St. Xavier's College (Autonomous)
Mumbai
Syllabus for 6th Semester Courses in
Chemistry
(June 2016 onwards)

Contents: Theory Syllabus for Courses:

SEMESTER VI **COURSE: S.CHE.6.01**

GENERAL PHYSICAL CHEMISTRY **[60 LECTURES]**

LEARNING OBJECTIVES

1. To encourage students to learn, integrate & analyze the concepts relevant to Physical Chemistry at the graduation level.

2. To learn the concept of concentration cells & its applications in determination of several constants & parameters.

3. To understand & appreciate the utility of electrochemistry in providing renewable sources of energy.

4. To study various aspects of chemical kinetics, catalysis, surface equilibria & phase equilibria.

5. To learn the utility of several colligative properties in determination of molecular weight of several solutes & state of solutes that are dissolved to form solutions using van't Hoff factor.

UNIT I: **(15 L)**

1.1: Electrochemical cells

1.1.1: Lewis concept of Activity and Activity coefficient, Mean ionic activity and mean ionic activity coefficient $\gamma_{\pm \text{ of}}$ an electrolyte. Variation of mean ionic activity coefficient with concentration, expression for activities of electrolytes of different valence type, ionic strength of a solution, Debye-Hückel limiting law (derivation not expected).

1.1.2: Classification of cells: (i) Chemical cells without transference (ii) Concentration cells with and without transference (derivations of expression for concentration cell EMF are expected). Origin of liquid-liquid junction potential and its elimination using a salt bridge.

1.1.3: Applications of EMF .measurements in the determination of

i) Mean ionic activity coefficient of an electrolyte.
ii) pH of a solution using quinhydrone and glass electrode.
iii) Solubility and solubility product of sparingly soluble salts using chemical and concentration cell.
iv) Ionic Product of water using chemical using chemical and concentration cell.

UNIT II: **(15 L)**

2.2: Applied Electrochemistry **(8L)**

2.1.1: Polarization, concentration polarization and its elimination.

2.1.2: Decomposition potential, experimental determination of decomposition potential, factors affecting decomposition potential (nature of electrolyte, nature of electrodes and temperature), overvoltage, experimental determination of over-voltage, Tafel's theory and Tafel's equation for hydrogen overvoltage, simultaneous deposition of metals.

2.1.3: Electroplating - objectives and process.

2.2: Renewable Energy Sources (5L)

2.2.1: Batteries – Secondary cells, Lithium Ion Cell.

2.2.2: Fuel Cells--Choice of fuel and oxidant, thermodynamic and kinetic aspect of electrochemical energy transformation, efficiency of fuel cells , Bacon's H_2 and O_2 fuel cell.

2.2.3: Solar cells, solar energy, photovoltaic effect, semiconductors as solar energy converters. Silicon solar cell.

2.2.4: Biomass energy from biomass and its sources, conversion of biomass into energy by alcohol fermentation and anaerobic digestion method.

2.2.5: Hydrogen: fuel of the future, production of hydrogen by direct electrolysis of water and biomass gasification, advantages of hydrogen as a universal energy medium.

2.3: Introduction to some materials of the future (3 L)

2.3.1: Liquid Crystals: Classification, Molecular ordering, identification, polymeric liquid crystals, application of liquid crystals – LC displays and thermography.

2.3.2: Organic Light Emitting Diodes.

UNIT III: (15 L)

3.1: Colloids (6 L)

3.1.1: Introduction to colloidal state of matter.

3.1.2: Origin of charge on colloidal particles. Concept of electrical double layer, zeta potential, Helmholtz and Stern mode, Electrokinetic phenomena:

(i) Electrophoresis
(ii) Electro-osmosis
(iii) Streaming potential
(iv) Sedimentation potential

3.1.3: Colloidal electrolytes.

3.1.4: Donnan Membrane Equilibrium.

3.1.5: Surfactants, micelle formation, applications of surfactants in detergents, food industry in pesticide formulations.

3.2: Surface Chemistry and Catalysis (9 L)

3.2.1: Adsorption Physical and Chemical Adsorption, types of adsorption isotherms, Langmuir's adsorption isotherm, (Postulates and derivation expected). B.E.T. equation for multilayer adsorption, (derivation not expected, significance of the terms involved in the equation is expected.), determination of surface area of an adsorbent using B.E.T. equation.

3.2.2: Catalysis: Homogeneous and heterogeneous catalysis, catalytic activity and selectivity, promoters, inhibitors, catalyst poisoning and deactivation, TON and TOF (introduction only).

3.2.3: Acid-Base catalysis, mechanism and kinetics of acid-base catalyzed reactions, effect of pH on acid-base catalyzed reactions. Mechanics and kinetics of enzyme catalyzed reaction (Michaelis-Menten equation).

3.2.4: Kinetics of surface reactions, heterogeneous catalysis:

i) Unimolecular surface reactions

ii) Bimolecular surface reaction (relevant rate expressions expected)

UNIT IV: (15 L)

4.1: Chemical Kinetics (6 L)

4.1.1: Collision theory of reaction rates. Application of collision theory to
(i) Bimolecular reaction
(ii) Unimolecular reaction (Lindemann theory, derivation expected).
Merits and drawbacks of collision theory. Activated complex theory of bimolecular reactions, expression for rate constant of bimolecular reaction (derivation not expected), comparison of collision theory and activated complex theory.

4.1.2: Classification of reactions as Slow, Fast and Ultra-fast. Study of kinetics of fast reactions by Stop flow method.

4.2: Colligative Properties of Dilute Solutions (5 L)

4.2.1: Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure.

4.2.2: Elevation in boiling point of a solution, thermodynamic derivation relating elevation

in the boiling point of a solution and the molar mass of the non-volatile solute.

4.2.3: Depression in freezing point of a solution, thermodynamic derivation relating the depression in the freezing point of a solution and the molar mass of the non-volatile solute.

4.2.4: Abnormal molar masses of solutes and van't Hoff factor (calculation of Degree of Association and Degree of Dissociation).

4.3: Phase Rule

(4 L)

4.3.1: Gibb's phase rule and terms involved in the equation.

4.3.2: Application of phase rule to TWO component systems, condensed systems, condensed phase rule, eutectic systems (Lead-Silver system), desilverisation of lead.

4.3.3: Introduction to THREE component systems, explanation of the phase diagram for three liquids forming one immiscible pair.

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CIA I: Short answer questions and numerical problems **20 MARKS**
CIA II: MCQ TEST **20 MARKS**

Template of Question Paper

GENERAL PHYSICAL CHEMISTRY **COURSE: S.CHE.6.01**

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	3	6	6	15
II	3	6	6	15
III	3	6	6	15
IV	3	6	6	15
TOTAL MARKS PER OBJECTIVE	12	24	24	60
% WEIGHTAGE	20	40	40	100

END SEMESTER PAPER PATTERN:

Total Marks: 60 **Maximum Time: 2 hours**

Total number of questions: 4 [all compulsory] of 15 marks each.
1 question per unit.
Questions set out of 22-23 marks [50 % internal choice]
Sub questions will not exceed 5 marks

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SYLLABUS UNDER AUTONOMY
CHEMISTRY

SEMESTER VI **COURSE: S.CHE.6.02**

SOLID STATE, SOLUTION AND MEDICINAL CHEMISTRY [60 LECTURES]

LEARNING OBJECTIVES

1. To encourage students to analyze and integrate concepts relevant to graduate level Inorganic Chemistry.
2. To understand structure of crystalline solids and defects that exist.
3. To expose students to concepts in Superconductivity.
4. To study aqueous and non-aqueous solvents.
5. To introduce students to applications in Medicinal Chemistry and Nanomaterials.

UNIT I: Solid State Chemistry (15 L)

1.1: Structures of Solids (10L)

1.1.1: Importance of solid state chemistry.

1.1.2: Crystals: size and shape of crystals, interfacial angles in crystals, symmetry and elements of symmetry in crystals.

1.1.3: Designation of planes in crystals: Miller indices.

1.1.4: Classification of solids on the basis of bonding.

1.1.5: Explanation of terms viz. crystal lattice, lattice points, unit cells and lattice constants.

1.1.6: Closest packing of rigid spheres (hcp, ccp) packing density in simple cubic, bcc, fcc and hcp lattices (numerical problems expected).

1.1.7: Structures of metallic solids.

1.1.8: Tetrahedral and octahedral interstitial voids in ccp lattice, tetrahedral holes, limiting radius ratios for different coordination numbers and their significance, calculation of ionic radii and limiting radius ratio for co-ordination number 4.

1.1.9: Structures of sodium chloride, cesium chloride and fluorite.

1.1.10: Structure of zinc chloride and failure of radius ratio rule (directional bonding), structure of wurtzite.

1.1.11: Defects in crystal structures; effects of Schottky and Frenkel defects.

1.2: Superconductivity (5 L)

1.2.1: Superconductivity, Meissner effect.

1.2.2: Different superconducting materials viz., conventional superconductors,organic superconductors, alkali metal fullerides (A_3C_{60}) and high temperature superconductors.

Self Study: Applications of superconducting materials.

UNIT II: Organ metallic Chemistry (15 L)

2.1: Organometallic Compounds of Transition Elements

2.1.1: Sigma bonded and pi bonded organometallic compounds, alkene and alkyne complexes and metal carbonyls.

2.1.2: Organometallic compounds of main group elements: Introduction, general synthetic methods:
i) Oxidative addition ii) Metal-Metal exchange (Transmetallation)
iii) Carbanion - Halide exchange (Metathesis) iv) Metal-Hydrogen exchange
v) Methylene insertion reactions.

2.1.3: Chemical reactions: i) Reactions with oxygen and halogens ii) Alkylation and arylation reactions iii) Reactions with protic reagents iv) Redistribution reactions v) Complex formation reactions.

2.1.4: Metallocenes: η^5 cyclopentadienyl complexes, η^6 arene metal complexes. Synthesis, structure and bonding, reactions and applications of Ferrocene.

2.1.5: Metal Clusters: δ bonding, bonding in Rhenium and Molybdenum halide complexes.

2.1.6: Transition Metal Organometallics as Catalytic reagents: Catalysis with reference to
i) Hydrogenation of alkenes (Wilkinson catalyst)
ii) Hydroformylation reaction (Roelen catalyst)
iii) Polymerisation of alkenes (Ziegler-Natta Catalyst).

UNIT III: Solution Chemistry (15 L)

3.1: Acid-base Chemistry in Aqueous Medium

3.1.1: Acidity of mono- and polyatomic cations.

3.1.2: Basicity of mono- and polyatomic anions (Latimer equation and predominance diagrams).

3.1.3: Measure of acidity and basicity : concepts based on electronegativity and thermodynamic aspects (Drago-Wayland equation).

3.2: Chemistry in Non-aqueous solvents

3.2.1: Classification of solvents and importance of non-aqueous solvents.

3.2.2: Characteristics of study of liquid ammonia, dinitrogen tetraoxide and acetic acid as non-aqueous solvents with respect to i) acid - base reactions ii) redox reactions.

UNIT IV: Inorganic Medicinal Chemistry And Nanomaterials (15L)

4.1: Nanomaterials (5 L)

4.1.1: Introduction and Importance of nanomaterials.

4.1.2: Properties (Comparison between bulk and nanomaterials): i) Optical properties ii) Electrical conductivity iii) Melting points and iv) Mechanical properties.

4.1.3: Forms of nanomaterials: nanofilms, nanolayers, nanotubes, nanowires and nanoparticles.

4.1.4: Methods of preparation.

4.2: Bioligands in biocoordination chemistry (10L)

4.2.1: Biological functions of biometals and role of metal ions in basic biological reactions.

4.2.2: Dependence of biological growth on the concentration of essential and toxic metals.

4.2.3: Role of transition metals in biological systems (Fe^{2+}/ Fe^{3+}, Zn^{2+}).

4.2.4: Radioisotopes in medicine.

4.2.5: Gastrointestinal agents viz. i) antacids (aluminium hydroxide, milk of magnesia, sodium bicarbonate and ii) cathartics (magnesium sulphate and sodium phosphate).

4.2.6: Topical agents viz. (i) protectives and adsorbents (talc, calamine) (ii) antimicrobial agents (potassium permanganate, tincture iodine, boric acid) and astringents (alum).

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CIA I: Short answer questions **20 MARKS**
CIA II: Assignments **20 MARKS**

Template of Question Paper

SOLID STATE, SOLUTION AND MEDICINAL CHEMISTRY   COURSE : S.CHE.6.02

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	6	6	3	15
II	6	6	3	15
III	6	6	3	15
IV	6	6	3	15
TOTAL MARKS PER OBJECTIVE	24	24	12	60
% WEIGHTAGE	40	40	20	100

END SEMESTER PAPER PATTERN :

Total Marks: 60   **Maximum Time: 2 hours**

Total number of questions: 4 [all compulsory] of 15 marks each.
1 question per unit.
Questions set out of 25 marks [50% internal choice].
Sub questions will not exceed 5 marks.

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SYLLABUS UNDER AUTONOMY
CHEMISTRY

SEMESTER VI   **COURSE: S.CHE. 6.03**

SPECTROMETRIC IDENTIFICATION AND SYNTHETIC   **[60 LECTURES]**

CHEMISTRY

LEARNING OBJECTIVES

1. To enable students to apply their knowledge of spectroscopy in the determination of the structure of simple organic molecules.
2. To study mechanisms involved in some name reactions and molecular rearrangements.
3. To give the students a knowledge of some reagents and catalysts in organic syntheses and an introduction to the concept of retrosynthesis.
4. To give the students an overview of polymers.

UNIT I: Spectroscopy (15 L)

1.1 : Introduction: Electromagnetic spectrum, units of wavelength and frequency.

1.2 **: UV-Visible Spectroscopy:** Basic theory, solvents, nature of UV-VIS spectrum, concept of chromophore, auxochrome, bathochromic shift, hypsochromic shift, hyperchromic effect and hypochromic effect. Chromophore-chromophore and chromophore-auxochrome interactions.

1.3 **: IR Spectroscopy:** Basic theory, nature of IR spectrum, selection rule, fingerprint region.

1.4 **:PMR Spectroscopy:** Basic theory of NMR, nature of PMR spectrum, chemical shift (δ unit), standard for PMR and solvents used. Factors affecting chemical shift: (**a**) inductive effect (**b**) anisotropic effect (with reference to C=C, C≡C, C=O and benzene ring). Spin-spin coupling and coupling constant. Proton exchange – Application of deuterium exchange. Application of PMR in structure determination.

1.5 :Spectral characteristics of the following classes of organic compounds with respect to UV-VIS, IR, PMR (broad regions characteristic of different groups):

(**a**) alkanes (**b**) alkenes and polyenes (**c**) alkynes (**d**) haloalkanes (**e**) alcohols (**f**) carbonyl compounds (**g**) ethers (**h**) carboxylic acids (**i**) esters (**j**) amines (**k**) amides (**l**) benzene and monosubstituted benzenes.

1.6 **:Mass Spectrometry:** Basic theory, nature of mass spectrum, general rules of fragmentation. Importance of: molecular ion peak, isotopic peaks, base peak, Nitrogen rule. Illustrative fragmentation of alkanes and aliphatic carbonyl compounds, Mclafferty rearrangement.

1.7 **:Problems on structure elucidation** of simple organic compounds using individual or a combination of spectra mentioned above. (index of hydrogen deficiency should be the first step in solving the problems).

UNIT II: Name Reactions and Molecular Rearrangements (15 L)

2.1: Mechanism of the following reactions with examples and synthetic applications:
(**a**) Claisen Condensation (**b**) Michael Reaction (**c**) Oppenauer Oxidation
(d) Stobbe Condensation (**e**) Wolff-Kishner Reduction (f) McMurry Reaction

2.2: Mechanism of rearrangements with examples and stereochemistry wherever applicable:

(a) Pinacol-Pinacolone (b) Wolff (c) Beckmann (d) Hofmann (e) Baeyer-Villiger Oxidation.

UNIT III : Synthetic Chemistry (15 L)

3.1: Retro Synthetic Analysis (8 L)

3.1.1: Introduction: Definitions: (i) Disconnection (ii) Functional Group Interconversion (iii) Reagents (iv) Synthon (v) Synthetic equivalent (vi) Target Molecule

3.1.2: Introduction to disconnections with respect to some simple molecules.

3.1.3: One Group Disconnections: Disconnection in molecules of alcohols, olefins, ketones.

3.2: Catalysts and Reagents (7 L)

Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism).

3.2.1: Catalysts: Catalysts for hydrogenation: Raney Ni, Pt and PtO_2: C=C, CN, NO_2, aromatic ring; Pd/C: C=C, COCl CHO (Rosenmund).

3.2.2: Reagents : (**a**) $LiAlH_4$ and Red-Al: reduction of CO, COOR, CN, NO_2

(**b**) $NaBH_4$: reduction of CO (**c**) Diborane: olefins to alcohols through hydroboration, reduction of COOH (**d**) SeO_2: hydroxylation of allylic and benzylic positions, oxidation of CH_2 alpha to CO to CO (**e**) *m*CPBA and H_2O_2/ NaOH for epoxidation of enones (f) Periodic acid oxidation (**g**) NBS: allylic and benzylic bromination and bromination of position alpha to CO

3.2.3:Organometallic Chemistry : (a) Organolithium compounds: Preparation using alkyl/aryl halides. Reactions with compounds containing acidic hydrogen, alkyl halides, carbonyl compounds, cyanides and CO_2. **Lithium dialkyl cuprates:** Preparation and reactions with **aliphatic/ aromatic/ vinylic halides. (b) Organozinc compounds:** Preparation and application in Simmons-Smith reaction with mechanism.

UNIT IV

(15 L)

4.1: Polymers

4.1.1: Introduction: General idea of monomers, polymers and polymerization. natural and synthetic polymers. Homopolymers and Copolymers. Classification of polymers. Copolymers – alternating, block, random and graft.

4.1.2: Mechanism of free radical, cationic and anionic addition polymerisation.

4.1.3: Stereochemistry of polymers: Tacticity, role of Ziegler–Natta catalyst (coordination polymerization) in directing the tacticity in polypropylene (no mechanism).

4.1.4: Elastomers: Natural and synthetic rubbers. Diene polymerization: 1,2-and 1,4-addition (*cis* and *trans)* polymerization of isoprene. 1,3-Butadiene- styrene copolymer.

4.1.5: Preparation and uses of polymers:

(**a**) Addition polymers: (**i**) polyethylene (**ii**) polypropylene (**iii**) PVC

(**iv**) polystyrene (**v**) polyacrylonitrile (**vi**) polyvinylalcohol
(**vii**) poly(tetrafluoroethelyene)

(b) Condensation polymers: (**i**) polyesters (**ii**) polyamides (Nylon-6, Nylon-66) (**iii**) polyurethans (**iv**) phenol-formaldehyde resin (v) urea-formaldehyde resin (**vi**) epoxy resin (**vii**) polycarbonates (viii) saran (ix) SAN (x) ABS

4.1.6: Additives to polymers: Plasticizers, stabilizers and fillers.

4.1.7: Recyclable polymers: Biodegradable polymers and their uses. Biomedical uses of polymers.

(Students are expected to identify monomers in a given polymer and draw the structure of a polymer from a given set of monomers).

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14. **W. Kemp,** Organic Spectroscopy, 3rd Edition, Palgrave, Indian Edition, 2005.
15. **Williams and Fleming,** Spectroscopic methods in Organic Chemistry, 5th Edition, McGraw Hill, 1995.
16. **D. Walton and P. Lorimer,** Polymers, Oxford University Press, New Delhi, Indian Edition, 2005.
17. **V.K. Ahluwalia and A. Mishra,** Polymer Science, Ane Books Pvt. Ltd., New Delhi, 2009.
18. **K.S. Tewari and N.K. Vishnoi,** Organic Chemistry, Vikas Publications.
19. **N.K. Vishoi,** Advanced Practical Organic Chemistry, 2nd Edition, Vikas Publications.
20. **I.L.Finar,** Organic Chemistry, Volume 2, 6th Edition, Pearson.
21. **U.Satyanarayana and U. Chakrapani, Essentials of Biochemistry** 2nd Edition, 2013**.**
22. **Stuart Warren,** Designing Organic Syntheses, Wiley India Pvt. Ltd., 2009.

CIA I: Short answer questions **20 MARKS**
CIA II: Problem solving based on Spectroscopy and Retrosynthesis **20 MARKS**

Template Of Question Paper

SPECTROMETRIC IDENTIFICATION AND SYNTHETIC CHEMISTRY

COURSE: S.CHE.6.03

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	5-6	5-6	4-5	15
II	5-6	5-6	4-5	15
III	5-6	5-6	4-5	15
IV	5-6	5-6	4-5	15
TOTAL MARKS PER OBJECTIVE	20-24	20-24	16-20	60
% WEIGHTAGE	34-40	34-40	27-34	100

END SEMESTER PAPER PATTERN:

Total Marks: 60 **Maximum Time: 2 hours**

Total number of questions: 4 [all compulsory] of 15 marks each.
1 question per unit.
Questions set out of 22-23 marks [50 % internal choice]
Sub questions will not exceed 5 marks.

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SYLLABUS UNDER AUTONOMY
CHEMISTRY

SEMESTER VI **COURSE: S.CHE.6.04**

INSTRUMENTAL METHODS OF ANALYSIS **[60 LECTURES]**

LEARNING OBJECTIVES

1. To expose students to various instrumental techniques involving sophisticated instruments commonly used in industry.
2. To understand the principles, theory, instrumentation and applications of instrumental methods.
3. To motivate students to solve numerical problems.
4. To familiarize students with concept of limit tests, bioavailability and bioequivalence studies.
5. To introduce students to dissolution and disintegration techniques.
6. To build on basic concepts of uncertainty in a measurement and understand the difference between uncertainty and errors.
7. To acquire knowledge about method development and validation.

UNIT I: Optical Methods **[15 L]**

1.1 : UV-Visible Spectrophotometry: Instrumentation of double beam spectrophotometer and their comparison with single beam.

1.2: Atomic Spectroscopy: Flame photometry: flame atomizer, types of burners, monochromators and detectors. **Atomic absorption spectroscopy:** flame and electrothermal atomizer, hollow cathode lamp, construction and working of instruments. Quantitative applications of atomic absorption spectroscopy and flame photometry. Calibration curve method, standard addition method and internal standard method.

1.3: Molecular Fluorescence Spectroscopy: Introduction to the terms- fluorescence and phosphorescence, instrumentation of fluorimeter and applications.

1.4: Infrared Spectroscopy: Sources, sample handling and detectors.

1.5: Turbidimetry and Nephelometry: Scattering of light, effect of concentration, particle size and wavelength on light scattering, instrumentation and applications**.**

1.6: Self Study: Instrumentation of single beam spectrophotometer.

UNIT II: Electroanalytical Methods [15 L]

2.1: Ion Selective Electrodes: Classification of ion selective electrodes, construction and working of Fluoride ion selective electrode.

2.2: D.C. Polarography: Polarizable and nonpolarizable electrodes, basic principles of

polarography, polarographic cell, residual current, diffusion current, limiting current, dropping mercury electrode, supporting electrolyte, half wave potential. Ilkovic equation [no derivation expected], oxygen interference and its removal, polarographic maxima and maxima suppressors, qualitative and quantitative analysis, calibration curve and standard addition method, applications {Numerical problems expected].

2.3: Amperometric Titrations: Basic principles, rotating platinum electrode, nature of the titration curves, applications, advantages and limitations.

2.4: Self Study: Introduction to ISE, properties of membrane, components of ISE, glass electrode.

UNIT III: Separation Techniques-2 and Miscellaneous Methods [15 L]

3.1: Ion exchange chromatography: Types of ion exchangers, mechanism of ion exchange, selectivity coefficients and separation factors, ion exchange capacity and its determination, factors affecting the separation of ions, applications.

3.2: Size exclusion chromatography: Principle and applications.

3.3: HPTLC: Instrumentation, applications.

3.4: Neutron Activation Analysis: Theory, technique and applications.

3.5: Thermal methods: Classification of thermal methods **TGA and DTA:** Basic principles, instrumentation, factors affecting the TG curve and applications.

3.6: Mass Spectrometry: Basic principle and introduction of components only.

UNIT IV: Treatment of Analytical Data- 2 and Introduction to Pharma Chemistry-2 [15 L]

Part I: Treatment of analytical data- 2 [8 L]

4.1.1: Distribution of random errors, Gaussian curve, student's t, confidence limits and confidence interval,

4.1.2: Criteria for rejection of result: 2.5 d rule, 4.0 d rule, Q test, testing for significance, null hypothesis, F test.

4.1.3: Graphical representation of data: Method of averages, least squares method.

4.1.4: Basic concept of uncertainty in a measurement (only introduction), difference between uncertainty and errors.

[Numerical problems expected]

Part II: Introduction to Pharma Chemistry- 2 [7 L]

4.2.1: Impurities in pharmaceutical preparation, source of impurities, permissible impurities.

4.2.2: **Definition of** Limit tests, limit tests for chloride, sulphate, iron, lead and arsenic.

4.2.3: Introductory concept of bioavailability and bioequivalence.

4.2.4: Introduction to dissolution and disintegration tests.

4.2.5: **Self-study:** Analytical method validation.

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2. **D. A. Skoog, F.J.Holler and T.A.Nieman,** Principles of Instrumental Analysis, 6thed. Philadelphia, Saunders College Publishing, 1996.

3. **G.D.Christian,** Analytical Chemistry, 6th ed. John Wiley and Sons Singapore, 2004.

4. **H. H. Willard, L. L. Merritt, Jr J. A. Dean and F. A. Settle,** Instrumental methods of Analysis, 6thed and 7th ed CBS (1986).

5. **M.Valcarcel,** Principles of Analytical Chemistry, Springer International Edition, Berlin, 2000.

6. **S. M. Khopkar,** Basic Concepts of Analytical Chemistry, 3rd ed, New Age International Publishers, 2008.
7. **A. I. Vogel,** Textbook of Quantitative Chemical Analysis, 6th ed, Pearson Education, 2002.

8. **O Samuelson**, Ion exchange separation in analytical chemistry, 2nd ed, John Wiley, 1963.

9. **H.F Walton Howden, Hutchenson and Rossing** , Ion exchange chromatography, 1976.

10. **J. M. Miller,** Separation methods in Chemical Analysis, John Wiley 1975.

11. **G W Ewing,** Instrumental methods of chemical analysis, 5thed, McGraw Hill, 1976.

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13. **G. R. Chatwal and S. K. Anand**, Instrumental methods of chemical analysis, Himalaya Publishing House.

14. **A. H. Beckett and J. B. Stenlake,** Practical Pharmaceutical Chemistry**,** 4th ed. Part I and II.

15. **P. J. Haines,** Thermal methods of Analysis, Blackie Academic & Professional, London (1995).

16. **W. W. Wendlandt,** Thermal Analysis, 3rd ed John Wiley, N.Y. (1986).

17. **Ashutosh Kar ,**Pharmaceutical Drug Analysis.

18. **A. M. Bond**, Anal. Chim. Acta., 62, 415 (1972).
19. **F. Elizabeth Prichard,** Quality in the Analytical Chemistry Laboratory.

CIA I: Short answer questions **20 MARKS**
CIA II: Instrumentation, including schematic diagrams of instruments **20 MARKS**

Template Of Question Paper

INSTRUMENTAL METHODS OF ANALYSIS **COURSE: S.CHE.6.04**

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	5-6	5-6	4-5	15
II	5-6	5-6	4-5	15
III	5-6	5-6	4-5	15
IV	5-6	5-6	4-5	15
TOTAL MARKS PER OBJECTIVE	20-24	20-24	16-20	60
% WEIGHTAGE	34-40	34-40	27-34	100

END SEMESTER PAPER PATTERN:

Total Marks: 60 **Maximum Time: 2 hours**

Total number of questions: 4 [all compulsory] of 15 marks each.
1 question per unit.

Questions set out of 22-23 marks [50 % internal choice]
Sub questions will not exceed 5 marks

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PRACTICAL CHEMISTRY **COURSE: S.CHE.6.PR**

LEARNING OBJECTIVES

1. **To learn to perform instrument based experiments and non-instrumental experiments with correct techniques.**
2. **To develop skills of observation, recording and analyzing data.**
3. **To learn to present the experimental work in a systematic manner.**

PHYSICAL CHEMISTRY: COURSE 1

NON-INSTRUMENTAL EXPERIMENTS

CHEMICAL KINETICS

1. To determine the energy of activation of acid catalysed hydrolysis of methyl acetate.

2. To study the effect of ionic strength (KCl) on the reaction between $K_2S_2O_8$ and KI.

3. To study the Saponification of ethyl acetate with sodium hydroxide at equal concentrations of ester and alkali.

PARTITION COEFFICIENT

4. To determine the partition co-efficient of I_2 between CCl_4 and H_2O.

5. To determine the equilibrium constant for the reaction $KI + I_2 = KI_3$ by partition method.

ADSORPTION EXPERIMENT

6. To study the adsorption of acetic acid / oxalic acid on charcoal.

PHASE RULE

7. To determine the phase diagram for the system water, chloroform, acetic acid at room temperature.

SOLUBILITY MEASUREMENT

8. To determine the solubility product of calcium hydroxide at room temperature.

VISCOSITY

9 . To determine the molecular weight of polyvinyl alcohol by viscosity measurements.
10. To determine the size (radius) of a glycerol molecule by viscosity.
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INORGANIC CHEMISTRY: COURSE 2

GRAVIMETRIC ANALYSIS

INORGANIC PREPARATIONS
TITRIMETRIC ANALYSIS

1. Gravimetric Analysis

1) Estimation of Barium as Barium Chromate in the presence of Iron.
2) Estimation of Nickel as Nickel dimethyl glyoxime in the presence of Copper.

2. Inorganic Preparations

1) Nickel dimethyl glyoxime.
2) Copper chloride dimethyl sulfoxide.
3) Potassium dioxalatocuprate (II) dehydrate

3. Titrimetric Analysis

1) Estimation of Cobalt by EDTA method using Xylenol Orange.
2) Analysis of talcum powder for magnesium content.
3) Analysis of calcium tablet.
4) Estimation of Aluminum using EDTA.

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ORGANIC CHEMISTRY: COURSE 3

ORGANIC SEPARATION

ORGANIC PREPARATION

1. Organic Separation

Separation of a binary mixture: Type of mixture, separation and identification (**microscale**) of both components through systematic scheme of identification.

Types: Volatile Liquid + Solid, Volatile Liquid + Non-volatile Liquid

Liquid: Volatile ~ 6-8mL, Non-volatile ~ 4-6 mL

2. Organic Preparation

Preparation of organic compounds as per the procedure given. Measuring the mass of crude, purification of the separated product by crystallization and recording of the m.p. Quantity of reactant to be given 1-2 g.

1) p-Bromoacetanilide to p-bromoaniline.
2) Anilne to 2,4,6 – tribromoaniline.
3) Adduct of anthracene and maleic anhydride.
4) Phthalic anhydride to anthranilic acid (2 step preparation).

Note: A minimum 6 mixtures and 3 preparations should be covered in the semester.

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ANALYTICAL CHEMISTRY: COURSE 4

INSTRUMENTAL EXPERIMENTS

1. Determination of amount of Fe (III) present in the given solution by EDTA titration colorimetrically.

2. Determination of the amount of fluoride in the given solution colorimetrically.

3. Determination of potassium content of a commercial salt sample by flame photometry using Calibration Curve Method.

4. Estimation of sodium in the given solution by flame photometry using Standard Addition Method.

5. Estimation of Vitamin C content of a tablet by using pH meter.

6. To determine percentage composition of a mixture of weak acid and strong acid by conductometric titration.

7. Determination of the amount of iron present in the given vitamin tablet colorimetrically.

8. Determination of HCl and H_2SO_4 in a mixture by titration with NaOH and $BaCl_2$.

9. Determination of Glucose by Folin-Wu method colorimetrically.
10. Nephelometric determination of sulphate.

REFERENCES

1. **O.P.Panday, D. N. Bajpai and S. Giri,** Practical Chemistry, Delhi: S. Chand, 2008.
2. **V.D.Athawale and P. Mathur,** Experimental Physical Chemistry: New Age International 2008.
3. **H.N.Patel, S.P. Turakhia, S.S. Kelkar and S.R.Puniyani,** Post Graduate Practical Chemistry, Himalaya Publishing House.
4. **H.N.Patel, S.P. Turakhia, S.S. Kelkar, S.R.Puniyani, K.P,Jain and S. B. Dharap ,** College Practical Chemistry, Himalaya Publishing House.

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CIA AND END SEMESTER PRACTICAL EXAMINATION

Course 1: Physical Chemistry – Non-instrumental Experiments.

Course 2: Inorganic Chemistry- Gravimetric Analysis, Inorganic Preparations, Titrimetric Analysis.

Course 3: Organic Chemistry - Organic Separation, Organic Preparation.
Course 4: Analytical Chemistry –Instrumental Experiments.

Journal: 5 Marks per course

CIA: 15 Marks per course

Duration: 4 periods to be conducted during regular practicals by the Faculty-in-charge.

One or more practical skills will be tested in the CIA.

End Semester Examination: 30 marks per course. This includes a 5 mark viva-voce based on the theory behind all the experiments conducted per course.

There will be an External Examiner and an Internal Examiner responsible for two courses each.

Duration: 3½ hours per course.

Batch size: Max 20 students per batch for courses 2 and 3 and 10 students per batch for courses 1 and 4 (involving instruments).

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