Principles of chromatography, classification of chromatographic techniques based on mechanism of retention, configuration, mobile and stationary phase. Importance and meaning of terms –Partition Ratio, Retention Time and Dead Time, Capacity Factor and Selectivity Factor, Efficiency of separation- plate theory (theoretical plate concept) and rate theory (Van Deemter equation).

Unit -3 Specialized chromatographic techniques (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Basic Principles of chromatography and Specialized chromatographic]

Principles ,instrumentation and applications of Gas Chromatography, HPLC, HPTLC and Ion exchange chromatography .

Unit -4 Electro-Analytical Chemistry (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Electro-Analytical Chemistry]

pH measurement with glass electrode, working of glass electrode, mechanism of pH measurement, calibration of glass electrode, errors in pH measurement. Classification, principle, properties and design of ion selective membrane electrodes- Glass electrodes for ions other than H^+, Solid precipitate electrode and single crystal electrode, Liquid ion exchange electrode, ion molecular sieve electrodes. Ion, Gas-sensing probes and enzyme substrate electrodes.

III. Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

M. Sc. Semester –II

IV. Reference books: PCH2804: Analytical Chemistry (Theory)

(1) Quantitative Chemical Analysis, by Daniel C. Harris, 5th Edition, W.H. Freeman and Company, New York.

(2) Analytical Chemistry, by Gary D. Christian, 6th Edition, John Wiley and Sons Inc. New Jersey.

(3) A Practical handbook of preparative HPLC by Donald Wellings, Elsevier, 2006.

(4) Ion-pair chromatography: Theory and Biological and Pharmaceutical Applications (Chromatographic Science), Milton Hearn (editor), Marcel and Dekker Inc. (1985).

(5) Practical Aspects of Gas Chromatography/Mass Spectroscopy by Gordon M. Message, John Wiley & Sons, 1984.

(6) Modern Practice of Gas Chromatography by Robert L. Grob and Eugene F. Barry, 3rd

edition, Wiley-Interscience, 1995.
(7) Basic Gas Chromatography by Harold M. McNair, James M. Miller, John Wiley and Sons,2008.
(8) Analytical gas Chromatography by Walter Jennings, Eric Mittlefehldt and Philip Stremple, second edition, Elsevier Science, 1997.
(9) Modern HPLC for practicing scientists by Michael W. Dong, Wiley Interscience, 2006.

M. Sc. Semester II

Paper: Inorganic Chemistry and Organic Chemistry (Practicals)
Course Code: PCH 2805L
No. of Credits: 04
Learning Hours: 60 (70 Marks)
I. Course: PCH 2805L (A) Inorganic Chemistry (practicals)
II. Course Content

(1) Preparation and determination of purity of double and complex salts. At least seven preparations should be done.

(2) Colourimetric estimation of any four out of Cu, Mn, NO_2, Ni, P, Fe, V, Ti, Cr, Co.

III. Teaching methodologies: Practical work, problem solving and group discussion etc.

M. Sc. Semester II

IV. References books: PCH2805L (A) : Inorganic Chemistry(Practicals)

(1) Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition, 2002.

(2) Advanced Practical Inorganic Chemistry, Gurdeepraj, Goel Publishing House, 2001.

(3) An Advanced Course in Practical Chemistry, A.K. Nad, B. Mahapatra, A. Ghosal, New Central Book Agency, 2004

M. Sc. Semester II

I. Course: PCH 2805L (B) Organic Chemistry (practicals)
II. Course Content

Mixture analysis: ternary mixture to be given. (S+S+S)or (L+L+L). Type determination. Separation by physical and chemical methods. (both permitted in case of liquids).

III. Teaching methodologies: Practical work, problem solving and group discussion etc.

M. Sc. Semester II

IV. References books: PCH2805L(B): Organic Chemistry (Practicals)

(1) A text book of practical organic chemistry – A. I. Vogel

(2) Practical organic Chemistry – Mann and Saunders

(3) A handbook of quantitative and qualitative analysis – H. T. Clarke

(4) Comprehensive Practical Organic Chemistry : Qualitative Analysis V K Ahluwalia& S. Dhingra.

(5) Comprehensive Practical Organic Chemistry : Preparations and Quantitative Analysis, V K Ahluwalia & R. Aggarwal Universities Press.

(6) An Advance Course in practical Chemistry, A K. Nad, B. Mahapatra and A. Ghoshal.

M. Sc. Semester II

Paper: Physical Chemistry and Analytical Chemistry (Practicals)
Course Code: PCH 2806L
No. of Credits: 04
Learning Hours: 60 (70 Marks)

I. Course: PCH 2806L (A) Physical Chemistry (practicals)
II. Course Content

(1) Conductometry

(a) Test of validity of Ostwald's dilution law and determination of dissociation constant of weak electrolyte like CH_3COOH & $ClCH_2COOH$
(b) Verification of Debye-Huckel-Onsager's equation in case of strong electrolytes like HCl, KCl, NaCl.

(2) Potentiometry

(a) Titration of dibasic acid like malonic, oxalic, succinic acid with NaOH and find the dissociation constant of acid.
(b) Precipitation titration → Titration of halids with $AgNO_3$.
(c) Redox titration Ferrous ammonium sulfate –$KMnO_4$, $K_2Cr_2O_7$.

(3) pH metry

(a) Determination of dissociation constant of weak acid like acetic and monochloroaceticacid
(b) To titrate phosphoric acid solution against alkali and to calculate the first, second and thirdioniozation constant of it.(0.05M phosphoric acid, 10% neutral $CaCl_2$, 0.5N NaOH)

(4) Kinetics

(a) Determination of the effect of (a) Change of temperature (b) Change ofconcentration of reactant and catalyst and (c) Ionic strength of the media on the velocity constant of an acid hydrolysis of an ester.
(b) Determination of order of reaction between $K_2S_2O_8$ and KI by a fractional change method

(5) Distribution method

(a) Determination of the formula of the complex formed between cupric ion and ammonia by distribution method.

III. Teaching methodologies: Practical work, problem solving and group discussion etc.

M. Sc. Semester II

IV. References books: PCH2806L (A): Physical Chemistry (Practicals)

(1) Practical physical chemistry –J. B. Yadav
(2) Practicals in physical chemistry – P. S. Sindhu
(3) Experimental physical chemistry – R. C. Das, B.Behera
(4) Experiments in physical chemistry- P. H. Parsania, F. Karia

M. Sc. Semester II

I. Course: PCH 2806L (B): Analytical Chemistry (practicals)

II. Course Content

(1) Determination of saponification value of oil.
(2) Determination of iodine value of oil.
(3) Determination of iron by chloride extraction by solvent extraction process.
(4) Determination of dissolved oxygen.
(5) Determination of chemical oxygen demand.
(6) Determination of iron in iron tablets.
(7) Simultaneous estimation of chromium (III) and iron (III) by EDTA titration.
(8) Simultaneous estimation of calcium (II) and zinc (II) by EDTA titration.
(9) Simultaneous estimation of lead (II) and magnesium (II) by EDTA titration.
(10) Separation of aminoacids/ dyes/ drugs by TLC.
(11) Determination of cation content in hard water by ion exchange chromatography.

III. Teaching methodologies: Practical work, problem solving and group discussion etc.

M. Sc. Semester II

IV. References books: PCH2806L (B): Analytical Chemistry (Practicals)

(1) Analytical Chemistry Practice, John H. Kennedy, Saunders College Publishing, Second Edition 1990.
(1) Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition, 2002.

M Sc Analytical Chemistry Sem III Overview

Sub. code	Course	Instruction Hrs/week	Internal Assessment Marks	Max Marks Semester Exams	Duration of Semester Exam (Hrs)	Credit
THEORY						
PCH 3801	Industrial Analytical Chemistry	4	30	70	3	4
PCH 3802	Qualitative Optical Spectroscopic Methods	4	30	70	3	4
PCH 3803	Electroanalytical Techniques	4	30	70	3	4
PCH 3804	Modern Separation Techniques	4	30	70	3	4
PRACTICALS						
PCH 3805L	Industrial Analytical Chemistry (Practicals)	3 3	30	70	3 3	4
PCH 3806L	Industrial Analytical Chemistry (Practicals)	3 3	30	70	3 3	4
	Total	**28**	**180**	**420**		**24**

Note:- Semester -I and Semester-II syllabus is common for all specializations to be selected by the students for final year i.e. Inorganic, Organic, Physical and Analytical. At present St. Xavier's College offers only Analytical Chemistry as a self-Finance in M Sc Chemistry.

M Sc Semester III (Analytical Chemistry)

CORE Paper: Industrial Analytical Chemistry(Theory)
Course Code: PCH 3801(ANA-SF)
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)

II. Course Overview & Course Objectives

Unit AC 01: Automationin Measurements

Unit AC 02: Food Analysis

Unit AC 03: Pharmaceutical Analysis

Unit AC 04: Analysis of pesticides, soaps and detergents, fertilizers

The main objective of the course will be to enhance the understanding and knowledge of Industrial Analytical Chemistry, for students studying, any branch of chemistry.

By the end of the paper, a student will be able to:

(a)Understand the important aspects of Automationin Measurements

(b)Learn the various aspects of Food Analysis

(c) Understand the important aspects of Pharmaceutical Analysis

(d) Learn the Chemistry of Analysis of pesticides, soaps and detergents, fertilizers

Thus, the knowledge from the course can help in the following:
(a) Finally, all students, of all branches whether organic or inorganic or analytical will be able to incorporate this knowledge, in their pursuit of research in their different fields.

II. Course Content

UNIT-1 Automationin Measurements (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Automationin Measurements]

Principles of automation, automatic and automated devices, Process control: off-line, at-line and on-line analysis. Continuous and discrete analyzers, feed back mechanism. Flow injection analysis, principles, dispersion coefficient, factors affecting peak height-sample volume, channel length, flow rate and channel geometry. Applications of FIA, stopped flow measurements and gradient FIA.

UNIT-2 Food Analysis (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Food Analysis]

Introduction to food analysis, regulations and international standards related to food analysis, nutritionallabeling,sampleandsamplepreparation.Compositionalanalysisof foods for moisture, proteins, fat, fiber, ash, vitamins and minerals. Adulteration of fats and oils; milk and milk products.

UNIT-3 Pharmaceutical Analysis (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Pharmaceutical Analysis]

Instrumental and titrimetric assays for anti-diabetic, anti-cancer, anti-tuberculosis, anti-malarial, anti-hypertensive and anti-HIV drugs based on USP/BP/IP. Heavy metal ion analysis in pharmaceuticals. Importance of UV-Visible spectrophotometry, IR spectroscopy and HPLC with UV, fluorescence and photodiode array detection in pharmaceutical industry.

UNIT-4 Analysis of pesticides, soaps and detergents, fertilizers (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Analysis of pesticides, soaps and detergents, fertilizers]

Classification of pesticides. Analysis of different pesticides by classical and instrumental methods. Classification of soaps and detergents with suitable examples. Characterization of soaps and detergents. Types of fertilizers and analysis of different elements like, nitrogen, phosphates, calcium, sodium, potassium and ammonia.

III. Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

M Sc Semester III

IV. Reference Books: PCH 3801: Industrial Analytical Chemistry (Theory)

(1) "AnalyticalChemistry"byGaryD.Christian,6th Edition, John Wiley and Sons Inc.New Jersey.

(2) "PrinciplesofInstrumentalAnalysis"byDouglasA.Skoog,3rdEdition,Holt-Saunders International Edition.

(3) Flow injection analysis of pharmaceuticals: automation in the laboratory by Jose Martinez Calatayud, Taylor and Francis, 1996.

(4) "Food Analysis" by S. Suzanne Nielsen, 3rdedition, Springer 2003.

(5) "Food Analysis Laboratory Manual" by S. Suzanne Nielsen, 3rdedition, Springer 2003.

(6) QuantitativeAnalysisofDrugsinPharmaceuticalFormulation,3rd edition, P. D. Sethi, CBS Publishers, 2008.

(7) "Handbook of Modern Pharmaceutical Analysis" by Satinder Ahuja and Stephen Scypinski, Volume 3, Academic Press, 2001.

(8) StandardMethodofChemicalAnalysisbyF.J.Welcher,sixthedition,volume1,2&3, Part two, Van Nostr and Reinhold Company.

M Sc Semester III (Analytical Chemistry)

Paper: PCH 3802: Qualitative Optical Spectroscopic Methods
CORE Paper: Qualitative Optical Spectroscopic Methods
Course Code: PCH 3802
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)

I. Course Overview & Course Objectives

Unit AC 01: Infrared Spectroscopy
Unit AC 02: Raman Spectroscopy
Unit AC 03: Nuclear Magnetic Resonance Spectroscopy
Unit AC 04: X – Ray Diffraction
The main objective of the course will be to enhance the understanding and knowledge of Qualitative Optical Spectroscopic Methods

By the end of the paper, a student will be able to :

(a)Understand the important aspects Infrared Spectroscopy
(b) Learn the various aspects of Raman Spectroscopy.
(c)Understand the important aspects of Nuclear Magnetic Resonance Spectroscopy
(d) Learn the Chemistry of X – Ray Diffraction.

Thus, the knowledge from the course can help in the following:
(a) Finally, all students, of all branches whether organic or inorganic or analytical will be able to incorporate this knowledge, in their pursuit of research in their different fields.

II. Course Content

Unit-1 Infrared Spectroscopy (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Infrared Spectroscopy]
Introduction, IR Frequency Range and Spectrum Presentation, Theory of Infrared Absorption, Dispersive Spectrometers, Fourier Transform Spectrometers, Hyphenated Methods Involving Infrared, Analytical Information : Qualitative and Quantitative, Applications

Unit-2 Raman Spectroscopy (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Raman Spectroscopy]
Introduction, Dispersive Spectrophotometers, Fourier Transform Spectrometers, Normal Raman Resonance Raman, FT – Raman, Surface – enhanced Raman Spectroscopy (SERS),Raman Microprobe, Remote Raman Analysis, Raman Depolarization Ratios, Analytical Information, Applications.

Unit - 3 Nuclear Magnetic Resonance Spectroscopy (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Nuclear Magnetic Resonance Spectroscopy]

Introduction, Physical and Chemical Principles, Instrumentation, Analytical Information: Qualitative and Quantitative, Applications

Unit -4 X - Ray Diffraction (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to X – Ray Diffraction]

Introduction, Single – Crystal Diffraction, Powder Diffraction, Analytical Information: Qualitative and Quantitative, Applications

III. Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

M Sc Semester III(Analytical Chemistry)

IV. Reference Books: PCH 1802: Qualitative Optical Spectroscopic Methods (Theory)

(1) "Handbookof Instrumental Techniques for Analytical Chemistry", Frank Settle, published Prentice Hall PTR,NewJersey,1997.

(2) "Applied Infrared Spectroscopy", Smith A L, published by Wiley, NewYork, 1979.

(3) "Instrumental Methods of Analysis", Willard H H, 7thedition, Belmont, CA : Wadsworth,1987.

(4) "Raman Spectroscopy", Long D A, McGraw – Hill, New York, 1977.

(5) ''Laboratory Raman Spectroscopy",Strommen D P, Nakamoto N, Wiley,NewYork,1984.

(6) "Spectrometric Identification of Organic Compounds", Silverstein R M, Bassler GC, Morrill T C, 5thedition, Wiley, New York, 1991.

(7) "Introduction to NMR Spectroscopy", Abraham R J, Fisher J, Loftus P, Wiley, New York,1988.

(8) "Elements of X –Ray Crystallography", Azaroff L V,McGraw–Hill,NewYork, 1968.

(9) "X – Ray Structure Determination : A Practical Guide", Stout G H,JensenL H, 2ndedition, Wiley, New York, 1989.

M Sc Semester III (Analytical Chemistry)

CORE Paper: Electroanalytical Techniques (Theory)
Course Code: PCH 3803
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)

I. Course Overview & Course Objectives

Unit AC 01- Electroanalytical Measurements
Unit AC 02- Voltammetry
Unit AC 03- Electrodeposition and Coulometry
Unit AC 04- Electrochemical and Bio-sensors

The main objective of the course will be to enhance the understanding and knowledge of Electroanalytical Techniques

By the end of the paper, a student will be able to:

(a) Understand the important aspects Electroanalytical Measurements
(b) Learn the various aspects of Voltammetry
(c) Understand the important aspects of Electrodeposition and Coulometry
(d) Learn the Chemistry of Electrochemical and Bio-sensors

Thus, the knowledge from the course can help in the following:

(a) Finally, all students, of all branches whether organic or inorganic or analytical will be able to incorporate this knowledge, in their pursuit of research in their different fields.

II. Course Content

Unit -1Electroanalytical Measurements (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Electroanalytical Measurements]

Voltage, Impedance, The electric double layer, Electrocapillarity, Current, Diffusion transport.

Unit -2Voltammetry (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Voltammetry]

Differential pulse polarography, Square wave polarography, A.C. polarography, Stripping analysis, Cycling voltammetry, Amperometric titration.

Unit -3Electrodeposition and Coulometry (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Electrodeposition and Coulometry]

Electrolysis, Current-Voltage relation, Electrogravimetric analysis at constant current, constant potential and at controlled potential, Coulometric analysis.

Unit -4Electrochemicaland Bio-sensors (15L)[14Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Electrochemicaland Bio-sensors]

Potentiometric sensors, Potentiometric biosensors, Amperometric sensors, Conductometric sensors, Applications of Field-Effect Transistors sensors.

III. Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

M.Sc. Semester III

IV. Reference books: PCH3803: Electroanalytical Techniques(Theory)

(1) Peter T. Kissinger, William R. Heineman "Laboratory Techniques in Electroanalytical Chemistry", Marcel Dekker Inc., NewYork

(2) Basil H.Vassos, Galen W.Ewing,"Electroanalytical Chemistry",John Wiley & Sons, NewYork.

(3) Allen J. Bard, Larry R. Faulkner, "Electrochemical Methods–Fundamentals and Applications", John Wiley & Sons, NewYork.

(4) DanielC.Harris,"QuantitativeChemicalAnalysis",W.H.FreemanandCompany,NewYork.

(5) I. M. Kolthoff, and P.J.Elving,"Treatiseon Analytical Chemistry",Wiley-Interscience, NewYork.

(6) BrianR.Eggins,"Chemical Sensors and Biosensors", John Wiley & Sons, NewYork.

M Sc Semester III (Analytical Chemistry)

CORE Paper: Modern Separation Techniques (Theory)
Course Code: PCH 3804
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)

I. Course Overview & Course Objectives

Unit -AC 01 Liquid Chromatography
Unit-AC 02 Gas Chromatography
Unit-AC 03 Electrophoresis
Unit-AC 04 Specialized chromatographic techniques

The main objective of the course will be to enhance the understanding and knowledge Modern Separation Techniques

By the end of the paper, a student will be able to:

(a) Understand the important aspects Liquid Chromatography
(b) Learn the various aspects of Gas Chromatography
(c) Understand the important aspects of Electrophoresis
(d) Learn the Chemistry of Specialized chromatographic techniques

Thus, the knowledge from the course can help in the following:
(a) Finally, all students, of all branches whether organic or inorganic or analytical will be able to incorporate this knowledge, in their pursuit of research in their different fields.

II. Course Content

Unit -1 Liquid Chromatography (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Liquid Chromatography]

Principle, theory, instrumentation and applications of high-performance liquid chromatography. LC-MS, preparative chromatography, chiral chromatography, ion- chromatography, ion-pair chromatography, size-exclusion/gel permeation chromatography and affinity chromatography

Unit-2 Gas Chromatography (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Gas Chromatography]

GC principle, theory, columns, detector types and applications in pharmaceutical analysis. Head space gas chromatography; Pyrolysis gas chromatography; GC-MS.

Unit-3 Electrophoresis (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Electrophoresis]

Principles of electrophoresis, theory and applications of polyacrylamide gel electrophoresis, capillary zone electrophoresis, micellar electro kinetic electrophoresis, capillary electro chromatography and capillary gel electrophoresis. Isoelectric focusing.

Unit-4 Specialized chromatographic techniques (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Specialized chromatographic techniques]

Principle, separation process on special columns, instrumentation and applications of counter current chromatography and ice chromatography. Superheated water chromatography- A green approach for the future. Flash chromatography.

III. Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

M Sc Semester III

IV. Reference books: PCH3804: Modern Separation Techniques (Theory)

(1) "Quantitative Chemical Analysis" by Daniel C. Harris, 5th Edition, W.H. Freeman and Company, NewYork.

(2) "Analytical Chemistry" by GaryD. Christian, 6thEdition, John Wiley and Sons Inc. New Jersey.

(3) Chiral Separation Techniques: A Practical Approach, 2nd edition, edited by Ganapathy Subramanian,Wiley-VCH,2001.

(4) Chiral Separations by Chromatography by Satinder Ahuja, American Chemical Society, 2000.

(5) Chiral Chromatography by Thomas E. Beesley, T.E. Beesley, R. P. W.Scott, JohnWiley and Sons, 1999.

(6) A Practical handbook of preparative HPLC by Donald Wellings, Elsevier, 2006.

(7) Ion-pair chromatography: Theory and Biological and Pharmaceutical Applications (Chromatographic Science), Milton Hearn (editor), Marcel and Dekker Inc.(1985).

(8) AdvancesinElectrophoresis(Volume2)byAndreasChrembach,MichaelJ.Dunn,BertoldJ. Radola,Wiley-VCH,1989.

(9) HighPerformanceCapillaryElectrophoresis:AnIntroductionbyDavidN.Heiger.Hewlett PackardGmbH,1992.
(10) High-speed countercurrent chromatography byYoichiro Itoand Walter D.Conway, JohnWiley and Sons,1995.
(11) Practical Aspects of Gas Chromatography/ Mass Spectroscopy by Gordon M. Message, John Wiley & Sons,1984
(12) Modern Practice of Gas Chromatography by Robert L. Grob and Eugene F. Barry, 3rd edition, Wiley Interscience, 1995.
(13) Basic Gas Chromatography by Harold M. Mc Nair, James M. Miller, John Wiley and Sons, 2008.
(14) Analytical gas Chromatography by Walter Jennings, Eric Mittlefehldt and Philip Stremple, secondedition,ElsevierScience,1997.
(15) Modern HPLC for practicing scientists by MichaelW.Dong,WileyInterscience,2006.

M Sc Semester III (Analytical Chemistry)

I. Course PCH 3805 L and 3806 L: Industrial Analytical Chemistry (Practicals)

II. Course Content

1. pKa determination of drugs by spectrophotometry
2. Characterisation of drugs substance by IR.
3. Flame Photometry and Atomic Absorption Spectrophotometry.
4. Simultaneous determination of metal ions by spectrophotometry.
5. Solvent extraction of transition metal ions
6. Ion-exchange separation of cations and anions
7. Fluorimetric determination of vitamins and drugs
8. Method validation for linearity, accuracy and precision.
9. Characterization of drug substances by IR Spectroscopy.
10. High performance liquid chromatography.
11. Gas chromatography.

III. Teaching methodologies: Practical work, problem solving, and group discussion etc.

M. Sc. Semester III (Analytical Chemistry)

IV. References books: PCH 3805 L and 3806 L:Industrial Analytical Chemistry (Practicals)

(1) Analytical Chemistry Practice, John H. Kennedy, Saunders College Publishing, Second Edition 1990.

(2) Vogels Textbook of Quantitative Chemical Analysis, 6th Edition, 2002.

M Sc Analytical Chemistry Sem IV Overview

Note:- Semester -I and Semester-II syllabus is common for all specializations to be selected by the students for final year i.e. Inorganic, Organic, Physical and Analytical. At present St. Xavier's College offers only Analytical Chemistry as a self-Finance in M Sc Chemistry.

Sub. code	Course	Instruction Hrs/week	Internal Assessment Marks	Max Marks Semester Exams	Duration of Semester Exam (Hrs)	Credit
THEORY						
PCH 4801	Selected topicsin Analytical Chemistry	4	30	70	3	4
PCH 4802	Quantitative Optical Spectroscopic Methods	4	30	70	3	4
PCH 4803	Advanced Analytical Instrumentation	4	30	70	3	4
PCH 4804	Environmental Chemistry	4	30	70	3	4
PRACTICALS						
PCH 4805L	Dissertation/industrial Training	3 3	30	70	3 3	4
PCH 4806L	Dissertation/industrial Training	3 3	30	70	3 3	4
	Total	**28**	**180**	**420**		**24**

M. Sc. Semester IV (Analytical Chemistry)

CORE Paper: Selected topics in Analytical Chemistry (Theory)
Course Code: PCH 4801
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)

I. Course Overview & Course Objectives

Unit -AC 01 Clinical Chemistry
Unit-AC 02 Analytical Aspects of Drug Discovery
Unit-AC 03 Clinical and Regulatory Aspects of Drug Discovery
Unit-AC 04 Bioanalysis

The main objective of the course will be to enhance the understanding and knowledge of some Selected topics in Analytical Chemistry

By the end of the paper, a student will be able to:

(a) Understand the important aspects of Clinical Chemistry
(b) Learn the various aspects of Analytical Aspects of Drug Discovery
(c) Understand the important aspects of Clinical and Regulatory Aspects of Drug Discovery
(d) Learn the Chemistry of Bioanalysis

Thus, the knowledge from the course can help in the following:
(a) Finally, all students, of all branches whether organic or inorganic or analytical will be able to incorporate this knowledge, in their pursuit of research in their different fields.

II. Course Content

Unit -1Clinical Chemistry (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Clinical Chemistry*]*

Composition of blood, collection and preservation of samples, common determinations- serum electrolytes, blood glucose, blood urea nitrogen, uric acid, albumins and globulins, acid and alkaline phosphatases, barbiturates. Principles of immunoassays, radioimmunoassay, fluorescence immunoassay, enzyme immunoassay.

Unit-2 Analytical Aspects of Drug Discovery (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Analytical Aspects of Drug Discovery]

Discovery of new chemical entity, Identity and purity assessment, bioavailability/dissolution requirement, high-throughput screening, degradation and impurity analysis of drug substances, residual solvent and its classification, stability studies, pre-formulation studies, method development and validation.

Unit-3 Clinical and Regulatory Aspects of Drug Discovery (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Clinical and Regulatory Aspects of Drug Discovery]

Clinical trials - Phase I, II, III and IV. Quality control and quality assurance. Regulatory considerations, regulatory compliance, International Conference on Harmonization (ICH) classification and FDA guidelines, global CMC NDA

Unit-4 Bioanalysis (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Specialized chromatographic techniques]

Components of bioanalytical methodology: extraction from biological matrices, chromatography and detection systems. Bioanalytical method validation parameters: sensitivity, selectivity, accuracy and precision, linearity (calibration curves), recovery, matrix effect and stability. Bioavailability and bioequivalence study, incurred sample reanalysis test for subject samples. USFDA guidelines for bioanalytical method validation and the acceptance criteria.

III. Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

M Sc Semester IV(Analytical Chemistry)

IV. Reference books: PCH4801: Selected topics in Analytical Chemistry (Theory)

(1) "Quantitative Chemical Analysis" by Daniel C. Harris, 5th Edition, W.H. Freeman and Company, New York.

(2) "Analytical Chemistry" by Gary D. Christian, 6th Edition, John Wiley and Sons Inc. New Jersey.

(3) "Principles of Instrumental Analysis" by Douglas A. Skoog, 3rd Edition, Holt-

Saunders International Editions.
(4) "Handbook of Modern Pharmaceutical Analysis" by Satinder Ahuja and Stephen Scypinski, Volume 3, Academic Press, 2001.
(5) "Handbook of Modern Pharmaceutical Analysis" (Drug and the Pharmaceutical Sciences)
ByLena Ohannesian and Anthony Streeter, Marcel Dekker Inc., New York, 2001.
(6) Quantitative Analysis of Drugs in Pharmaceutical Formulation, 3rd edition, P.D. Sethi, CBS Publishers, 2008.
(7) Bioanalytical Chemistry by S. Mikkelsen and E. Corton, John Wiley and Sons, 2004.
(8) Clinical Chemistry: Principles, Procedures, Correlations, 4th edition by Michael L. Bishop, JanetL. Duben-Engelkrik, Edward P. Fody, Lippincott Williams and Wilkins, 2000.

M Sc Semester IV (Analytical Chemistry)

CORE Paper: Quantitative Optical Spectroscopic Methods (Theory)
Course Code: PCH 4802
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)
I. Course Overview & Course Objectives

Unit -AC 01 Atomic Absorption Spectrometry
Unit-AC 02 Inductively Coupled Plasma Atomic Emission Spectroscopy
Unit-AC 03 Atomic Fluorescence Spectroscopy
Unit-AC 04 X – Ray Fluorescence Spectrometry

The main objective of the course will be to enhance the understanding and knowledge of Quantitative Optical Spectroscopic Methods

By the end of the paper, a student will be able to:

(a) Understand the important aspects of Atomic Absorption Spectrometry
(b) Learn the various aspects of Inductively Coupled Plasma Atomic Emission Spectroscopy
(c) Understand the important aspects of Atomic Fluorescence Spectroscopy
(d) Learn the Chemistry of X – Ray Fluorescence Spectrometry

Thus, the knowledge from the course can help in the following:
(a) Finally, all students, of all branches whether organic or inorganic or analytical will be able to incorporate this knowledge, in their pursuit of research in their different fields.

II. Course Content

Unit -1 Atomic Absorption Spectrometry (15L)[14 Marks]
[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Atomic Absorption Spectrometry]
Introduction, Basic Principles, Instrumentation, Interferences, Techniques for Quantification of Elements, Recent Developments, Applications

Unit-2 Inductively Coupled Plasma Atomic Emission Spectroscopy (15L)[14 Marks]
[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Inductively Coupled Plasma Atomic Emission Spectroscopy]
Introduction, Physical and Chemical Principles, Spectrometers, Detection, Calculation, and Output, Analytical Information : Qualitative and Quantitative, Applications

Unit-3 Atomic Fluorescence Spectroscopy (15L)[14 Marks]
[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Atomic Fluorescence Spectroscopy]

Introduction, Physical and Chemical Principles, Instrumentation, Accuracy, Precision, Detection Limits, Analytical Information : Quantitative, Applications

Unit-4 X – Ray Fluorescence Spectrometry (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to X – Ray Fluorescence Spectrometry]

Introduction, Instrumentation, Analytical Information : Qualitative and Quantitative, Applications

III. Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

M Sc Semester IV

IV. Reference books: PCH3804: Modern Separation Techniques (Theory)

(1) "Handbook of Instrumental Techniques for Analytical Chemistry", Frank Settle, published by Prentice Hall PTR, New Jersey, 1997.

(2) "Specrochemical Analysis by Atomic Absorption and Emission", Lajunen L H J, Cambridge, UK : The Royal Society of Chemistry, 1992.

(3) "Advances in Atomic Spectroscopy", Sneddon J, CT : JAI Press, Greenwich, 1992.

(4) "CRC Handbook of Inductively Coupled Plasma Atomic Emission Spectrometry", Varma A, FL : CRC Press, Boca Raton, 1991.

(5) "Multielement Detection Systems for Spectrochemical Analysis", Busch K W, Busch M A, Wiley, New York, 1990.

(6) "Principles and Practice of X – Ray Spectrometric Analysis", 2nd edition, Bertin, Eugene, Plenum Press, New York, 1975.

(7) "An Introduction to X –Ray Spectrometry", Jenkins, Ron, Heyden & Sons, London, 1974.

(8) "Principles of Quantitative X – Ray Fluorescence", Tertian R, Claisse F, Heyden, London, 1982.

M Sc Semester IV (Analytical Chemistry)

CORE Paper: Advanced Analytical Instrumentation (Theory)
Course Code: PCH 4803
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)

I. Course Overview & Course Objectives

Unit -AC 01 UHPLC and SFC
Unit-AC 02 Advanced mass spectrometry
Unit-AC 03 LC-NMR and LC-MS
Unit-AC 04 ICP-MS

The main objective of the course will be to enhance the understanding and knowledge of Advanced Analytical Instrumentation

By the end of the paper, a student will be able to:

(a) Understand the important aspects of UHPLC and SFC
(b) Learn the various aspects of Advanced mass spectrometry
(c) Understand the important aspects of LC-NMR and LC-MS
(d) Learn the Chemistry of ICP-MS

Thus, the knowledge from the course can help in the following:

(a) Finally, all students, of all branches whether organic or inorganic or analytical will be able to incorporate this knowledge, in their pursuit of research in their different fields.

II. Course Content

Unit -1UHPLC and SFC (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to UHPLC and SFC]

Principle, theory, instrumentation and applications of ultra high-performance liquid chromatography (UHPLC) and super critical fluid chromatography (SFC). Comparison with HPLC.

Unit-2Advanced mass spectrometry (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Advanced mass spectrometry]

Ion sources- matrix assisted laser desorption ionization (MALDI), thermospray, electrospray, atmospheric pressure chemical ionization (APCI), atmospheric pressure photo ionization (APPI) and atmospheric pressure secondary ion ionization (APSI); Mass analyzers- quadrupole, ion-

trap, time of flight (TOF), ion-cyclotron resonance and Fourier transform mass spectrometry. Tandem mass spectrometry. Applications in the analysis of biomolecules.

Unit-3 LC-NMR and LC-MS (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Electrophoresis]

Principle, theory, instrumentation and applications of liquid chromatography-nuclear magnetic resonance and liquid chromatography-mass spectrometry. Applicationof LC-NMR-MS.

Unit-4 ICP-MS (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to ICP-MS]

Principle, theory, instrumentation and applications of inductively coupled plasma-mass spectrometry.

III. Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

M Sc Semester IV(Analytical Chemistry)

IV. Reference books: PCH3804: Modern Separation Techniques (Theory)

(1) "Quantitative Chemical Analysis" by Daniel C. Harris, 7th Edition, W.H. Freeman And Company, New York.

(2) "Analytical Chemistry" by Gary D. Christian, 6th Edition, John Wiley and Sons Inc. New Jersey.

(3) On-line LC-NMR and related techniques, Klaus Albert (editor), John Wiley and Sons, 2002.

(4) Practical Guide to ICP-MS by Robert Thomas, Marcel Dekker Inc., 2004.

(5) Packed columns SFC by T.A. Berger, RSC Chromatography Monographs, RSC, 1995.

(6) Introduction to Mass Spectrometry: Instrumentation, Applications, and Strategies for Data
Interpretation by J. Throck Watson, O. David Sparkman, Wiley, 2007.

(7) Interpretation of Mass Spectra by Fred W. Mc Lafferty, Turecek University Science Books, 1993.

(8) Mass spectrometry-Principles and Applications by Edmond de Hoffmann and Vincent Stroobant, John Wiley and Sons, 2007.

M Sc Semester IV (Analytical Chemistry)

CORE Paper: Environmental Chemistry(Theory)
Course Code: PCH 4804
No. of Credits: 04
Learning Hours: 60 hrs (70 Marks)

I. Course Overview & Course Objectives

Unit -AC 01 Performance and Structure of Analytical Methods
Unit-AC 02 The atmosphere
Unit-AC 03 The hydrosphere
Unit-AC 04 The lithosphere and the biosphere
The main objective of the course will be to enhance the understanding and knowledge of Environmental Chemistry

By the end of the paper, a student will be able to:

(a) Understand the important aspects ofPerformance and Structure of Analytical Methods

(b) Learn the various aspects of the atmosphere
(c) Understand the important aspects of The hydrosphere
(d) Learn the Chemistry of The lithosphere and the biosphere
Thus, the knowledge from the course can help in the following:
(a) Finally, all students, of all branches whether organic or inorganic or analytical will be able to incorporate this knowledge, in their pursuit of research in their different fields.

II. Course Content

Unit -1Performance and Structure of Analytical Methods (15L)[14 Marks]
[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to Performance and Structure of Analytical Methods]

Choosing method, A statistical view of analytical procedures, Criteria for selecting a method, Sources of error in trace analysis, Sampling, Dissolution and decomposition of samples, Separation, Determination, The complete analytical procedure.

Unit-2The atmosphere (15L)[14 Marks]
[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to the atmosphere]
Composition of the atmosphere, Common air pollutants and their sources, Gases, vapours and particles, Air pollution and health, Sampling of air borne solids, Examination of airborne solids, Direct instrumental methods for gaseous pollutants, Sampling of gases and the atmosphere, Gas chromatography, Some chemical methods for determining trace gases, Some case studies of air pollution.

Unit-3 The hydrosphere (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to The hydrosphere]

The hydrological cycle and pollution, The oxygen balance in natural waters, Observations on sampling, Storage of samples and prevention of contamination, The analysis of water, Selected analytical methods for water quality control, pH measurement – the glass electrode, Conductivity, Dissolved oxygen (DO), Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Methods for the determination of inorganic nitrogen, Determination of phosphate, Automation of colorimetric procedures, The determination of chloride by titrimetry (visual), Ion-selective electrodes, Ion chromatography, The determination of heavy metals, The importance of chemical species – speciation, Trace organics in water – total organic carbon (TOC), Determination of some individual compounds or groups of compounds in polluted water, Gas chromatography / mass spectrometry (GC / MS), The EPA survey procedure : priority pollutants.

Unit-4 The lithosphere and the biosphere (15L)[14 Marks]

[Prerequisites or topics for Self Study: Basic terms and fundamental aspects related to The lithosphere and the biosphere]

Introduction, The need for chemical analysis of solids and rocks, Available elements, Particles size distribution in solids, Soil analysis versus visual symptoms shown by plants, Sampling problems with rocks and soils, Subsampling, Dissolution for total element analysis, Some selected chemical methods in soil analysis, Flame atomic absorption spectroscopy, Flame emission spectroscopy, Other emission techniques, Identification of minerals, The nature of the biosphere, The need for analysis of zoological specimens, The merits of treating the biosphere as a whole, Sampling problems, Sample preparation problems, Sample dissolution, Analysis of plant tissues for N, P, K, Ca and Mg, Boron in plant tissue, Cobalt in plant tissue, Sulphur in plant tissue, Simultaneous multi-element analysis, The role of trace element in living systems, Trace element determinations on very small samples, Cold vapour and hydride generation systems in AAS.

III. Teaching methodologies: Apart from the conventional black board teaching, other modes of teaching that will be adopted are power points, problem solving, and group discussion. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

M Sc Semester IV

IV. Reference books: PCH4804: Environmental Chemistry(Theory)

(1) Lain L. Marr, Malcolm S. Cresser, "Environmental Chemical Analysis", Published by International Textbook Company, New York.

(2) Laitinen, H. A. and Harris, W. E., "Chemical Analysis", 2dn Edition, McGraw-Hill, New York.

(3) Katz, M., "Methods of Air Sampling and Analysis", 2ed Edition, American Public HealthAssociation, Washington, DC.

(4) Israel, H. and Israel, G.W., "Trace Elements in the Atmosphere". Ann Arbor, Michigan.
(5) Z. Marczenko, "Spectrophotometric Determination of the Elements", Ellis Horwood, Chichester.
(6) Wilson, A.L., "The Chemical Analysis of Water : General Principles and Techniques", The Society for Analytical Chemistry, London.
(7) Black, C.A., "Methods of Soil Analysis", American Society of Agronomy, Madison, Wisconsin.
(8) Brooks, R.R., "Geobotany and Biogeochemistry in Mineral Exploration", Harper and Row, New York.

M Sc Semester IV (Analytical Chemistry)

I. Course PCH 4805 L and 4806 L: Industrial Analytical Chemistry (Practicals)

II. Course Content: Dissertation/industrial Training

III. Teaching methodologies: Practical work, problem solving, and group discussion etc as per the Industry or topic of the work selected.

M. Sc. Semester III (Analytical Chemistry)

IV. References books: PCH 4805 L and 4806 L: Industrial Analytical Chemistry (Practicals)

As per the Industry or topic of the work selected or the material of the topic selected.