St. Xavier's College (Autonomous),

Mumbai

Syllabus of the courses offered by the Department of Chemistry

(2016 onwards)

St. Xavier's College – Autonomous Mumbai

Syllabus for 1st Semester Course in CHEMISTRY(June 2014 onwards)

Contents: Theory Syllabus for Courses:

SYLLABUS UNDER AUTONOMY
CHEMISTRY

SEMESTER I **COURSE: S.CHE.1.01**

CONCEPTS OF PHYSICAL AND ANALYTICAL CHEMISTRY I [45 LECTURES]

LEARNING OBJECTIVES

1. To understand mole concept, concentration calculations and stoichiometric relations.
2. To apply inter – conversions to relate various concentration units.
3. To differentiate between primary and secondary standards.
4. To understand the importance of accuracy, precision, errors and its sources, presentation of experimental data and significant figures.
5. To understand the behaviour of fluids and study the physical phenomena involved.
6. To understand the statistical methods of representing experimental data.
7. To understand the kinetics of various order reactions and apply these concepts to various categories of catalysed reactions.

Unit I: Introduction to Analytical Chemistry and its interdisciplinary nature (15 L)

1.1: Chemical Calculations and Stoichiometry

1.1.1: Moleconcept, determination of molecular massby gram molecular volume relationship for chemicalreactions, problemsbased on mole concept.

1.1.2: Methods of expressing concentration of solutions: molarity, normality,molality,mole fraction,formality, dilution of solutions, inter-conversion between different concentration units, conceptof milliequivalents, millimoles, ppm and ppb.

1.1.3: Analysis of Commercial Samples: Calculation of concentration of commercial samples of acidsand bases like HCl, H_2SO_4, acetic acid and ammonia.

1.1.4: Gravimetric and Volumetric analysis: use of digital balance, calibration of glassware, pipette, burette and volumetric flask, primary and secondary standards.

1.1.5: Importance of accuracy, precision and sources of error in analyticalmeasurements, presentation of experimental data and results from the point of view of significant figures.

Unit II: Study of Fluids (15 L)

2.1: Behaviour of Real Gases (9 L)

2.1.1: Recapitulation of ideal behaviour of gases, deviations from ideal gas behaviour, compressibility factor - Z and its variation with pressure for different gases. Causes of deviation from ideal behaviour.

2.1.2: Van der Waal's equation of state, its derivation and application in explaining real gas behaviour(Mention of other equations of state: Berthelot, Dietrici).

2.1.3: Isotherms of real gases and their comparison with Van der Waal's isotherms, continuity of states,critical state, experimental determination of Pc, Tc and Vc,critical constant ofgas in terms of Van der Waal's constant.

2.2: Physical properties of Liquids (6 L)

2.2.1: Measurable physical properties of liquid such as vapour pressure, surface tension and viscosity.

2.2.2: Experimental determination of vapour pressure, surface tension and coefficient of viscosity (one method of each), effect of addition ofvarious solutes on surface tension and viscosity.

2.2.3: Temperature variation of viscosity of liquids and comparison with that of gases.

Unit III: Kinetics and Catalysis (15 L)

3.1: Kinetics (10 L)

3.1.1: Graphical representation of equations:Co-relation between mathematical functions and shapes of the graph, rules for drawing graph co-ordinates etc., equation of straight line, slope and intercept, plotting the graph from the data of chemical properties, determination of equation of line of best fit (method of averages and least squares) for y = mx only and problems.

3.1.2: Recapitulation of basic concepts**:** Rate law, specific rate constant, comparison between order and molecularity with examples, integrated rate equations for zero and firstorder reactionsand their half life (no derivations), numerical problemsexpected.

3.1.3: Second order reaction:Derivation of integrated rate equation (for equal and unequal concentration of reactants), characteristics of second order reactions with suitable examples, effectof temperature on rate of reaction (no derivation expected for Arrhenius equation).

3.2: Catalysis (5 L)

3.2.1: Catalyst and catalysis, positive and negative catalysis, type of catalysis,characteristics of catalytic reactions, promoters, catalytic poisoning,autocatalysis.

3.2.2: Activation energy and catalysis,theories ofcatalysis, active centre on catalyst surface, adsorption theory and catalytic activity **(theoretical aspect only).**

3.2.3: Acid – Base catalysis (**theoretical aspect only**) and its applications in industry.

3.2.4: Enzyme catalysis,mechanism of enzyme catalysis, characteristics ofenzyme catalysis, effect of temperature on enzyme catalysis (**qualitative approach only**), applications.

REFERENCES:

1. Principles of Physical Chemistry,4th edition by S.H. Marron and C.F.Pruton.
2. Textbook of Physical Chemistry, Samuel Glasstone.
3. Physical Chemistry, Ira Levine, 5th Edition, 2002 Tata McGraw Hill Publishing Co. Ltd. [Chapter 4,14].
4. Physical Chemistry, G.M. Barrow, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
5. Physical Chemistry 9th Ed.,Atkins, P. W. & Paula, J. de Atkins Oxford UniversityPress2011.
6. University Chemistry, Bruce Mahan.
7. Textbook of Physical Chemistry, Sharma and Puri.
8. Fundamentals of analytical chemistry, 8th edition, Skoog, West, Holler and Crouch.
9. Physical Chemistry, 3rd Ed., Ball, D. W. Cengage India.2012.
10. *Physical Chemistry 4th Ed.,* Castellan, G. W. Narosa 2004.
11. *Chemical Kinetics*, J. LaidlerK. Pearson Education: New Delhi 2004.
12. Rogers, D. W. *Concise Physical Chemistry* Wiley 2010.

CIA I: Short answer questions and cross-word **20 MARKS**

CIA II: MCQ **20 MARKS**

Template of Question Paper

CONCEPTS OF PHYSICAL AND ANALYTICAL CHEMISTRY I COURSE: S.CHE.1.01

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	4	4	12	20
II	6	8	6	20
III	3	7	10	20
TOTAL MARKS PER OBJECTIVE	13	19	28	60
% WEIGHTAGE	22	32	46	100

END SEMESTER PAPER PATTERN:

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

Total number of questions: 3 [all compulsory] of 20 marks each
1 question per unit.
Question set out of 30 marks[50% internal choice]
Sub questions will not exceed 5 marks.

SEMESTER I **COURSE: S.CHE.1.02**
FUNDAMENTALS OF INORGANIC AND ORGANIC CHEMISTRY I [45 LECTURES]

LEARNING OBJECTIVES

1. To reinforce the basics of Inorganic Chemistry with special reference to atomic structure, periodic table and periodicity of properties.
2. To study the chemistry of the 's' block elements with emphasis on physical and chemical properties.
3. To understand the anomalous behaviour of Lithium and Berylium and the diagonal relationship.
4. To study the trends of properties of the 'p' block elements.
5. To understand Group 18 elements.
6. To understand the principles and theory in Qualitative Analysis of a mixture of radicals especially when they interfere with each other in the detection.
7. To correctly name an organic compound using IUPAC nomenclature and to accurately represent an organic compound given a IUPAC name.
8. To introduce mechanism of organic reactions and to learn to classify reaction types and intermediates.
9. To investigate nucleophilic substitution as well as elimination reactions in detail including a comparative analysis.

UNIT I: Fundamentals of Inorganic Chemistry and Chemistry of s-block elements (15L)

1.1:Atomic Structure (3L)

Bohr's theory of Hydrogen atom, wave theory, Heisenberg's Uncertainty Principle, orbitals (shapes of s,p and d orbitals), quantum numbers.

1.2: Periodic Table and Periodicity of properties (3L)

Arrangement of elements in the long form of the periodic table, correlation of classification of elements into s, p, d and f-block on the basis of electronic configuration, Pauli's Exclusion Principle, Aufbau Principle and Hund's Rule of maximum multiplicity, anomalies in electronic configuration.

1.3: Periodic Properties (4L)

1.3.1: Atomic and ionic radii, ionization energy, electron affinity, effective nuclear charge and calculations using Slater's Rule, electronegativity and its determination using Mulliken's and Pauling's method (numerical problems expected), metallic and non-metallic character, oxidation states, melting / boiling points, colour, magnetic properties, polarizability.

1.3.2: Trends in the periodic table and applications in predicting and explaining chemical behaviour.

1.4: Chemistry of 's' block (Groups 1 and 2) (5L)

1.4.1: Position of elements in the periodic table, electronic configuration, trends in the properties with respect to family relationship, physical and chemical properties, ionization potential (charge to size ratio), electronegativity, polarizing power, oxidation state, hydration energy of ions.

1.4.2: Anamolous behaviour of Li and Be and diagonal relationship.

1.4.3: General methods of preparation of organolithium and organomagnesium compounds with applications.

UNIT II: Chemistry of 'p' block and Group 18 elements and theory of Qualitative Analysis **(15L)**

2.1: Chemistry of 'p' block elements **(4L)**

Position of elements in the periodic table, electronic configuration, trends in periodic properties with respect to family relationship, physical and chemical properties, ionization potential (charge to size ratio), electronegativity, oxidation state and metallic character.

2.2: Chemistry of Group 18 **(3L)**

History, peculiar properties of Helium, clathrate compounds, preparation of Xenon compounds.

2.3: Principles involved in Qualitative Analysis **(8L)**

2.3.1: Use of borax, sodium carbonate, cobalt nitrate, hydrogen sulphide and ammonium chloride in qualitative analysis.

2.3.2: Detection of the following acid radicals in presence of each other: carbonate, sulphite, chloride, bromide, iodide, nitrite and nitrate.

UNIT III: Fundamentals of Organic Chemistry **(15L)**

3.1: IUPAC nomenclature: ALIPHATIC system only (including cyclic systems) with multiple functional groups. **(2L)**

3.2: Geometry and structure of sp^3, sp^2 and sp hybridized carbon, nitrogen and oxygen atoms and some common functional groups eg. carbonyl and cyano. **(2L)**

3.3: Applications of electronic factors **(4L)**

3.3.1: Impact of inductive effect on pK_a and pK_b.

3.3.2: Resonance in organic compounds.

3.3.3: Hyperconjugation and effect on stability of carbocation and carbon radicals.

3.4: Reaction Mechanism **(7L)**

3.4.1: Introduction including bond fission, classification of reactions, reagents and intermediates .

3.4.2: Structure and stability of carbocations, carbanions and carbon radicals.

3.4.3: Mechanism of nucleophilic substitution, SN_1, SN_2 and SN_i. Effect of substrate, nucleophile, leaving group and solvent on rate of reaction.

3.4.4: Elimination Reactions E_1 and E_2.

3.4.5: Rearrangements of intermediates [hydride and methyl shift].

3.4.6: Elimination v/s Substitution, emphasis on factors that influence substitution / elimination.

REFERENCES:

1. Organic Chemistry, R.T. Morrison and R.N. Boyd, 6th Edition, Pearson Education.
2. Organic Chemistry, T.W.G. Solomon and C.B. Fryhle, 8th Edition, John Wiley & Sons.

3. Organic Chemistry, Paula Y. Bruice, Pearson Education, 2008.
4. Organic Chemistry, John McMurray
5. Organic Chemistry, L.G.Wade Jr.,
6. Concise Inorganic Chemistry, J.D. Lee, 5th edition, Oxford Press.
Advanced Inorganic Chemistry, Volume I, S.Prakash, G.D. Tuli, S.K.Basu, R.D.Madan.
7. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson, 3rd edition, 1977.
8. Inorganic Chemistry, James E. Huheey, 3rd edition, Harper & Row Publishers, Asia, Pte Ltd., 1983.
9. Inorganic Chemistry, D. F. Shriver, P. W. Atkins and C. H. Langford, 3rd edition, Oxford University Press,1999.
10. Theoretical Inorganic Chemistry, C. M. Day & J. Selbin, Affiliated East West Press Pvt. Ltd., 1985.
11. Advanced Inorganic Chemistry, Volume I and II, Bahl, Tuli and Anand.

CIA I: Objective and short answer questions **20 MARKS**

CIA II: MCQ **20 MARKS**

Template of Question Paper

FUNDAMENTALS OF INORGANIC AND ORGANIC CHEMISTRY I COURSE:S.CHE.1.02

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	10	06	04	20
II	10	06	04	20
III	04	08	08	20
TOTAL MARKS PER OBJECTIVE	24	20	16	60
% WEIGHTAGE	40	33	27	100

END SEMESTER PAPER PATTERN:

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

Total number of questions: 3 [all compulsory] of 20 marks each
1 question per unit.
Question set out of 26-28 marks with internal choice.
Sub questions of 2-3 marks.

PRACTICAL CHEMISTRY **Course No. S.CHE.1.PR**

LEARNING OBJECTIVES:

1. **To learn to perform experiments that have specific aims 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.**

SEMESTER I : COURSE 1
Volumetric Estimations
Chemical Kinetics

SEMESTER I : COURSE 2
Organic Purification
Gravimetric Estimation

COURSE 1:

VOLUMETRIC ESTIMATIONS:
Determination of percentage composition of a mixture of Na_2CO_3 + $NaHCO_3$.
Determination of percentage composition of a mixture of Oxalic acid + Potassium oxalate.
Estimation of Fe^{2+} versus $K_2Cr_2O_7$ using an internal indicator (diphenylamine).

CHEMICAL KINETICS:
1. To investigate the hydrolysis of methyl acetate in HCl and identify the rate constant graphically as well as by calculations.
2. To identify the relative strength of HCl and H_2SO_4 using hydrolysis of methyl acetate.

COURSE 2:

ORGANIC PURIFICATION :
1. Organic compounds to be purified by crystallization using water and aqueous alcohol as solvent system , purity to be confirmed by melting point and the yield obtained to be calculated.
2. Determination of mixed melting point also to be included.

GRAVIMETRIC ESTIMATION:
1. To study the effect of heat on the following mixtures:
   a) NH_4Cl + $BaSO_4$ and b) Na_2CO_3 + $NaHCO_3$
   and to calculate the percentage composition of the mixture.
2. To determine the water of crystallization of hydrated salts

❖ **CIA AND END SEMESTER PRACTICAL EXAMINATION**

COURSE 1: Volumetric Estimations + Organic Purification
COURSE 2: Chemical Kinetics + Gravimetric Estimation

Journal: 5 marks per course.

CIA : 15 marks per course.

Duration: 3 periods to be conducted during regular practicals by the faculty-in-charge
CIA for each course will be an exercise to test a practical skill (Qualitative and Quantitative).

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

Duration: 3 hours. Students are to perform two experiments **(one per course).**

Batch Size: Maximum 20 students per batch.

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St. Xavier's College – Autonomous Mumbai

Syllabus for 2nd Semester Course in CHEMISTRY(June 2014 onwards)

Contents: Theory Syllabus for Courses:

SYLLABUS UNDER AUTONOMY
CHEMISTRY

SEMESTER II **COURSE: S.CHE.2.01**

CONCEPTS OF PHYSICAL AND ANALYTICAL *CHEMISTRY* II [45 LECTURES]

LEARNING OBJECTIVES

1. To study and understand the tenets of thermodynamics pertaining to First and Second Laws of thermodynamics.
2. To understand operation of Carnot cycle in order to determine thermodynamic efficiency.
3. Significance and mathematical definition of entropy.
4. To understand limitation of Second Law/ Necessity to introduce work functions A and G.
5. To correlate free energy change and spontaneity of a process.
6. To understand and be able to elucidate the difference between molecular and atomic spectra and understand various types of spectroscopy.
7. To understand the basic concepts involved in qualitative analysis and solve the numerical problems based on these concepts.
8. To understand the fundamentals involved in various titrimetric analysis.

Unit I: Chemical Thermodynamics (15 L)

1.1.1: Recapitulation of some important mathematical concepts: derivatives, rules of differentiation and partial differentiation, algebraic, logarithmic and exponential functions. Integration; rules of integration, algebraic and exponential functions. ***(Self Study)***

1.1.2: Intensive and extensive properties, state and path functions, isolated, closed and open systems, zeroth law of thermodynamics (definition only).

1.1.3: First Law of thermodynamics: Definition, relation and comparison between heat capacities, calculations of *q*, *w*, *E* and *H* for reversible, irreversible and free expansion of ideal gases under isothermal and adiabatic conditions, limitations of first law and need for introducing new functions. (numerical problems expected)

1.1.4: Second Law of thermodynamics: Carnot cycle, mechanical efficiency, entropy changes for system and surroundings for reversible and irreversible processes, entropy changes for an ideal gas in isothermal, isobaric and isochoric processes, entropy changes in chemical reactions, entropy changes accompanying state change, physical significance of entropy, need for introducing new functions. (numerical problems expected)

1.1.5: Free Energy Functions: Gibbs and Helmholtz energy; variation of *G* and *A* with *P*, *V* and *T*; Gibbs energy change and spontaneity, exergonic and endergonic reactions, Gibbs-Helmholtz equation, thermodynamic equation of state. (numerical problems expected)

Unit II: Introduction to Spectroscopy (15 L)

2.1.1: Physical quantities and their dimensions: International system of units, derived units, subsidiary units, prefixes for S.I. units, some important conversion factors.

2.1.2: Interaction of low energy radiation with matter: Electromagnetic spectrum, quantisation of energy, absorption of radiation, absorption process, absorbance, transmittance, Beer's law, absorption spectrum, atomic absorption, molecular absorption, limitations of Beer's Law, Beer - Lambert's Law and its applications.

2.1.3: Emission of electromagnetic radiation: Emission spectra, line spectra, band spectra, continuous spectra, effect of concentration on line and band spectrum, emission by fluorescence and phosphorescence (introduction only), electronic, vibrational and rotational energy levels and transitions in atoms and molecules.

2.1.4: Electronic Spectra and Molecular Structure: Kinds of transitions, significance and applications of various types of spectroscopies (qualitative discussion only).

Unit III: Analytical Chemistry (15 L)

3.1: Principles of Qualitative Analysis (9 L)

3.1.1: Buffer solutions: types of buffers, derivation of Henderson–Hesselbelch equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry (numerical problems expected).

3.1.2: Solubility product, factors affecting precipitation equilibria (solubility product) in qualitative analysis: common ion effect, pH, complexation, diverse ion effect, oxidation states (numerical problems expected).

3.2: Volumetric Analysis (6 L)

3.2.1: Classification of volumetric analysis (basic concepts only) (1 L)

3.2.2: Acid base (neutralisation) titrations: (1 L)

Theory of indicators, theory of acid base indicators, mixed and universal indicators, explaination of the shapes of neutralisation curves for strong acid - strong base, weak acid - strong base, weak base - strong acid, weak acid - weak base, choice of indicators (numerical problems expected).

3.2.3: Oxidation-Reduction Titration: (1 L)

Principle and only theoretical discussion (using suitable examples), detection of end points, numerical problems.

3.2.4: Complexometric Titration: (1 L)

Principle (using suitable examples), standardisation, detection of end point.

3.2.5: Iodometry and Iodimetry: (1 L)

General discussion, detection of end point, difference between iodometry and iodimetry.

3.2.6: Precipitation Titration: (1 L)

Principle and only theoretical discussion (using suitable examples), detection of end point.

REFERENCES:

1. Mathematical preparation for physical Chemistry By F. Daniel, Mc. Graw Hill publication.
2. University General Chemistry. By C.N. R. Rao Mc. Millan Publication.
3. Principles of Physical Chemistry. By Maron and Pruton 4th Ed. Oxford and IBH publication.
4. Physical Chemistry. By G.M. Barrow.
6. Peter, A. & Paula, J. de. *Physical Chemistry 9th Ed.,* Oxford University Press 2011.
7. Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa 2004.
8. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall 2012.
9. McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi 2004.
10. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY 2011.Page **19** of **80**
11. Levine, I .N. *Physical Chemistry 6th Ed.,*Tata Mc Graw Hill 2010.
12. Metz, C.R. *2000 solved problems in chemistry,* Schaum Series 2006.

CIA I: Objective and short answer questions **20 MARKS**

CIA II: MCQ **20 MARKS**

Template of Question Paper

CONCEPTS OF PHYSICAL AND ANALYTICAL *CHEMISTRY* II **COURSE: S.CHE.2.01**

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	4	4	12	20
II	6	8	6	20
III	3	7	10	20
TOTAL MARKS PER OBJECTIVE	13	19	28	60
% WEIGHTAGE	22	32	46	100

END SEMESTER PAPER PATTERN:

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

Total number of questions: 3 [all compulsory] of 20 marks each
1 question per unit.
Question set out of 26-28 marks with internal choice.
Sub questions of 2-3 marks.

SEMESTER II **COURSE: S.CHE.2.02**

FUNDAMENTALS OF INORGANIC AND ORGANIC CHEMISTRY II [45 LECTURES]

LEARNING OBJECTIVES:

1. To understand some characteristic properties of elements of groups 13 to 17.
2. To study the chemistry of representative elements of groups 13 [aluminium] and 14 [silicon].
3. To understand some properties of a few selected compounds of groups 15,16 and 17.
4. To introduce manufacturing processes of bulk chemicals [ammonia and sulphuric acid].
5. To understand the concept of isomerism, and represent the structures of organic compounds
6. To study properties of unsaturated hydrocarbons.
7. To study the reactivity of various aliphatic organic compounds and their interconversions in 5 – 6 steps.

UNIT I: CHEMISTRY OF p-BLOCK ELEMENTS (15 L)

1.1: Group 13 (3 L)

1.1.1: Structures of electron-deficient compounds with reference to boron hydrides, inert pair effect.

1.1.2: Chemistry of Aluminium compounds – halides, oxides and alkyls.

1.2: Group 14 (3L)

1.2.1: Catenation and allotropy with special reference to carbon.

1.2.2: Chemistry of silicon, preparation and uses of silicones.

1.3: Groups 15 and 16 (6L)

1.3.1: Physical properties of hydrides of elements of groups 15 and 16 with respect to hydrogen bonding.

1.3.2: Manufacture of bulk chemicals - ammonia by Haber's process and sulphuric acid by Contact process [principles, reactions and flow chart expected].

1.4: Group 17 (3L)

1.4.1: Pseudohalogen chemistry with respect to comparison with halogens, preparation and uses- cyanogens, thiocyanogens and selenocyanogens.

UNIT II: STEREOCHEMISTRY AND HYDROCARBON CHEMISTRY (15L)

2.1: Stereochemistry

2.1.1: Isomerism: Types of isomerism; structural isomerism (chain , position and functional) and stereoisomerism. **(1L)**

2.1.2: Chirality: Configuration, chirality and enantiomers, stereogenic / chiral centre, asymmetric carbon atom, representation of configuration by flying wedge formula and projection formulae - Fischer, Newmann and Sawhorse. **(2L)**

2.1.3: Stereochemistry of carbon compounds with one and two similar and dissimilar asymmetric carbon atoms, enantiomers, diastereomers and racemic mixtures and their properties; threo, erythro and meso isomers. **(2L)**

2.1.4: Geometrical isomerism due to restricted rotation around carbon – carbon double bond and cycloalkanes [disubstituted 3- and 4-membered cycloalkanes], E-Z nomenclature. **(2L)**

2.1.5: Conformations; difference between conformation and configuration, conformations of ethane, propane and n-butane. **(2L)**

2.2: Hydrocarbon Chemistry

2.2.1: Alkanes - mechanism of halogenation. **(1L)**

2.2.2: Reactions of alkenes and cycloalkenes: hydrogenation, halogenation, addition of HX – Markovnikov and anti- Markovnikov additions with mechanism. **(2L)**

2.2.3: Reactions of alkadienes – Diels-Alder reaction and 1,2- and 1,4- addition of X_2 [mechanism is not expected] **(1L)**

2.2.4: Reactions of alkynes: hydration, addition of HX, selective hydrogenation to cis- and trans- alkenes, acidity of terminal alkynes, preparation of metal acetylides and their alkylation. **(2L)**

UNIT III: FUNCTIONAL GROUP CHEMISTRY (15 L)

3.1: Reactions of alkyl halides with: aqueous alkali, alcoholic alkali (dehydrohalogenation), potassium cyanide, conversion of alkyl cyanide further to primary amine and carboxylic acid, ammonia, silver salt of carboxylic acid, sodium alkoxide, Wurtz reaction. **(4L)**

3.2: Reactions of alcohols with sodium metal, dehydration, esterification, oxidation of primary, secondary and tertiary alcohols. **(2L)**

3.3: Reactions of aldehydes and ketones:

a) Addition to carbonyl compounds:

i) HCN and ii) $NaHSO_3$

b) Condensation reaction with hydroxylamine

c) Oxidation with acidic $K_2Cr_2O_7$ and PCC

d) Reduction of aldehydes and ketones:

i) catalytic reduction ii) Clemmensen reduction iii) reduction with $LiAlH_4$ and $NaBH_4$ iv) Wolff - Kishner reduction **(4L)**

3.4: Reactions of carboxylic acids: Formation of salt [comparative 'acidity'], anhydride, amide, acid halide, ester and alkane. **(2L)**

3.5: Reactions of amines: Acetylation of amines with acetic anhydride and acetyl chloride, action of nitrous acid on primary / secondary / tertiary amines, alkylation of primary / secondary / tertiary amines yielding quaternary ammonium salts. **(3L)**

Note : Each reaction should be studied with respect to compounds upto 6 carbon atoms. Based on these and the reactions of alkanes, alkenes and alkynes, multi-step synthesis of compounds having one functional group are expected, the number of carbon atoms in each being not more than six. No mechanisms are expected.

REFERENCES:

1. Organic Chemistry, R.T. Morrison and R.N. Boyd, 6th Edition, Pearson Education.
2. Organic Chemistry, T.W.G. Solomon and C.B. Fryhle, 8th Edition, John Wiley & Sons.
3. Organic Chemistry, Paula Y. Bruice, Pearson Education, 2008.
4. Organic Chemistry, John McMurray.
5. Organic Chemistry, L.G.Wade Jr.
6. Concise Inorganic Chemistry, J.D. Lee, 5th edition, Oxford Press.
7. Advanced Inorganic Chemistry, Volume I, S.Prakash, G.D. Tuli, S.K.Basu, R.D.Madan.
8. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson, 3rd edition, 1977.
9. Inorganic Chemistry, James E. Huheey, 3rd edition, Harper & Row Publishers, Asia, Pte Ltd., 1983.
10. Inorganic Chemistry, D. F. Shriver, P. W. Atkins and C. H. Langford, 3rd edition, Oxford University Press,1999.
11. Theoretical Inorganic Chemistry, C. M. Day & J. Selbin, Affiliated East West Press Pvt. Ltd., 1985.
12. Advanced Inorganic Chemistry, Volume I and II, Bahl, Tuli and Anand.

CIA I: Objective and short answer questions **20 MARKS**

CIA II : MCQ **20 MARKS**

Template of Question Paper

FUNDAMENTALS OF INORGANIC AND ORGANIC CHEMISTRY II **COURSE: S.CHE.2.02**

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	10	06	04	20
II	10	06	04	20
III	04	08	08	20
TOTAL MARKS PER OBJECTIVE	24	20	16	60
% WEIGHTAGE	40	33	27	100

END SEMESTER PAPER PATTERN:

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

Total number of questions: 3 [all compulsory] of 20 marks each
1 question per unit.
Question set out of 26-28 marks with internal choice.
Sub questions of 2-3 marks.

PRACTICAL CHEMISTRY **Course No. S.CHE.2.PR**

LEARNING OBJECTIVES:

1. **To learn to perform experiments that have specific aims with the correct techniques.**
2. **To develop skills of observation, recording and analyzing data.**
3. **To learn to present the experimental work in a systematic manner.**

SEMESTER II: COURSE 3

Physico-Chemical Exercises
Commercial Analysis

SEMESTER II: COURSE 4

Organic Preparations
Semi-micro Inorganic Qualitative Analysis

COURSE 3:

VISCOMETRY:
To determine co-efficient of viscosity of some organic liquids.

STALAGMOMETRY:
Determination of Surface Tension of some organic liquids.

SEMI-MICRO INORGANIC QUALITATIVE ANALYSIS:
Inorganic mixtures containing four radicals, 2 cations and 2 anions.
Preliminary dry tests, preparation of solution for analysis and wet tests for confirmation of the presence of the radicals.

COURSE 4:
ORGANIC PREPARATIONS [including calculation of yield and melting point]:
i) Anhydride from Phthalic acid
ii) Hydrolysis of amides
iii) Bromination of acetanilide

COMMERCIAL ANALYSIS :
To determine the strength of commercial samples of antacid, vinegar, acetic acid and HCl [standard succinic acid solution to be prepared by the students to standardize the given NaOH solution].

CIA AND END SEMESTER PRACTICAL EXAMINATION

COURSE 3: Physico-Chemical Exercises + Commercial Analysis

COURSE 4: Organic Preparations +Semi-micro Inorganic Qualitative Analysis

Journal: 5 marks per course.

CIA: 15 marks per course.

Duration: 3 periods to be conducted during regular practicals by the faculty-in-charge.
CIA for each course will be an exercise to test a practical skill (Qualitative and Quantitative).

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

Duration: 3 hours. Students are to perform two experiments **(one per course).**

Batch Size: Maximum 20 students per batch.

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St. Xavier's College – Autonomous Mumbai

Syllabus for 3rd Semester Course in Chemistry (June 2015 onwards)

Contents: Theory Syllabus for Courses:

SYLLABUS UNDER AUTONOMY
CHEMISTRY

SEMESTER III **COURSE: S.CHE.3.01**
PHYSICAL AND ANALYTICAL CHEMISTRY I **[45 LECTURES]**

LEARNING OBJECTIVES

1. To understand some more concepts of thermodynamics from a chemist's viewpoint.
2. To predict the feasibility of a reaction.
3. To understand concepts involved in electrolytic cells and their applications.
4. To motivate students to solve numerical problems with different systems of units which illustrate the applicability of these concepts in chemistry.
5. To provide an introduction to analytical chemistry and information about latest developments in analytical techniques widely used in quality control and R&D of different types of chemical industries.

Unit I **(15 L)**

1.1: Chemical Thermodynamics

1.1.1: Recapitulation: Gibbs' free energy and Helmholtz free energy, Gibbs–Helmholtz equation (Derivation is not expected).

1.1.2: Physical equilibrium involving pure substances, Clapeyron's equation and variation of vapour pressure with temperature, Clausius- Clapeyron equation and its application. partial molal properties with special reference to volume and free energy, introduction to chemical potential and its significance, Gibbs - Duhem equation.

1.1.3: Variation of chemical potential with pressure and temperature, fugacity, activity and their relationship with chemical potential, activity and activity coefficient.

1.1.4: Techniques to achieve low temperature: (i) Joule-Thomson effect, concept of inversion temperature (Derivation is not expected), derivation of Joule -Thomson coefficient (ii) Adiabatic demagnetization technique.

1.1.5: Thermodynamic derivation of Law of Mass Action, K_p, K_c and their inter-relation, van't Hoff's reaction isotherm and reaction isochore.

1.2: Self study

Numerical problems based on first and second law of thermodynamics, Gibbs' free energy and Helmholtz free energy, Gibbs - Helmholtz equation.

Unit II **(15 L)**

2.1: Solutions of Electrolytes

2.1.1: Introduction of the terms involved: electronic and electrolytic conductors, conductivity, resistivity, specific resistivity, measurement of conductivity of solutions, conductometer, conductivity cell, cell constant, specific conductivity, molar conductivity and equivalent conductivity with their units in SI and C.G.S. systems.

2.1.2: Variation of molar conductivity with change in concentration of solution for strong and weak electrolytes. Arrhenius theory and Ostwald's dilution law for weak electrolytes.
Debye -Huckel theory for strong electrolytes (asymmetric and electrophoretic effect), concept of limiting molar conductivity.
2.1.3: Kohlrausch's law of independent migration of ions.
2.1.4: Applications of Kohlrausch's law: (i) Determination of limiting molar conductivity of weak electrolytes (ii) Determination of dissociation constant of a weak acid (iii) Determination of solubility of sparingly soluble salts.
2.1.5: Migration of ions, transport number, determination of transport number by i) Hittorf's method using unattackable electrodes (only qualitative explanation) ii) Moving boundary method. Use of coulometer, factors affecting the transport number of ions, relation between transport number and ionic conductivity of an ion.
2.1.6: Relationship between ionic mobility and ionic conductivity of an ion (Derivation is not expected).

2.2: Self study
Numerical problems based on all the above concepts.

Unit III Basic concepts of Analytical Chemistry (15 L)

3.1: Introduction to Analytical Chemistry (9L)
3.1.1: Scope and importance of analytical chemistry, analytical chemistry and chemical analysis, classification of analytical methods, classical and instrumental techniques, destructive and non-destructive testing, qualitative and quantitative analysis – an overview (introductory concepts only).
3.1.2: Steps involved in chemical analysis: selection of a method for analysis, obtaining a sample: sampling, importance of sampling, terms involved in sampling, sampling techniques, purpose of sampling, types of sample and sampling, pre-treatment, measurement, calculation, evaluation and presentation of results.

3.2: Use of Instrumental methods in Titrimetric analysis (6L)
3.2.1: Conductometric titrations
Basic principles, experimental set up, titration curves in the titration of :
(i) strong acid vs. strong base (ii) weak acid vs. strong base (iii) weak acid vs. weak base (iv) mixture of strong and weak acids vs. strong base (v) sodium chloride vs. silver nitrate (vi) barium hydroxide vs. magnesium sulphate. Advantages and limitations.
3.2.2: Potentiometric titration
Principle, concept of indicator electrode and different types of graphical methods to determine the equivalence point.

3.3: Self-study
Application of analytical methods in various fields such as chemical and pharmaceutical industries, environmental analysis and monitoring.

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2. Physical Chemistry: G.M. Barrow 6th Ed, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
3. Physical Chemistry : G.K. Vemulapalli (1997) Prentice Hall of India Pvt. Ltd., New Delhi.
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11. Properties of Liquids and Solutions: J.N. Murrell and E.A. Boucher, Wiley, 1982.
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CIA I: Short answer questions **20 MARKS**

CIA II: Assignment+ **20 MARKS**

St. Xavier's College, Mumbai

Dept. of ----------

ASSESSMENT OF WRITTEN ASSIGNMENT

NAME OF STUDENT :
TITLE OF ASSIGNMENT :
DATE:

Assessment Grid : Place one tick in each appropriate row. Overall mark should reflect the positions of ticks in the individual rows

100	ASSIGNMENT	80-100% (17 -20Marks)	60-80% (13- 16 Marks)	40- 60% (9-12 Marks)	20-40% (5-8 Marks)	0-20% (0-4 Marks)
30 %	ORGANISATION	Effective Presentation, Logical Format, Clear Statement of Ideas, Relevant Details, sequence of information and ideas could be easily followed	Few Problems	Many problems	Inadequate presentation, Ineffective format, Ineffective Communication of Ideas, Lack Relevant Details – But an attempt	No Attempt to organise
60%	CONTENT	Excellent - Impression of wide reading (research), good knowledge and comprehensive understanding. Evidence of thoughtful input. Ability to critique, Bibliography mentioned.	Good	Satisfactory	Poor	Very Poor
5 %	VOCABULARY	Richness of Vocabulary	Very good range of vocabulary with some errors	Good range of vocabulary with some errors	Small range of vocabulary with errors	Little or no effort has been made to demonstrate vocabulary knowledge
5%	GRAMMAR, SPELLINGS, MECHANICS	Grammar, Spellings, Punctuations Correct.	Very Few Errors	Some Errors	Many Errors	No effort

TOTAL MARKS FOR WRITTEN ASSIGNMENT: _____ OUT OF 20
COMMENTS:

NAME OF FACULTY MEMBER:_____
SIGNATURE: _____

St. Xavier's College, Mumbai

Dept. of ----------

Template of Question Paper

PHYSICAL AND ANALYTICAL CHEMISTRY I COURSE: S.CHE.3.01

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	5 - 7	6 - 8	7 - 9	20
II	5 - 7	6 - 8	7 - 9	20
III	6 - 8	6 - 8	6 - 8	20
TOTAL MARKS PER OBJECTIVE	16 - 22	18 - 24	20 - 26	60
% WEIGHTAGE	27 – 37	30 – 40	37 – 43	100

END SEMESTER PAPER PATTERN:

Total marks: 60 **Maximum Time: 2 hours**
Total number of questions: 3 [all compulsory] of 20 marks each
1 question per unit.
Questions set out of 30 marks [50 % internal choice]
Sub questions will not exceed 5 marks.

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SEMESTER III **COURSE: S.CHE.3.02**

INORGANIC AND INDUSTRIAL CHEMISTRY I [45 LECTURES]

LEARNING OBJECTIVES

1. To introduce students to the basic concepts involved in chemical bonding.
2. To help students to determine the shape of a molecule by applying VSEPR theory.
3. To encourage students to analyze and integrate concepts relevant to inorganic chemistry required to understand compound formations with special reference to Valence Bond Theory and Molecular Orbital theory.
4. To enable students to understand the theories of Acids and Bases.
5. To expose students to principles of Gravimetric Analysis.

UNIT I: Chemical Bonding (15 L)

1.1: Basics Of Chemical Bonding

1.1.1: Types of bonds: Ionic bond, covalent bond, single and multiple bonding, coordinate bond, sigma and pi-bonds, metallic bonds.

1.1.2: **Ionic bond:** Formation of ionic solids, lattice energy, solvation energy, Born-Haber cycle, Kapustinskii's equation (numerical problems expected).

1.1.3: Structures of some simple ionic solids like alkyl halides and stability of ionic structures based on radius ratio rules.

1.1.4: **Covalent bond:** Writing Lewis structures, formal charge and Lewis structures, concept of resonance and resonance energy, exceptions to the octet rule, bond enthalpy.

1.1.5: Sidgwick -Powell Theory.

1.1.6: **VSEPR concept:** Effect of lone pairs, effect of electronegativity, isoelectronic principle, shapes of chemical species on the basis of VSEPR theory.

1.1.7: **Metallic bond:** Theories of bonding in metals and free electron theory. MO or band theory, conductors, insulators and semiconductors.

UNIT II: Theories Of Chemical Bonding (15L)

2.1: Valence Bond Theory (8L)

2.1.1: Hybridisation: sp^3, sp^2, sp hybridization of carbon and nitrogen, sp^3 and sp^2 hybridization of oxygen in organic compounds; theory of hybridization with respect to equivalence of contributing atomic orbitals in the following examples: CH_4, NH_3 and H_2O.

2.1.2: Energetics of hybridization, types of hybridization and extent of d-orbital participation in molecular bonding. sp, sp^2, sp^3, sp^3d, sp^3d^2 , sp^3d^3 and sd with illustrations like $BeCl_2$, BF_3, $SiCl_4$, PCl_5, SF_6, IF_7, ClF_3, ICl_2^-, BrF_5, SO_2, SO_3 and $BaCl_2$.

2.1.3: Merits and Demerits of Valence Bond Theory.

2.2: Molecular Orbital Theory [M.O.T.] (7L)

2.2.1: Conditions for the formation of Molecular Orbitals.

2.2.2: Linear Combination of Atomic Orbitals to obtain Molecular Orbitals [LCAO-MO] Approach.

2.2.3: Application of the LCAO-MO to the formation of:

i) Homo- and Hetero-nuclear diatomic molecules and ions e.g. H_2, N_2, O_2, F_2, He_2, Li_2, Be_2, C_2, Ne_2, CO, NO, HCl, HF and CN^- .

ii) Occurrence of the Molecular ions O_2^+, O_2^{1-}, O_2^{2-} .

Discussion should include orbital interaction, stabilization of orbitals, bond order and correlation with stability, bond length, bond energy and magnetic properties.

UNIT III (15 L)

3.1: Theories of Acids and Bases (10L)

3.1.1: Recapitulation of Arrhenius theory.

3.1. 2: Lowry-Bronsted concept: Bronsted acids and bases, acid-base properties of water, pH, strength of acids and bases, weak acids and acid ionization constants, weak bases and base ionization constants, relationship between ionization constants of acids and their conjugate bases, diprotic and polyprotic acids.

Solvent levelling, solvent-system definition of acids and bases.

Lux-Flood, Lewis & Usanovich concept.

3.1.3: Lewis acid concept: Examples of Lewis acids and bases, characteristics of Lewis acids.

Pearsons concept of Hard and Soft Acids and Bases (HSAB), applications of HSAB.

3.1.4: Applications of acid-base chemistry: Superacids and superbases, heterogeneous acid-base reactions.

3.2: Gravimetric Analysis (5 L)

3.2.1: Definition and Types of Gravimetric Analysis.

3.2.2: Precipitation Gravimetry with respect to theory and practice.

(i) Solubility considerations: Common ion effect, diverse ion effect, pH and temperature.

(ii) Controlling particle size with respect to nucleation and rate of crystal growth.

3.2.3: Treatment of precipitates in Gravimetry: Digestion, Filtration and Washing, Drying and Ignition.

3.2.4: Use of Organic Reagents in Gravimetric analysis e.g. Dimethyglyoxime, Salicylaldoxime, Cupron, Oxine and Cupferron.

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9. Inorganic Chemistry, P. A. Cox, Bios Scientific Publishers Ltd.
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CIA I: Short answer questions / MCQ **20 MARKS**

CIA II: Problem solving / Presentations **20 MARKS**

Template of Question Paper

INORGANIC AND INDUSTRIAL CHEMISTRY I **COURSE : S.CHE.3.02**

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	6-8	6-8	6-8	20
II	6-8	6-8	6-8	20
III	6-8	6-8	6-8	20
TOTAL MARKS PER OBJECTIVE	18-24	18-24	18-24	60
% WEIGHTAGE	30 – 40	30 – 40	30 – 40	100

END SEMESTER PAPER PATTERN :

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

Total number of questions: 3 [all compulsory] of 20 marks each.
1 question per unit.
Questions set out of 30 marks [50% internal choice].
Sub questions will not exceed 5 marks.

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SEMESTER III **COURSE: S.CHE.3.03**

ORGANIC AND INDUSTRIAL CHEMISTRY I **[45 LECTURES]**

Learning Objectives:

1. To understand the mechanism of reactions involving the reactive intermediates.
2. To introduce the concepts of aromatic, non aromatic and anti aromatic compounds.
3. To study the mechanism of aromatic electrophilic substitution and the effect of substituents on the orientation of an incoming electrophile.
4. To familiarize the students with preparation, reactions and applications of aromatic hydrocarbons, haloarenes, phenols, ethers and epoxides and understand mechanisms of certain reactions.
5. To introduce the aspects of a chemical plant and study the sources and classification of fuels.

UNIT I **(15 L)**

1.1: Mechanism of Organic reactions **(6L)**

The mechanism of reactions involving the following reactive intermediates:

1.1.1: Carbocations: Different types of carbocations such as alkyl, allyl, benzyl.
S_N1 reaction. Electrophilic addition across an olefinic double bond.
Rearrangements : Wagner-Meerwein rearrangement, Pinacole-Pinacolone rearrangement.

1.1.2: Carbanions: Concept of carbon acid. Alkylation of carbon acids (active methylene compounds and terminal alkynes) using alkyl halides and synthetic applications of these reactions.
Reactions of Grignard reagents at sp^3carbon and carbonyl group. Aldol condensation with mechanism.

1.1.3: Carbon radicals: General reactions of radicals – abstraction, addition to C=C, combination, disproportionation. Addition of HBr to alkenes in presence of peroxide. Polymerization.

1.1.4: Carbenes: Generation of carbenes through alpha elimination, from diazoalkanes, from ketenes. Structure and stability of carbenes. Reactions: insertion into C-H bond and addition to olefin.

1.2 : **Tautomerism:** **(1L)**

Keto-enol tautomerism in aldehydes and ketones, acid and base catalysed enolisation, enol content and stabilized enols: β –ketoesters, β-diketones, phenols.

1.3: **Aromatic Electrophilic Substitution Reaction:** **(8L)**

1.3.1: Electronic structure and Huckel's Rule of aromaticity and its applications to carbocyclic and heterocyclic compounds, benzenoid and non-benzenoid compounds and ions including nomenclature of aromatic systems.
Concept of anti-aromaticity, non- aromaticity.

1.3.2: General mechanism of aromatic electrophilic substitution reaction with energy profile diagram.

1.3.3: Drawing resonance structures of mono-substituted benzenes - activated and deactivated aromatic rings.

1.3.4: Effect of electron-withdrawing and electron-donating substituents on the orientation of an incoming electrophile on the basis of – (i) electron-density distribution (ii) stability of intermediate.
Cases to be studied: Mono and disubstituted benzenes containing - alkyl, amino, hydroxyl, alkoxy, halo, acyl, nitro, carboxy groups, ortho / para ratio.

UNIT II **(15 L)**

2.1: Aromatic Hydrocarbons **(3L)**

2.1.1: Structures of benzene, naphthalene, linear and angular arenes.

2.1.2: Alkyl arenes: Preparation of alkyl arenes through reforming, Friedel-Crafts alkylation (with mechanism), using – olefins, alcohols, alkyl halides.

2.1.3: Reactions of alkyl arenes – side-chain oxidation, ring vs side-chain halogenation (mechanism).

2.2: Haloarenes **(4L)**

2.2.1: Preparations of haloarenes. Halogenation of arenes – Halogenation of benzene and substituted benzenes with molecular halogens (mechanism), limitations.

2.2.2: Reactions of haloarenes: Lack of reactivity of aryl halides under S_N1 and S_N2 reaction conditions. General mechanism (addition-elimination) of aromatic nucleophilic substitution reaction with energy profile diagram. Effect of substituents on the reaction - hydrolysis and amination of haloarenes. Benzyne intermediate mechanism (elimination-addition) of aromatic nucleophilic substitution reaction . Grignard reagent formation. Ullmann reaction.

2.2.3: Applications of aromatic halogen compounds.

2.3: Phenols **(3L)**

2.3.1: Preparation of phenols: Preparation from (i) halobenzenes (ii) from aromatic sulfonic acids (benzene and naphthalene sulfonic acids) (iii) isopropyl and 2-butylbenzene by hydroperoxide method.

2.3.2: Reactions of phenols: Acidity of phenols – effect of substituents on acidity of phenols. Salt Formation. Etherification – direct reaction with alcohol. Williamson synthesis. O-acylation. Halogenation, Nitration, Fries rearrangement of aryl carboxylates, Claisen rearrangement of allyloxyarenes.

2.3.3: Applications of phenols.

2.4: Ethers **(3L)**

2.4.1: Preparation: Dehydration of alcohols **(**mechanism), reactions of phenols with alcohols, Williamson synthesis (mechanism).

2.4.2: Reactions: Acid-catalyzed cleavage – reaction with HX (mechanism).

2.4.3: Applications: Applications of ethers, Crown ethers: Structure of 12-crown-4 and 18-crown-6 and their uses.

2.5: Epoxides: **(2L)**

2.5.1: Preparation: Oxidation of olefins – ethylene oxide. Reaction of peracids with olefins; from vicinal halohydrins.

2.5.2: Reactions**:** Reactivity. Ring opening reactions by nucleophiles
(a) in acidic conditions, hydrolysis, reaction with – HX, alcohol, HCN.
(b) In neutral or basic conditions: ammonia, amines, metal cyanides, Grignard reagents, alkoxides.

2.5.3: Applications of epoxides (including chiral epoxides).

UNIT III **(15 L)**

3.1: Chemical Industry **(4L)**

3.1.1: Introduction to aspects of a chemical plant, terminology [raw materials, intermediates, end products, by-products, waste-products], unit operations, unit processes [single and multiple], batch and continuous operations, block diagrams, flow diagrams.

3.2: Sources of Organic Compounds **(7L)**

3.2.1: Introduction

3.2.2: Solid – eg. Destructive Distillation, Coal Tar Refining.

3.2.3: Liquid – eg. Petroleum: characteristics, refining of petroleum [applying block / flow diagrams to unit processes involved in refining like cracking].

3.2.4: Gaseous - eg. Natural gas: production, conversion to methanol [manufacturing process].

3.2.5: Renewable Sources – (i) conversion of biomass into chemicals (ii) biofuels: types and brief description of a few representative examples [bioethanol, biodiesel].

3.3: Manufacture of Bulk Chemicals **(4L)**

3.3.1: Phenol, styrene and dodecylbenzene [including reactions and reaction conditions, block / flow diagram, description].

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23. Biomass for Renewable Energy, Fuels & Chemicals: Donald L. Klass, Academic Press, London, UK.

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

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

Template of Question Paper

ORGANIC AND INDUSTRIAL CHEMISTRY I **COURSE: S.CHE.3.03**

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	7	7	6	20
II	7	7	6	20
III	7	7	6	20
TOTAL MARKS PER OBJECTIVE	21	21	18	60
% WEIGHTAGE	35	35	30	100

END SEMESTER PAPER PATTERN:

Total marks: 60 **Maximum Time: 2 hours**
Total number of questions: 3 [all compulsory] of 20 marks each.
1 question per unit.
Questions set out of 30 marks [50 % internal choice].
Sub questions will not exceed 5 marks.

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PRACTICAL CHEMISTRY **Course No. S.CHE.3.PR**

LEARNING OBJECTIVES

1. **To learn to perform experiments that have specific aims 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.**

SEMESTER III :

COURSE 1: PHYSICAL CHEMISTRY
COURSE 2: INORGANIC CHEMISTRY
COURSE 3: ORGANIC CHEMISTRY

COURSE 1: PHYSICAL CHEMISTRY

CHEMICAL KINETICS:
To study the reaction between KI and $K_2S_2O_8$ using equal concentrations and unequal concentrations.

pH METRY:
pH metric titration of weak acid vs strong base and to determine pK_a value.

CONDUCTOMETRY:
Conductometric titration of strong acid vs strong base.
Conductometric titration of weak acid vs. strong base.

COURSE 2: INORGANIC CHEMISTRY

SEMI-MICRO QUALITATIVE ANALYSIS:

Analysis of mixtures containing 2 cations and 2 anions. Dry tests and wet tests to be performed.
Cations: Cu^{2+}, As^{3+}, Bi^{3+}, Pb^{2+}, Sn^{2+}. Sb^{3+}, Al^{3+}, Fe^{2+}, Fe^{3+}, Mn^{2+}, Cr^{3+}, Zn^{2+}, Ni^{2+},
Co^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, NH^{4+}, K^{+}
Anions: Cl^{-}, Br^{-}, NO_2^{-}, NO_3^{-}, CO_3^{2-}, SO_4^{2-}, PO_4^{3-} , $Cr_2O_7^{2-}$
At least 6 mixtures to be analyzed with interfering radicals. More emphasis to be placed on separation and detection of cations.

INORGANIC PREPARATIONS

1. Synthesis of $CuCl_2$. 2DMSO.
2. Preparation of (double salt) copper (II) ammonium sulfate $(NH_4)_2SO_4.CuSO_4.6H_2O$.
3. Synthesis of (complex) Tetrammine Copper (II) Sulphate hydrate $[Cu(NH_3)_4]SO_4.H_2O$.
4. Preparation of Double salt (Mohr's salt).

COURSE 3: ORGANIC CHEMISTRY

1. Derivative preparation: The exercise is aimed at imbibing the concept of derivative preparation as a method of identifying a given compound from a set of compounds having the same functional group. Based on the m.p. identify the given compounds looking at the chart. About 500 mg of a suitable compound be given. The candidate will prepare the given derivative. Crystallization is expected. M.P. of the dried derivative should be taken and appropriate inference drawn. The derivative preparation should involve one of the following reactions: (a) oxime preparation (b) nitration of aromatic compounds (c) N/O-acylation (d) Schiff base preparation (e) 2,4-DNP hydrazone formation (f) oxidation of aromatic compounds.

2. Estimation of an Organic Compound: The following estimations be given:

a) Estimation of formaldehyde by oxidation using iodine and alkali.
b) Estimation of aniline by bromination using brominating solution.
c) Estimation of acetamide by hydrolysis.
d) Saponification Value of the given oil.

Note:

(1) A minimum of three estimations be done by the candidates.

(2) For the estimations, the concentrations and the quantities be reduced. For dilution a standard flask of 100 cm^3 capacity and for the transfer a pipette of 10 cm^3 capacity be used. The concentrations of the solutions be around 0.05N.

❖ CIA AND END SEMESTER PRACTICAL EXAMINATION

Course 1: Physical Chemistry - Exercise to test practical skills.

Course 2: Inorganic Chemistry - Exercise to test practical skills, qualitative /quantitative.

Course 3: Organic Chemistry - Exercise to test practical skills, qualitative /quantitative.

Journal: 5 marks per course.

CIA: 15 marks per course.

Duration: 4½ periods to be conducted during regular practicals by the faculty-in- charge.

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

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

Duration: 3 hrs per course. To be conducted at the end of the semester.

Batch size: Maximum 20 students per batch.

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St. Xavier's College – Autonomous Mumbai

Syllabus for 4th Semester Course in Chemistry (June 2015 onwards)

Contents: Theory Syllabus for Courses:

S.CHE.4.01 - PHYSICAL AND ANALYTICAL CHEMISTRY II

S.CHE.4.02 - INORGANIC AND INDUSTRIAL CHEMISTRY II

S.CHE.4.03 - ORGANIC AND INDUSTRIAL CHEMISTRY II

PRACTICAL COURSE SYLLABUS FOR S.CHE 4 PR

4th Semester Syllabus for Core Component Course in Chemistry, St. Xavier's College – Autonomous, Mumbai.

SYLLABUS UNDER AUTONOMY
CHEMISTRY

SEMESTER IV **COURSE: S.CHE.4.01**

PHYSICAL AND ANALYTICAL CHEMISTRY II **[45 LECTURES]**

LEARNING OBJECTIVES

1. Introducing the concept of phase rule to understand the behaviour of heterogeneous systems.
2. To understand basic principles involved in separation of liquid mixtures by distillation.
3. To understand the concept of steam distillation and its applications.
4. To give latest information and understanding of different types of electrodes used in various galvanic cells.
5. To understand Beer Lambert's law and its applications in various quantitative as well as qualitative analysis and the experimental procedure of spectroscopy.
6. To motivate the students to solve numerical problems.
7. To encourage students to use computer software like spreadsheet to plot the appropriate graph and obtain accurate results from experimental data.

Unit I: Electrochemistry **(15 L)**

1.1: Introduction to Electrolytic cell and Electrochemical cells (Galvanic /Voltaic cell).

1.2.1: Ion selective and ion specific electrodes, comparison, simple examples.
Types of ion specific electrodes: (i) Metal-metal ion electrode (ii) Gas electrode (including S.H.E.) (iii) Metal- metal insoluble salt electrode (including reference calomel electrode.) (iv) Redox electrode (v) Amalgam electrode.

1.2.2: Cell representation of galvanic cell from cell reactions and vice versa.
Concept of combination electrode : Glass electrode- construction and working (in brief).

1.3.1: Derivation of Nernst equation for the emf of a cell and hence for a single electrode potential, potential of glass electrode and quinhydrone electrode in terms of pH.
Determination of equilibrium constant from EMF measurements.
Thermodynamic parameters [ΔG, ΔH and ΔS] for the reaction taking place in a chemical cell.

1.3.2: Introduction to electrode concentration cell and electrolyte concentration cell.

1.4: Introduction to pH metric titrations. Titration curves for:(i) strong acid vs. strong base (ii) weak acid vs. strong base. Determination of equivalence point from titration curves (pH vs V, ΔpH/ ΔV vs. mean volume). Determination of K_a for weak monobasic acid. Advantages and limitations of pH-metry.

Self study: Numerical problems on calculation of pH of different types of acids, bases and buffer solutions.

Unit II: Phases in Equilibria (15 L)

2.1: Introduction to the terms in Phase Equilibria
Phase, components, degrees of freedom, Gibb's phase rule, phase diagram (with one suitable example).

2.2: Two component systems

2.2.1: Completely miscible liquid-liquid mixtures: Phase diagrams of ideal mixture: vapour pressure composition and temperature composition diagrams. Raoult's law, ideal solutions. Deviation from Raoult's law, positive and negative deviations (Numerical Problems expected).

2.2.2: Phase diagrams of non- ideal mixtures, azeotropes, distillation of azeotropic mixtures.

2.2.3: Partially miscible liquid-liquid mixtures: only introduction and examples.

2.2.4: Completely immiscible liquid-liquid mixtures: Steam distillation and its applications (Numerical Problems expected).

2.3: Physico-chemical aspect solvent extraction
Nernst distribution law: partition coefficient and distribution ratio, solute undergoing association and dissociation. Derivation of expression for amount of solute remaining unrestricted in the aqueous phase after multiple extractions with an organic solvent (Numerical Problems expected).

Self study: Additional numerical problems on above topics, one component system: CO_2 system, breaking of azeotropes.

Unit III: Visible Spectroscopy and Separation Techniques (15 L)

3.1: Visible spectroscopy (6L)

3.1.1: Recap: Terms involved: radiant power, absorbance, transmittance, wavelength of maximum absorption. Beer – Lambert's Law [derivation expected] , molar absorptivity Deviations from Beer –Lambert's law.

3.1.2: Components of an optical instrument, photometer and spectrophotometer, construction and working of a single beam colorimeter.

3.1.3: Photometric titrations
Basic principles and titration curves. Advantages and Limitations.

3.2: Introduction to Separation Techniques (7L)

3.2.1: Solvent extraction
Principle, separation factor, criteria for selection of solvent.

3.2.2: Chromatography
Introduction to chromatographic techniques, basic principles, classification of chromatographic techniques**.**

3.3: Introduction to analytical method validation (2L)
Performance characteristics of an analytical method: accuracy, precision, detection limit, dynamic range, sensitivity, selectivity, use of calibration curve for quantitative analysis.

Self Study: Applications of Colorimetry and numerical problems based on Spectroscopy.

REFERENCES

1. The Elements of Physical Chemistry: P.W. Atkins (1996) 2nd Ed, Oxford University Press, Oxford.
2. Physical Chemistry: G.M. Barrow 6th Ed, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
3. Physical Chemistry : G.K. Vemulapalli (1997)Prentice Hall of India Pvt. Ltd., New Delhi.
4. Physical Chemistry: G.W. Castellan, 3rd ed., Narosa Publishing House, New Delhi.
5. Text Book of Physical Chemistry, S. Glasstone, Affiliated East-West press Pvt.Ltd., New Delhi.
6. Thermodynamics for Chemist: S. Glasstone Affiliated East-West Press Pvt. Ltd., New Delhi.
7. Physical Chemistry: K.J. Laidler and J.H. Meiser, 2nd ed.(First Indian ed.1999) CBS Publishers and Distributors, New Delhi.
8. Physical Chemistry: Ira N.Levine (1995), 4th ed., McGraw Hill, Inc
9. Phase equilibria –Reisman Arnold, Edited by Ernest M. Loebe, New York and London Academic Press.
10. Phase Rule: F.D. Ferguson and P.K. Jones, (Bitterworth Publisher).
11. Properties of Liquids and Solution: J.N. Murrell and E.A. Boucher, Wiley, 1982.
12. Introduction to Principles of Heterogeneous Catalysis: Thomas J.M., and Thomas W.J. Academic, 1967.
13. An Introduction to Electrochemistry – Samuel Glasstone Affiliated East-West Press.
14. Modern Electrochemistry: J. O'M Bokris and A.K.N. Reddy,Maria Gamboa – Aldeco, 2nd ed, 1st Indian reprint, Springer, (2006) .
15. Principles and Applications of Electrochemistry : D.R.Crow, 4th ed., Blackie, London, (1994) .
16. Instrumental Methods of Chemical Analysis: Chatwal and Anand, 5th ed.,Himalaya Publication.
17. 2000 Solved Problems in Physical Chemistry : S.R.Metz, Tata McGraw Hill Publishers, New Delhi.
18. A Textbook of Physical Chemistry, K.L. Kapoor, MacMillan India Ltd.
19. Physical Chemistry: N.B.Singh, Shiva Saran Das, Rmji Singh, New Age International Pvt. Ltd.,Publishers, New Delhi. (2003).
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21. G.D.Christian, Analytical Chemistry, 6th ed. John Wiley &Sons, new York, 2003.
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4th Semester Syllabus for Core Component Course in Chemistry, St. Xavier's College – Autonomous, Mumbai.

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

CIA II: Numerical Problems **20 MARKS**

Template of Question Paper

PHYSICAL AND ANALYTICAL CHEMISTRY II **COURSE: S.CHE.4.01**

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	5 - 7	6 - 8	7 - 9	20
II	5 - 7	6 - 8	7 - 9	20
III	6 - 8	6 - 8	6 - 8	20
TOTAL MARKS PER OBJECTIVE	16 - 22	18 - 24	20 - 26	60
% WEIGHTAGE	27 – 37	30 – 40	37 – 43	100

END SEMESTER PAPER PATTERN:

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

Total number of questions: 3 [all compulsory] of 20 marks each
1 question per unit
Questions set out of 30 marks [50 % internal choice]
Sub questions will not exceed 5 marks

SYLLABUS UNDER AUTONOMY
CHEMISTRY

SEMESTER IV **COURSE: S.CHE.4.02**

INORGANIC AND INDUSTRIAL CHEMISTRY II **[45 LECTURES]**

LEARNING OBJECTIVES

1. To introduce students to Co-ordination Chemistry, elucidating concepts like the theories involved in "bonding" and features of coordination compounds.
2. To introduce students to organometallic compounds.
3. To understand a few bioinorganic molecules.
4. To introduce students to the basic concepts involved in metallurgy and corrosion.
5. To study Environmental Chemistry with reference to some common pollutants.

UNIT I: **(15L)**

1.1: Co-ordination Chemistry **(8L)**

1.1.1: Introduction to Co-ordination Compounds. Distinction between Double salts and Co-ordination compounds.

1.1.2: Terms involved in Co-ordination Chemistry: Co-ordination Compound, central metal atom or ions, complex compound, Complex ion, Ligand: Definition, Classification, Chelates and chelating agents, Co-ordination Sphere, Co-ordination Number, Charge of the complex ion, calculation of oxidation and coordination number of metal etc.

1.1.3: Werner's Theory – postulates.

1.1.4: IUPAC nomenclature of Co-ordination compounds.

1.1.5: Sidwick Model (Eighteen electron rule), EAN rule limitations.

1.1.6: Isomerism in Co-ordination compounds:
Structural isomerism (ionization, hydrated, linkage ligand, coordination position, polymerization isomers) and Geometrical isomerism and optical isomerism.

1.2: Bonding in Co-ordination Compounds: **(7L)**

1.2.1: Pauling's Valence Bond Theory – Assumptions, concept of hybridization, Limitations and Drawbacks.

1.2.2: Bonding in tetrahedral, square planer, trigonal bipyramidal and octahedral complexes with examples.

1.2.3: Inner and outer orbital complexes.

1.2.4: Electroneutrality principle and Back (Multiple) bonding.

1.2.5: Applications of Co-ordination Compounds (complexes) in different fields

UNIT II: (15L)

2.1: Organometallic Compounds (7L)

2.1.1: Introduction to Organometallic compounds and Definition.

2.1.2: Classification on the basis of Hapticity and Nature of Metal – Carbon bond.

2.1.3: 18-electron rule and its application to: carbonyls (including carbonyl hydrides and carbonylates), nitrosyls, cyanides, metal-carbon sigma and pi-bonded organometallics of transition metals.

2.1.4: Classification of metal carbonyls: Mononuclear, polynuclear, non-bridged and bridged carbonyls. General methods of preparation of carbonyls. Molecular orbital configuration of CO molecule. CO molecule acts as terminal and bridging carbonyl group.

2.2: Bioinorganic Chemistry: (8L)

2.2.1: Essential and trace elements in biological processes; Role of metal in bioinorganic chemistry (Na+,K^+,Ca^{2+},Mg^{2+},Fe^{3+}/Fe^{2+},Cu^{2+}/Cu^+,Zn^{2+}).

2.2.2: Metalloporphyrins with special reference to active site structures and biofunctions of cytochromes and Heme proteins-myoglobin and haemoglobin. Functions of oxygen transfer, Fe (II) complex of porphyrin, oxygen binding O_2 transfer, partial pressure, pH dependence. Nature of oxyheamoglobin and deoxyheamoglobin, geometry of complex.

2.2.3: Photosynthesis – PS-I and PS-II.

2.2.4: Metal ion induced toxicity and chelation therapy; metal ions as drugs (cisplatin and a few gold drugs).

UNIT III: Industrial Inorganic Chemistry: (15L)

3.1: Corrosion (5L)

3.1.1: Introduction to Corrosion [including the economics and importance of corrosion].

3.1.2: Types of Corrosion.

3.1.3: Electrochemical Theory of Corrosion.

3.1.4: Methods of Protection of Metals : (i) Coating (ii) Electroplating (iii) Cathode Protection (iv) Anodizing (v) Sacrificial Coating.

3.1.5: Passivity of metals: Definition, Theories of passivity - (i) oxide film theory (ii) Gaseous film theory (iii) Physical film theory, valence theory, catalytic theory, Allotropic theory, electrochemical passivity.

3.2: Environmental Chemistry (5 L)

3.2.1: Basic properties of chemicals in the environment.

3.2.2: Environmental transformations and degradation processes.

3.2.3: Contaminants in the environment- pesticides, soaps and detergents, organometallic compounds, polychlorinated biphenyls and dioxin.

3.2.4: Radioactive pollution.

3.3: Metallurgy (5L)

3.3.1: Metallurgical operations-Pulverisation, calcination, roasting and refining.
3.3.2: Physicochemical principles involved in hydrometallurgy, pyrometallurgy and electrometallurgy.

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3. James E. Huheey, Inorganic Chemistry, 3rd edition, Harper & Row Publishers, Asia, Pvt Ltd., 1983.
4. Shriver Atkins Inorganic Chemistry, P. W. Atkins, Overton, Rourke Weller, Armstrong, 5th edition, Oxford University Press.
5. Introduction to coordination , solid state and descriptive inorganic chemistry, Glen E. Rogers.
6. Chemistry Science of change, 3rd edition, D.W. Oxtoby, W.A. Freeman, T.F. Block.
7. The Organometallic chemistry of transition metals, R.H. Crabtree, 5th edition, Wiley.
8. Fundamental transition metal, Organometallic chemistry, C.M. Lukehart.
9. Chemistry-The molecular science, J.W. Moore, C.L. Stanitski and P.C. Jurs, 3rd edition, Thomson Publishers.
10. Advanced Inorganic Chemistry, Bahl, Anand & Tuli, Vol 1 & 2.
11. Chemistry, McMurray and Fay.
12. Organometallic chemistry, R.C. Mehrotra and A. Singh.
13. Inorganic chemistry, Gary Wulfsberg.
14. Principles of Organometallic chemistry, 2nd edition, P. Powell.
15. Bionorganic Chemistry: Inorganic elements in the chemistry life, Wiley, 2nd edition, W. Kaim, B.Schwederski, A. Klein.
16. Environmental chemistry, Lewis publishers, D. W. Connell.
17. Inorganic Chemistry (Biological and environmental aspects), A.K. Das.
18. Metal ions in Biochemistry, Narosa Publishing House, P. K. Bhattacharya.
19. An introduction to electrochemistry, Samuel Glasstone.
20. Metallic corrosion passivity and protection, U. R. Evans.
21. Basics of corrosion chemistry, Norio Sato.
22. Extractive Metallurgy, Newton.

4th Semester Syllabus for Core Component Course in Chemistry, St. Xavier's College – Autonomous, Mumbai.

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

CIA II: MCQ **20 MARKS**

Template of Question Paper

INORGANIC AND INDUSTRIAL CHEMISTRY II **COURSE : S.CHE.4.02**

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	6-8	6-8	6-8	20
II	6-8	6-8	6-8	20
III	6-8	6-8	6-8	20
TOTAL MARKS PER OBJECTIVE	18-24	18-24	18-24	60
% WEIGHTAGE	30 – 40	30 – 40	30 – 40	100

END SEMESTER PAPER PATTERN :

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

Total number of questions: 3 [all compulsory] of 20 marks each.
1 question per unit.
Questions set out of 30 marks [50% internal choice].
Sub questions will not exceed 5 marks.

SYLLABUS UNDER AUTONOMY
CHEMISTRY

SEMESTER IV **COURSE: S.CHE.4.03**

ORGANIC AND INDUSTRIAL CHEMISTRY II **[45 LECTURES]**

LEARNING OBJECTIVES

1. To study the preparations, reactions and applications of aromatic nitrogen and amino compounds, aromatic aldehydes and ketones, aromatic carboxylic and sulphonic acids with mechanisms of certain reactions.
2. To understand stereochemistry including assignment of descriptors to chiral centres and resolution of racemates.
3. To logically predict structures of organic compounds and plan multi-step syntheses.
4. To understand the concepts of 'clean and green' reactions and techniques that is becoming increasingly significant in making organic synthesis environment friendly.

UNIT I: Aromatic nitrogen compounds, heterocycles and stereochemistry (15 L)

1.1: Aromatic nitro compounds (3 L)

1.1.1: Preparation: Nitration using mixed acid (mechanism). Preparation of mononitro and dinitro compounds through nitration of benzene, nitrobenzene, toluene, chlorobenzene and anisole.

1.1.2: Reactions: Reduction of aromatic nitro compounds by – catalytic hydrogenation, dissolving metal reduction using – Fe-HCl, Sn-HCl and Zn- AcOH and partial reduction using NaHS.

1.2: Aromatic amino compounds (2 L)

1.2.1: Preparation: Reduction of nitro compounds , amination of halobenzenes and Hoffmann bromamide reaction.

1.2.2: Reactions: Basicity of aromatic amines, effect of substituents on basicity of aniline, salt formation, N-alkylation and N-acylation.

1.3: Aromatic diazonium salts (2 L)

1.3.1: Preparation: Diazotization of aromatic primary amines (mechanism).

1.3.2: Reactions: (i) Replacement of diazo group by -H, -OH, -CN, Sandmeyer, Gattermann and Gomberg reaction (ii) Azo-coupling reaction with phenols/ naphthols and aromatic amines and (iii) Reduction of diazonium salt to aryl hydrazine.

1.4: Aromatic heterocycles (4 L)

1.4.1: Electronic structure and aromatic character of furan, thiophene, pyrrole and pyridine.
1.4.2: Reactivity towards electrophilic substitution on the basis of stability of intermediates.
1.4.3: Comparison of basicity of pyrrole, pyridine and piperidine.

1.5: Stereochemistry (4 L)

1.5.1: Assigning stereodescriptors to chiral centres: Cahn-Ingold-Prelog (CIP) Rules of assigning absolute configuration (R and S) to stereogenic centres. Assigning absolute configuration to molecules having maximum two chiral carbon atoms.
1.5.2: E and Z stereodescriptors to geometrical isomers.
1.5.3: Chemical Resolution of enantiomers.

UNIT II: Aromatic carbonyl and acidic compounds, structure determination and multi-step syntheses (15 L)

2.1: Aromatic carbonyl compounds (6 L)

2.1.1: Preparation of aromatic aldehydes: Gattermann-Koch reaction, Gattermann reaction, Vilsmeier-Haack reaction, Reimer-Tiemann reaction (mechanism), oxidation of methyl arenes and Rosenmund reduction.
2.1.2: Preparation of aromatic ketones: Friedel-Crafts acylation using acid chloride and acid anhydride (mechanism).
2.1.3: Reactions with mechanism: Knoevenagel , Claisen-Schmidt , Cannizzaro and Reformatsky reactions with applications.

2.2: Aromatic carboxylic acids (3 L)

2.2.1: Preparation of mono- and di-carboxylic acids: Side-chain oxidation of alkyl benzenes, reaction of Grignard reagents with solid carbon dioxide, hydrolysis of aryl nitriles and Kolbe-Schmidt reaction.
2.2.2: Reactions: (i) Acidity and effect of substituents on the acidity of benzoic acid (ii) Acid- catalysed esterification, (iii) Conversions to acid chloride, amide and anhydride (iv) Reduction and (v) Decarboxylation.

2.3: Aromatic sulfonic acids (2 L)

2.3.1: Preparation of aromatic sulfonic acids: Commonly used sulfonating agents. Sulfonation of benzene (with mechanism) and mono-substituted benzenes.
2.3.2: Reactions: Acidity of arene sulfonic acids. Comparative acidity of carboxylic acids and sulfonic acids, salt formation, desulfonation and Ipso substitution. – SO_3H as a solubilizing and blocking group, preparation of sulfonate esters.

2.4: Structure Determination and Multistep Syntheses (4 L)

2.4.1: Structure determination through a series of reactions.
2.4.2: Planning multistep synthesis of polysubstituted benzenes.

UNIT III: Green Chemistry and Environment friendly techniques (15 L)

3.1: Green Chemistry (8 L)

3.1.1: Definition, need and importance of Green Chemistry. 12 principles of Green Chemistry with relevant examples, concepts and simple calculations on – yield and selectivity, E-factor, atom economy.
3.1.2: Examples of Green Chemistry in Industry : (i) Green Starting Materials (ii) Green Reagents (iii) Green Chemical Solvents (iv) Green Chemical Products (v) Green Catalysts.

3.2: Environment friendly techniques: (7 L)
3.2.1: The use of Phase Transfer Catalysis and Polymer Support.
3.2.2: Synthesis using microwave and ultrasound.

REFERENCES

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2. Organic Chemistry, Francis A Carey, Pearson Education, 6th Edition, Special Indian Education, 2008.
3. Organic Chemistry, R.T. Morrison and R.N. Boyd, 6th Edition, Pearson Education.
4. Organic Chemistry, Finar Vol. I.
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12. Organic Reaction Mechanism, 3rd Edition, V.K. Ahluwalia and R.K. Parashara, Narosa Publications.
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14. An Introduction to Green Chemistry, V.K. Ahluwalia, Vishal Publishing Co.

4th Semester Syllabus for Core Component Course in Chemistry, St. Xavier's College – Autonomous, Mumbai.

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

CIA II: MCQ **20 MARKS**

Template of Question Paper

ORGANIC AND INDUSTRIAL CHEMISTRY II **COURSE : S.CHE.4.03**

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	7	7	6	20
II	7	7	6	20
III	6	7	7	20
TOTAL MARKS PER OBJECTIVE	20	21	19	60
% WEIGHTAGE	33	35	32	100

END SEMESTER PAPER PATTERN :

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

Total number of questions: 3 [all compulsory] of 20 marks each.
1 question per unit.
Questions set out of 30 marks [50% internal choice].
Sub questions will not exceed 5 marks.

4th Semester Syllabus for Core Component Course in Chemistry, St. Xavier's College – Autonomous, Mumbai.

PRACTICAL CHEMISTRY **Course No.: S.CHE.4.PR**

LEARNING OBJECTIVES:

1. To learn to perform experiments that have specific aims with correct techniques.
2. To develop skills of observation, recording and analysing data.
3. To learn to present the experimental work in a systematic manner.

SEMESTER IV: COURSE 1
Instrumentation
Commercial Analysis

SEMESTER IV: COURSE 2
Gravimetric estimation
Volumetric estimation

SEMESTER IV: COURSE 3
Organic Spotting

COURSE I:

1. **POTENTIOMETRY**:
Determination of E^0_{cell}, free energy and equilibrium constant for a cell having cell reaction **:**
$Ag^+ + Cu \rightarrow Ag + Cu^{++}$

2. pH METRY:

pH metric titration of weak acid versus strong base and to determine pK_a value.

3.CONDUCTOMETRY:
Conductometric titration of a mixture of a strong and weak acid versus strong base.

4. CONDUCTOMETRY:
Verification of Ostwald's dilution law for weak electrolyte (Acetic acid).

5. COLORIMETRY:

Determination of λ_{max} for potassium permanganate solution using photometer, determination of unknown concentration by calibration curve method.

6. **COMMERCIAL ANALYSIS:**

Assay of commercial sample of aspirin using phenol red indicator.

COURSE II

1. VOLUMETRIC ESTIMATION:

a) Iodometry and Iodimetry:

(i) Estimation of tincture iodine.

(ii) Estimation of Cu^{2+}

b) Complexometry : estimation of Mg^{2+}/ Zn^{2+}, Cu^{2+} using EDTA

c) Estimation of Fe^{3+} using Internal Indicator.

2. GRAVIMETRIC ESTIMATION :

a) Ba^{2+} as $BaSO_4$

b) Ba^{2+} as $BaCrO_4$

c) Fe^{3+} as Fe_2O_3

d) Ni^{2+} as Ni-DMG

COURSE III

ORGANIC SPOTTING

Identification of an Organic Compound: The identification should be done through: preliminary tests, solubility, element detection, functional group tests, physical constant determination. The analysis should be done by micro-scale techniques. For the identification of an organic compound about 500mg of any compound with not more than two functional/neutral groups be given belonging to the following categories: Acids (carboxylic acids/sulphonic), phenols, aldehydes/ketones, alcohols, esters, amines (primary, secondary and tertiary), carbohydrates, hydrocarbons, halo/nitro hydrocarbons.

Note: A minimum of 12 compounds be given for the identification: at least one from each of the categories mentioned above.

CIA AND END SEMESTER PRACTICAL EXAMINATION

CIA: 20 MARKS PER COURSE PER SEMESTER: Total: **60 MARKS**

COURSE 4.01: 15 MARKS oral presentation on instrumentation
5 MARKS: journal

COURSE 4.0 2: 15 MARKS: exercise to test a quantitative practical skill
5 MARKS: journal

COURSE 4.03: 15 MARKS: exercise to test a qualitative practical skill
5 MARKS: journal

END SEMESTER EXAMINATION: 30 MARKS PER COURSE
Total: **90 MARKS**

The practical exam will be conducted for 3 sessions (one per course) of 3 hours duration each.

Course 4.01: 25 Marks and 5 Marks written test

Course 4.02: 25 Marks and 5 Marks written test

Course 4.03: 25 Marks and 5 Marks written test

Batch Size: Maximum 20 students per batch.

St. Xavier's College (Autonomous)
Mumbai

Syllabus for 5th Semester Courses in Chemistry
(June 2016 onwards)

CONTENTS: THEORY SYLLABUS FOR COURSES:

SEMESTER V **COURSE: S.CHE.5.01**

SPECTROSCOPY, MOLECULAR & NUCLEAR DYNAMICS [60 LECTURES]

LEARNING OBJECTIVES

1. To encourage students to learn, integrate & analyze the concepts relevant to physical chemistry at the graduation level.
2. To understand the underlying principles of various types of spectroscopy, the rules governing their transitions & their utility in determination of bond length of diatomic molecules & elucidating structures of molecules.
3. To acquire knowledge about methods of detection of various ionizing radioactive radiations, various types of nuclear reactions & nuclear reactors.
4. To understand the basics of quantum chemistry & appreciate the concept of entropy as a probability factor.
5. To learn about basic laws governing photochemical reactions & understand the basic principles of fluorescence, phosphorescence & chemiluminescence.

UNIT I: SPECTROSCOPY (15 L)

1.1: Molecular Spectroscopy

1.1.1: Dipole moment: Polarization of a bond, bond moment, dipole moment and Molecular structure.

1.1.2 Rotational / Microwave Spectroscopy: Rotational spectrum of a diatomic molecule, rigid rotor, moment of inertia, energy levels, limitations of rotational spectra, selection rule, nature of spectrum, determination of inter nuclear distance and isotopic shift.

1.1.3: Vibrational (IR) Spectroscopy: Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels, zero point energy, conditions for obtaining vibrational spectrum, selection rule, nature of spectrum. Anharmonic Oscillator : energy levels, selection rule, fundamental band, overtones.

1.1.4: Vibration-Rotation Spectroscopy of diatomic molecules: Vibrating rotor, energy levels, selection rule, nature of spectrum, R and P branches, applications of

vibration-rotation spectrum: (i) Force constant, determination and significance (ii) determination of inter-nuclear distance, isotopic shift. Introduction to infrared spectra of simple molecules like H_2O and CO_2.

1.1.5: Raman Spectroscopy: Scattering of electromagnetic radiation, Rayleigh scattering, Raman scattering, nature of Raman spectrum , Stoke's lines, anti-Stoke's lines, Raman shift, quantum theory of Raman scattering, comparative study of IR and Raman spectra, rule of mutual exclusion (example of CO_2 molecule).

UNIT II **(15 L)**

2.1: Nuclear Magnetic Resonance Spectroscopy **(7 L)**

2.1.1: Nuclear spin, magnetic moment, nuclear 'g' factor, energy levels, Larmor precession. Relaxation processes in NMR (spin-spin relaxation and spin-lattice relaxation),

2.1.2: NMR spectrometer, chemical shift, shielding and de-shielding of protons, low resolution NMR spectrum of methanol and ethanol, fine structure of NMR - nuclear spin-spin interaction with reference to methanol and ethanol.

2.2: Electron Spin Resonance Spectroscopy (introductory concepts) **(3 L)**

2.2.1: Derivative curves & g-values, Hyperfine splitting with respect to methyl radical and benzene radical.

2.2.2: Applications of ESR Spectroscopy.

2.3: Mass Spectrometry **(5 L)**

2.3.1: Basic Principles of mass spectrometry, Molecular ion peak, base peak, metastable peak & their uses, nitrogen rule, fragmentation.

2.3.2: Instrumentation, determination of molecular formulae with example, mass spectrum of simple organic compounds e.g., alkanes.

(Numerical problems expected in the above topics)

UNIT III: Molecular & Nuclear Dynamics (15 L)

3.1: Nuclear Chemistry

3.1.1: Types of nuclear radiations and their characteristics, behaviour of ion-pairs in electric field, detection and measurement of nuclear radiations using G.M. counter and scintillation counter.

3.1.2: Kinetics of radioactive decay, units of radioactivity (Curie, Becquerel, Rutherford).

3.1.3: Radioactive equilibrium (secular and transient) Determination of radioactive constants for radio-elements having (i) moderate half -life (ii) long half -life (iii) extremely long or short half -life.

3.1.4: Use of radioisotopes as tracers in (i) chemical investigations - reaction mechanism (ii) Age determination – dating by tritium content and by Carbon-14.

3.1.5: Nuclear Reactions: nuclear transmutation, artificial radioactivity (suitable examples using different projectiles are expected.), Q-value of nuclear reaction threshold energy.

3.1.6: Fissile and fertile material, nuclear fission, chain reaction, factors controlling fission process (multiplication factor and critical size or mass of fissionable material), nuclear power reactor and breeder reactor.

3.1.7: Nuclear fusion, characteristics of nuclear fusion, thermonuclear reactions occurring in stellar bodies.

UNIT IV (15 L)

4.1: Basics of Quantum Chemistry (9 L)

4.1.1: Classical mechanics, limitations of classical mechanics, Black body radiation, photoelectric effect, Compton Effect.

4.1.2: Introduction to quantum theory, Planck's theory of quantization, wave particle dualism, de-Broglie equation, Heisenberg's uncertainty principle. Simple numerical problems.

4.1.3: Progressive and standing waves, boundary conditions, Schrödinger's time

independent wave equation, interpretation and properties of wave function.

4.1.4: State function (wave function) and its significance. Concept of operators: definition, addition, subtraction and multiplication of operators, commutative and non-commutative operators, linear operator, position, momentum and energy operators. Eigen function and eigen value, eigen value equation.

4.2: Third Law of Thermodynamics (3 L)

4.2.1: Entropy & probability: recapitulation

4.2.2: Statement of Third Law of Thermodynamics

4.2.3: Absolute entropy of solids, liquids & gases.

4.3: Photochemistry (3 L)

4.3.1: Laws of Photochemistry, Jablonski energy level diagram – primary & secondary Photochemical processes.

4.3.2: Radiationless transition – internal conversion & intersystem crossing.

4.3.3: Radiative transitions – fluorescence , relation to structure. Phosphorescence-conditions for phosphorescence emission (spin – orbit coupling). Singlet and triplet.

4.3.4: Chemiluminiscence**.**

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CIA I: Short answer questions and numerical problems **20 Marks**
CIA II: Assignment **20 Marks**

Template of Question Paper

SPECTROSCOPY, MOLECULAR & NUCLEAR DYNAMICS COURSE: S.CHE.5.01

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

SYLLABUS UNDER AUTONOMY
CHEMISTRY

SEMESTER V **COURSE: S.CHE.5.02**

CHEMICAL BONDING AND CO-ORDINATION CHEMISTRY [60 LECTURES]

LEARNING OBJECTIVES

1. To encourage students to analyze and integrate concepts relevant to graduate level Inorganic chemistry.

2. To understand the bond formation of compounds with special reference to MOT and CFT.

3. To build on basic concepts of Co-ordination Chemistry with reference to planar, tetrahedral and octahedral complexes.

4. To study Electronic Spectra of Polyelectronic atoms.

UNIT I: Chemical Bonding (15 L)

1.1: Molecular Symmetry (8 L)

1.1.1: Introduction and Importance.
1.1.2: Symmetry elements and symmetry operations.
1.1.3: Concept of a Point Group with illustrations using the following point groups: (i) $C\infty v$ (HCl) (ii) $D\infty h$ (H_2) (iii) C_{nv}: C_2v (H_2O), C_3v (NH_3), C_{4v} (iv) C_{nh}: C_{2h} (trans-dichloroethylene) (v) D_{nh}: D_{2h}, D_{3h} (BCl_3), D_{4h} (vi) D_{nd}: D_{2d} (allene), T_d(CH_4) and O_h

1.2: Molecular Orbital Theory for polyatomic species (5 L)

(Prior Knowledge: MOT for diatomic molecules)
1.2.1: Simple triatomic species H_3^+ and H_3 (correlation between bond angle and molecular orbitals)
1.2.2: (i) BeH_2 (ii) H_2O (iii) NH_3 (iv) CH_4 and (v) CO_2

1.3: Metallic Bond (2 L)

1.3.1: Band theory

1.3.2: Explanation of electrical properties of conductors, insulators and semiconductors (n- and p- types) on the basis of Band theory.

UNIT II: Inner Transition Elements (15 L)

2.1: Lanthanide Series (11 L)

2.1.1: Chemistry of lanthanides with reference to i) Occurrence & extraction of Lanthanides (ii) lanthanide contraction (iii) oxidation states (iv) magnetic properties (v) color and spectra (f-f transition spectra) and (vi) complex formation (types and stereochemistry of the complexes).

2.1.2: Separation of lanthanides by (i) ion-exchange and (ii) solvent extraction methods.
Self Study**:** Application of lanthanides.

2.2 Actinide Series (4 L)

2.1.1: Chemistry of Uranium and Plutonium with reference to occurrence, extraction (solvent extraction method), properties and applications.
Self Study**:** i) Applications of actinides.
ii) Comparative chemistry of lanthanides and actinides.

UNIT III: Co-ordination Chemistry (15 L)

3.1: Crystal Field Theory (CFT) (8 L)

3.1.1: Basic tenets of Crystal Field Theory and effect of Crystal Field on central metal valence orbitals

3.1.2: Splitting of d orbitals in octahedral, tetrahedral and square planar complexes and Jahn Teller Effect

3.1.3: Crystal field splitting energy (10Dq/Δo) for octahedral complexes and factors affecting the magnitude of Δo.

3.1.4: Crystal field stabilization energy (CFSE), calculation of CFSE for octahedral and tetrahedral complexes with d_1 to d_{10} metal ion configurations, high-spin and low-spin complexes.

3.1.5: Effect of crystal field splitting on (i) Ionic radius and (ii) Lattice energy.

3.1.6: Experimental evidence for co-valence in co-ordination compounds:
i) ESR spectrum of $[IrCl_6]^{2-}$.
ii) NMR spectrum of tris(acetylacetonato)vanadium(III) complex.
iii) Intensities of d-d transitions and (iv) Nephelauxetic effect.
Self Study: Merits and Demerits of CFT.

3.2: Molecular Orbital Theory (MOT) of Coordination Complexes (4 L)

3.2.1: Application to octahedral complexes in case of (i) $[Ti(H_2O)_6]^{3+}$ (ii) Fluoro complexes of Fe (II) and Co (III) (iii) Cyano complexes of (Fe (III) and ammino complexes of Co (III).

Self Study: Molecular orbital diagram for Fluoro complexes of Fe(III) and Cyano Complexes of Fe (II).

3.2.2: Effect of pi-bonding on ligand field splitting parameter in M→L π- and L→M π- interactions.

3.3 Stability of Octahedral Complexes (3 L)

3.3.1: Thermodynamic stability and kinetic stability of complexes with examples.
3.3.2: Stability constants: stepwise and overall constants and their inter-relationship**.**
3.3.3: Factors affecting thermodynamic stability.
Self Study*:* Method of determination of stability constants.

UNIT 1V: Spectra and Substitution Reactions (15 L)

4.1: Electronic States and Terms of Polyelectronic atoms (4 L)

4.1.1: Introduction: electronic configuration and electronic states, Term symbols, coupling of spin momenta (MS), orbital momenta (ML) and spin orbit coupling or Russell-Saunders coupling.
4.1.2: Determination of Terms for p.p and p^2 electronic configuration (as in a carbon atom), Hund's rule.
4.1.3: Terms and micro-states for transition metal atoms/ions.

4.2: Electronic Spectra (4 L)

4.2.1: Types of electronic transitions like intra-ligand transitions, charge transfer transitions and intra-metal transitions (d-d or ligand field transitions for transition metals).
4.2.2: Rules for electronic transitions: Spin and Orbital or Laporte selection rules.
4.2.3: Splitting of Terms in weak crystal field, the Hole Formalism.
4.2.4: Orgel Diagrams for D Terms (i.e d^1, d^4 , d^6 , d^9 electronic configurations) and their use in interpretation of visible electronic absorption spectra of these configurations.

4.3: Magnetic Properties of Transition Metal Complexes (3 L)

4.3.1: Types of magnetic behavior, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments and application of magnetic moment data for 3d metal complexes.

4.4. Substitution Reactions in Octahedral Complexes (4 L)

4.4.1: Introduction, types of reactions in complexes.

4.4.2: Ligand substitution reactions: basic mechanism.

4.4.3: Inert and labile complexes and electronic configurations and lability of complexes.

4.4.4: Acid hydrolysis, base hydrolysis and anation reactions.

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CIA I: Short answer questions **20 MARKS**
CIA II: Multiple choice questions **20 MARKS**

Template of Question Paper

CHEMICAL BONDING AND CO-ORDINATION CHEMISTRY COURSE: S.CHE.5.02

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.

SYLLABUS UNDER AUTONOMY
CHEMISTRY

SEMESTER V **COURSE: S.CHE.5.03**

STEREOCHEMISTRY AND NATURAL PRODUCTS [60 LECTURES]

LEARNING OBJECTIVES

1. To consolidate the students' understanding of stereochemistry of the molecules and reactions.
2. To investigate reaction mechanisms.
3. To give the students an overview of biomolecules.

UNIT I: Stereochemistry (15 L)

1.1: Elements of symmetry: Mirror plane, centre (inversion centre), rotation-reflection alternating) axis. **(2 L)**

1.2: Molecular chirality: Compounds without stereogenic centres but with chiral axis: cummulenes, spirans and biphenyls; and with chiral planes: cyclophanes and ansa compounds. Assignment of descriptors - (R,S) nomenclature. **(4 L)**

1.3: Conformational analysis of cyclohexane: Angle, eclipsing and transannular strain in small , medium and large cycloalkanes (4- and 5- membered rings). Mono- and di- alkyl cyclohexanes and their relative stabilities. **(3 L)**

1.4: Stereoselectivity and stereospecificity: Idea of enantioselectivity (*ee*) and diastereoselectivity (*de*). Topicity – enantiotopic and diastereotopic ligands and faces. **(1 L)**

1.5: Stereochemistry and reaction mechanisms: (5 L)

a) Substitution reactions – S_Ni .
b) Elimination reactions - E_1 and E_2.
c) Addition reactions to olefins - i) catalytic hydrogenation ii) bromination iii) syn- hydroxylation with OsO_4 and $KMnO_4$ iv) peroxyacids.

UNIT II: Mechanism of organic reactions (15 L)

2.1: Investigation of reaction mechanisms: Product analysis including crossover products, trapping of intermediates, isotopic labeling, kinetic and stereochemical evidence. **(2 L)**

2.2: Thermodynamic and kinetic control of organic reactions: Concept with mechanisms of the following reactions: Addition of HX to butadiene; sulfonation of naphthalene. Nucleophilicity/electrophilicity v/s Basicity/acidity. **(3 L)**

2.3: Mechanism of reactions of carbonyl compounds with nucleophiles: (5 L)

a) Formation of acetals from aldehydes and ketones.
b) Reaction of aldehydes and ketones with primary and secondary amines.
c) Acyl nucleophilic substitution (tetrahedral mechanism): Acid-catalysed esterification of carboxylic acids and base-promoted hydrolysis of esters.

2.4: Effect of neighbouring group participation (NGP) on organic reactions: (3 L)

For reactions involving groups or substituents like halogen, oxygen, sulphur, phenyl ring, C-C bond of the ring (non-classical carbocations).

2.5: Pericyclic reactions:

[2+2] and [4+2] cycloaddition reactions. **(2 L)**

UNIT III: Natural Products (15 L)

3.1 Introduction: Introduction to natural products with respect to sources and classes. **(1 L)**

3.2: Carbohydrates

3.2.1: Introduction: Sources,Classification , reducing and non-reducing sugars, D and L- notations. **(1 L)**

3.2.2: Structures of Monosaccharides: Open chain structures of aldoses and ketoses, ring structures of aldohexoses, aldopentoses and ketohexoses. **(2 L)**

3.2.3: Determination of open chain configurations of Monosaccharides: Configuration of D (+) Glucose and D(-) Fructose . **(2 L)**

3.2.4: Stereoisomers of Monosaccharides: **(2 L)**
Enantiomers and diastereoisomers of monosaccharides, epimers, anomers, mutarotation (with mechanism) in D-Glucose.

3.2.5: Chain lengthening and shortening reactions: **(2 L)**
Kiliani-Fischer synthesis, Wohl's method.

3.2.6: Reactions of D-Glucose and D-Fructose: **(2 L)**
(**a**) osazone formation
(**b**) reduction with $NaBH_4$ and Ni / H_2

(**c**) oxidation with bromine water, conc.HNO_3 and HIO_4
(**d**) interconversion of D (+) Glucose to D(-)Fructose and D(-)Fructose to D(+)Glucose
(**e**) acetylation
(**f**) methylation [(**e**) and(**f**) with cyclic pyranose form].

3.2.7: Introduction to disaccharides and structures of sucrose and maltose. **(1 L)**

3.2.8: Glycosides: General structure giving indican as an example. **(2 L)**

UNIT IV: Chemistry of important Biomolecules **(15 L)**

4.1: Amino acids and Proteins **(6 L)**

4.1.1: Amino acids: Introduction, Classification, syntheses of amino acids-Strecker synthesis, Amidomalonate synthesis and Erlenmeyer Azalactone synthesis.

4.1.2: Polypeptides : Introduction, peptide bond, Merrifields solid phase peptide synthesis, Bergmann method.

4.1.3: Proteins: Structure of proteins, classification of proteins, properties of proteins, denaturation of proteins, biosynthesis of proteins.

4.1.4: Separation and purification of proteins:
Gel filtration chromatography, electrophoresis.

4.1.5: Catabolism of amino acids: Transamination, oxidative deamination, decarboxylation.

4.2: Nucleic Acids (6 L)

4.2.1: Introduction, classification of nucleic acids.
4.2.2: Structures of sugars and bases in nucleic acids.
4.2.3: Structures of nucleosides and nucleotides in DNA and RNA.
4.2.4: Structure of DNA: Chargaff's rule of DNA configuration, Watson-Crick model of DNA.
4.2.5: Structure of RNA, types of RNA.
4.2.6: DNA replication, mutations, DNA repair.
4.2.7: Transcription, DNA sequencing, polymerase chain reaction and its applications.

4.3: Alkaloids and Terpenoids (3 L)

4.3.1: Introduction, functions of alkaloids and terpenoids.
4.3.2: Structure elucidation, synthesis and biological properties of nicotine and citral.

REFERENCES

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CIA I: Written test **20 Marks**

CIA II: Models or 3-D representations of molecules with stereochemistry 20 Marks

Template of Question Paper

STEREOCHEMISTRY AND NATURAL PRODUCTS COURSE: S.CHE.5.03

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	5	5	5	15
II	5	5	5	15
III	5	5	5	15
IV	5	5	5	15
TOTAL MARKS PER OBJECTIVE	20	20	20	60
% WEIGHTAGE	33	34	33	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

SYLLABUS UNDER AUTONOMY
CHEMISTRY

SEMESTER V **COURSE: S.CHE.5.04**

GENERAL ANALYTICAL AND PHARMACEUTICAL CHEMISTRY

[60 LECTURES]

LEARNING OBJECTIVES

1. To understand sources of errors in measurement.
2. To promote an understanding about data collection, manipulation and interpretation.
3. To expose students to commonly used sampling techniques.
4. To understand the principles involved in titrimetric analysis.
5. To give the students a knowledge of non-aqueous titration.
6. To comprehend the principles and instrumental techniques involved in chromatography and solvent extraction.
7. To motivate students to solve numerical problems.
8. To familiarize the students with different concepts in pharmaceutical chemistry.
9. To bridge the gap between academics and industry.

UNIT I: Treatment of Analytical Data-I and Sampling (15 L)

1.1: Treatment of Analytical Data-I (7 L)

1.1.1: Types of errors, determinate and indeterminate errors, minimization of errors, constant and proportionate errors.

1.1.2: Accuracy and precision, measures of dispersion and central tendency: mean, median, average deviation, relative average deviation, standard deviation, variance, coefficient of variation (Numerical problems expected).

1.2: Sampling (8 L)

1.2.1: Sampling techniques, equipments used in sampling of gases.

1.2.2: Methods and equipments used in sampling of homogeneous and heterogeneous liquids, sampling of static and flowing liquids.

1.2.3: Samplers used in sampling of solids, importance of particle size and sample size, method of reduction in sample size. Collection, preservation and dissolution of the sample.

1.2.4: Self Study: Terms involved in sampling, importance and objectives of sampling.

UNIT II: Titrimetric Analysis (15 L)

2.1: Precipitation titrations: Argentimetric titrations, construction of the titration curves, detection of end point by (i) Mohr's method (ii) Volhard's method (iii) using adsorption indicators, theory and applications.

2.2: Complexometric titrations: General introduction, EDTA titrations, advantages and limitations of EDTA as the titrant, absolute and conditional formation constants of metal- EDTA complexes, Construction of titration curves, types of EDTA titrations, methods of increasing the selectivity of EDTA as a titrant, metallochromic indicators, theory and applications.

2.3: Redox titrations: General introduction, theory of redox indicators, construction of the titration curves in the case of (i) Fe (II) vs. Ce(IV) (ii) Fe(II) vs. dichromate. Use of diphenyl amine and ferroin as redox indicators.

2.4: Nonaqueous titration: Need for non-aqueous titration, basic principle, requirement of solvent, types of solvents, solvents used in non-aqueous titration and end point detection, applications.

2.5: Self Study: Acid –base titrations: Construction of titration curves and choice of indicators in the titration of : (i) strong acid and strong base (ii) strong acid and weak base (iii) weak acid and strong base (iv) weak acid and weak base.

UNIT III: Separation Techniques-1 (15 L)

3.1: Solvent extraction: Role of complexing agents in solvent extraction, chelation, Ion pair formation, solvation, types of **solvent extraction**: batch, continuous

3.2: Planar chromatography: Principle, techniques and applications of Paper Chromatography and Thin layer chromatography.

3.3: Principle, instrumentation and applications of **Gas Chromatography and High Performance Liquid Chromatography.**

3.4: Supercritical fluid chromatography: Introduction, supercritical fluid choice, their properties, instrumentation and applications.

3.5: Electro-chromatography: Electrophoresis.

3.6: Self Study: Introduction to chromatographic techniques, basic principles, classification of Chromatographic techniques**.**

UNIT IV: **Introduction to Pharmaceutical Chemistry-1** **(15 L)**

4.1: Introduction to pharmaceutical chemistry, TQM, concept of Quality, Quality Control, Quality Assurance and their inter-relation.

4.2: Concept of FDA, their role and importance, classification of drugs according to FDA

Pharmacopoeia: History, Drug act and schedules, components of pharmacopoeia.

4.3: Good Laboratory Practices [GLP], ISO series.

4.4: Good Manufacturing Practice [GMP], Drug Technical Advisory Board [DTAB].

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2. **D. A. Skoog, F.J.Holler, T.A.Nieman,** Principles of Instrumental Analysis, 6th ed. Philadelphia, Saunders College Publishing, 1996.
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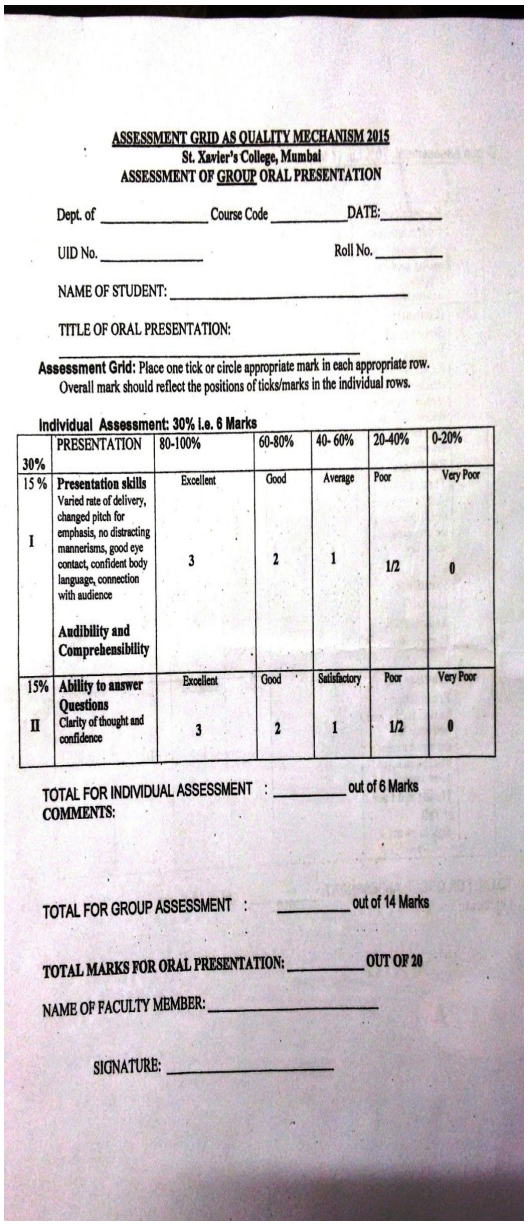
CIA I: Short answer questions **20 MARKS**
CIA II: Oral Presentation **20 MARKS**

❖ ASSESSMENT GRID FOR ORAL PRESENTATION



ASSESSMENT GRID AS QUALITY MECHANISM 2015
St. Xavier's College, Mumbai
ASSESSMENT OF GROUP ORAL PRESENTATION

Dept. of _____ Course Code _____ DATE: _____

UID No. _____ Roll No. _____

NAME OF STUDENT: _____

TITLE OF ORAL PRESENTATION: _____

Assessment Grid: Place one tick or circle appropriate mark in each appropriate row.
Overall mark should reflect the positions of ticks/marks in the individual rows.

Individual Assessment: 30% i.e. 6 Marks

30%	PRESENTATION	80-100%	60-80%	40- 60%	20-40%	0-20%
15 % I	**Presentation skills** Varied rate of delivery, changed pitch for emphasis, no distracting mannerisms, good eye contact, confident body language, connection with audience **Audibility and Comprehensibility**	Excellent 3	Good 2	Average 1	Poor 1/2	Very Poor 0
15% II	**Ability to answer Questions** Clarity of thought and confidence	Excellent 3	Good 2	Satisfactory 1	Poor 1/2	Very Poor 0

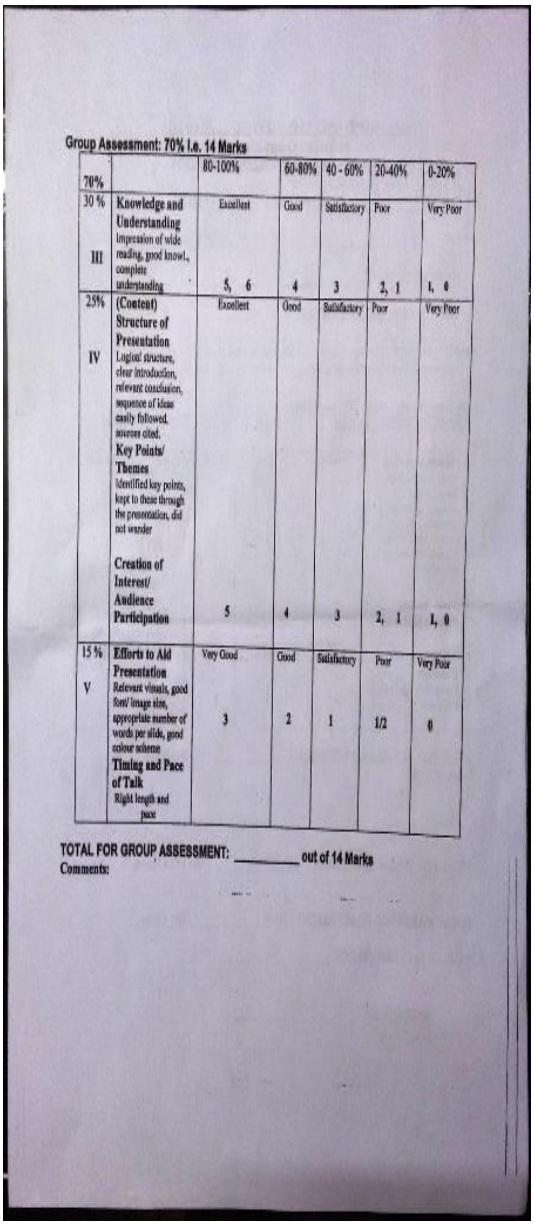
TOTAL FOR INDIVIDUAL ASSESSMENT : _____ out of 6 Marks
COMMENTS:

TOTAL FOR GROUP ASSESSMENT : _____ out of 14 Marks

TOTAL MARKS FOR ORAL PRESENTATION: _____ OUT OF 20

NAME OF FACULTY MEMBER: _____

SIGNATURE: _____



Group Assessment: 70% i.e. 14 Marks

70%		80-100%	60-80%	40 - 60%	20-40%	0-20%
30 % III	**Knowledge and Understanding** Impression of wide reading, good knowl., complete understanding	Excellent 5, 6	Good 4	Satisfactory 3	Poor 2, 1	Very Poor 1, 0
25% IV	**(Content) Structure of Presentation** Logical structure, clear introduction, relevant conclusion, sequence of ideas easily followed, sources cited. **Key Points/ Themes** Identified key points, kept to these through the presentation, did not wander **Creation of Interest/ Audience Participation**	Excellent 5	Good 4	Satisfactory 3	Poor 2, 1	Very Poor 1, 0
15 % V	**Efforts to Aid Presentation** Relevant visuals, good font/ image size, appropriate number of words per slide, good colour scheme **Timing and Pace of Talk** Right length and pace	Very Good 3	Good 2	Satisfactory 1	Poor 1/2	Very Poor 0

TOTAL FOR GROUP ASSESSMENT: _____ out of 14 Marks
Comments:

Template Of Question Paper

GENERAL ANALYTICAL AND PHARMACEUTICAL CHEMISTRY:

COURSE: S.CHE.5.04

OBJECTIVES

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

PRACTICAL CHEMISTRY **COURSE: S.CHE.5.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

INSTRUMENTAL EXPERIMENTS

A. POTENTIOMETRY

1. To determine the pK_a value of a given weak monobasic acid (CH_3COOH) by e.m.f. measurements using Quinhydrone electrode.

2. To determine solubility product and solubility of silver chloride potentiometrically using chemical cell.

3. To determine solubility product and solubility of silver chloride potentiometrically using concentration cell.

4. To determine electrode potential of saturated calomel electrode at room temperature and using this value to determine standard potential of Ag^+ | Ag electrode.

5. To determine the amount of Fe (II) and formal redox potential in the given solution by potentiometric titration against a standard solution of potassium dichromate.

B. CONDUCTOMETRY

6. To determine the relative strength of monochloroacetic acid and acetic acid conductometrically.

7. To determine the strength of a given dibasic acid by conductometric titration.

C. POLARIMETRY

8. To determine the specific rotation of glucose / cane sugar.

D. SPECTROPHOTOMETRY

9. To verify Beer-Lambert's law using potassium dichromate / potassium permanganate solution & hence determine its molar absorptivity.

E. pH METRY

10. To determine the acidic and basic dissociation constants of an amino acid and its iso-electric point.

INORGANIC CHEMISTRY: COURSE 2

INSTRUMENTAL
INORGANIC PREPARATIONS
TITRIMETRIC ANALYSIS

1. Instrumental

i) To study the complex formation between Fe(III) and salicylic acid, find the formula and stability constant of the complex using colorimeter.
ii) To determine the strength of unknown KCl, KBr and KI solutions in a mixture of all three potentiometrically when titrated against N/10 $AgNO_3$ solution.

2. Inorganic Preparations

i) Tris-(ethylenediamine)nickel(II)thiosulphate.
ii) Bis-(acetylacetonato) copper(II).
iii) Bis-8-hydroxyquinolato magnesium(II).
iv) Potassium trioxalato chromate (III).

3. Titrimetric analysis

i) Determination of metal content in Tris(ethylenediamine)nickel(II)thiosulphate.
ii) Determination of metal content in Bis(acetylacetonato) copper(II).
iii)Determination of metal content in Bis-8-hydroxyquinolato magnesium(II).
iv)Determination of metal content and oxalate ions in Potassium trioxalato chromate (III)

ORGANIC CHEMISTRY: COURSE 3

A. **Organic Separation**
Separation of a binary mixture: Type of mixture, Separation and Identification (microscale) of both the components through systematic scheme of identification. Type: Solid + Solid (no carbohydrates to be given) Mass of solid: 3—4 g.

B. **Preparation of organic compounds**
Preparation of organic compound as per the procedure given. Measuring the mass of crude, purification of the separated product by crystallisation and recording of the m.p. Quantity of the reactant to be given: 1 g.

Preparations:

1. 2- Naphthol to Methyl-2-naphthyl ether
2. Hydroquinone / 2-Naphthol to Acetate

3. Phthalic anhydride to Phthalimide
4. Glucose to Glucosazone

C. **Green Chemistry: Demonstration Experiments**

1. Benzil-benzylic acid rearrangement.
2. Pechmann condensation in Coumarin synthesis.

Note: A minimum of **six** mixtures and four preparations should be covered in the Semester.

ANALYTICAL CHEMISTRY: COURSE 4

NON-INSTRUMENTAL EXPERIMENTS

1. Estimation of persulphate in the given sample by the method of back titration.
2. Determination of the calcium and magnesium content of a Dolomite sample.
3. Determination of glucose content in a honey sample by Willstatter's method.
4. Determination of Vitamin C by titration with potassium bromate.
5. Determination of dissolved oxygen in the given water sample.
6. Determination of Iodine value by Wij's method for the given oil sample.
7. Thin layer chromatographic separation of organic compound.
8. Chemical Oxygen Demand (COD) of water sample.
9. Determination of salinity of the given water sample.
10. Estimation of drug by non-aqueous titration.

REFERENCES:

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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, 2012.

❖ CIA AND END SEMESTER PRACTICAL EXAMINATION

Course 1: Physical Chemistry – Instrumental Experiment.
Course 2: Inorganic Chemistry – Instrumentation, Inorganic Preparation and Estimation.
Course 3: Organic Chemistry – Separation and Identification of solid-solid mixture.
Course 4: Analytical Chemistry – Non-instrumental Experiment.

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 hrs 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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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.

REFERENCES

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2. G.M. Barrow, Physical Chemistry: 6th Ed, Tata McGraw Hill Publishing Co. Ltd., 2008.
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4. G.W. Castellan, Physical Chemistry: 3rd ed., Narosa Publishing House, 2004.
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6. S. Glasstone, Thermodynamics for Chemist: Affiliated East-West Press Pvt. Ltd., New Delhi.
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43. K.L. Kapoor, A Textbook of Physical Chemistry, (Vol 1 – 5), Macmillan India Ltd, 2008.

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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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21. **C. M. Day and J. Selbin**, Theoretical Inorganic Chemistry, 2nd ed, Affiliated East West Press Pvt. Ltd., 1971.
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23. **F. Basolo and R. G. Pearson**, Mechanism of Inorganic Reactions, 2nd ed, Wiley, New York, 1973.
24. **R. H. Crabtree**, The Organometallic Chemistry of the Transition Metals, Wiley-Interscience, New York, 1988.
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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	APPLICATIO N	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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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.

REFERENCES

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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.

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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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INTRODUCTION TO NEUROSCIENCE **Course No.: S.CHE.5AC**
FOUR CREDIT COURSE **Total Lectures 60**

Learning Objectives:
This course presents current topics in the broad field of neuroscience and is geared to upper level undergraduate students. The course focuses mostly on mammalian and human brains and resembles in content some of what is taught to most medical students. Topics covered include historical foundations of neuroscience, synaptic and neurotransmitter systems, sensory and motor systems, neurocellular anatomy, motivation, mental illness, and cognitive neuroscience topics. In addition to the lectures in class students will be provided with material for a Study Pack.

UNIT I **15 Lecturess**

1.1 Central Nervous System
1.1.1 Course content, expectations and examinations; Basic Organization of the CNS
1.1.2 Autonomic Nervous Systems
1.1.3 Diffuse Modular Systems
1.1.4 Neurons and Glia; Neuronal Membrane
1.1.5 Action Potential

1.2 CNS Drugs
1.2.1 Classification based on pharmacological actions
1.2.2 Anxiolytics: Barbiturates (Phenobarbitone), Benzodiazepines (Alprazolam)
1.2.3 Anticonvulsants and Antiepileptics : Oxazolidinediones (Trimethadione), Hydantoins (Phenytoin)
1.2.4 Antischizophrenics: Phenothiazines (Chlorpromazine)
1.2.5 Antidepressants: Imipramine , Fluoxetine

UNIT II **15 Lectures**

2.1 Working of the CNS
2.1.1 Synaptic Transmission: Chemical and Electrical
2.1.2 Neurotransmitter Systems
2.1.3 Chemical Control of the Brain
2.1.4 Neurocortical activation during decision making; Free will?
2.1.5 Addictions

2.2 Cognition
2.2.1 Phantom Syndrome and Pain
2.2.2 Motivation
2.2.3 Consciousness
2.2.4 Perception and Attention

UNIT III **15 Lectures**

3.1 Sensory systems and Processes

3.1.1 Visual System
3.1.2 Auditory System
3.1.3 Somato Sensory System
3.1.4 Emotions and Mood

3.2 Motor Systems

3.2.1 Spinal Control of Movement
3.2.2 Alpha Motor Neutrons
3.2.3 Gamma Motor Neurons
3.2.4 Cortical Control of Movement
3.2.5 Planning of Movement by the Cerebral Cortex

UNIT IV **15 Lectures**

4.1 Memory Systems

4.1.1 Memory Systems
4.1.2 How we learn and Study
4.1.3 Sleep Patterns
4.1.4 Stress and De-stress

4.2 Neuro-diseases and Everyday Life

4.2.1 Neuro diseases of Aging
4.2.2 Brain fitness to delay aging
4.2.3 Genes or Environment?
4.2.4 Brain waves and Meditation
4.2.5 Sex and the Brain

Reference Book: Mark F. Bear, Barry W. Connors, Michael A. Paradiso, *Introduction to Neuroscience*

Examinations: We follow the Bloomberg System of testing knowledge, understanding and application in equal proportion.

CIA I: 20 Marks Maximum- Consists of questions which are multiple choice, matching, true/false, short answer, labeling brain structures.

CIA II: 20 Marks Maximum- Group Research Assignment + Class Assignments

End Semester Paper Pattern:

Total marks: 60 Marks Maximum. Time: 2 hours Total no. of questions: 10 (out of 12) of 6 marks each Questions may be set out of 9 marks [50 % internal choice]

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Neuroscience Practical Course S.CHE.5.AC.PR.

SEMESTER V

Learning Outcomes

The experiments for this Practical Course are made up of a set of demonstrations of classic and contemporary experiments and concepts from the neurosciences. These experiments will allow the students to experience at first hand a variety of important experimental studies, which will help them understand the design of the study, the data, and the significance of the research. Besides the content material that students will assimilate it is expected that the practical work will develop in them a keen sense of research methodology as well as incite them to do further reading in the area. It is my hope that, though not a requirement, some of the more interested students would also go on to design other similar experiments, thus giving them a real entry into the world of cognition and neuroscience.

Methodology

The students are expected to read the background theory. After listening to the instructions they will perform the experiment, note down the data, and then proceed to analyze the data. Results, entered in the proper format have to be initialed by the faculty member supervising the experiment.

ATTENTION

Expt 1: Attentional Blink

Expt 2: Change Detection

PERCEPTION

Expt 3: Apparent Motion

Expt 4: Garner Interference

NEUROCOGNITION

Expt 5: Brain Asymmetry

Expt 6: Blind Spot

SENSORY MEMORY

Expt 7: Metacontrast Masking

Expt 8: Modality Effect

SHORT-TERM MEMORY

Expt 9: Brown-Peterson

Expt 10: Position Error

WORKING MEMORY

Expt 11: Irrelevant Speech Effect

Expt 12: Memory Span

Examination: There will be 13 marks for class participation, 12 marks for successful completion of the assignment at the end of each experiment and one end semester research paper of 25 marks which will also include a presentation.

Reference: Francis, Greg, Ian Neath, Daniel VanHorn, *Coglab*, Wadsworth, 2008.

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SEMESTER 6

DRUGS AND COLOUR CHEMISTRY **Course No: S.CHE.6.AC**
FOUR CREDIT COURSE **[60 Lectures]**

Learning Objectives:

1) To familiarize students with the mode of action of drugs.
2) To understand the uses and the side effects of certain drugs for various diseases.
3) To study the synthesis of different drugs
4) To study the nomenclature and characteristics of dyes.
5) To study the concept of colour and its relation to chemical structure.
6) To familiarize the students with the types of fibres, application of dyes and how the dyes are attached to them.
7) To familiarize the students with the synthesis of some representative dyes.
8) To create an awareness of the current concern about the toxicity of dyes and their effect on ecology.

UNIT I **(15 Lectures)**

1.1 General Introduction to drugs. **(7 Lectures)**

1.1.1: Definition of drug, requirement of an ideal drug, classification of drugs (based on Therapeutic action)

1.1.2: Nomenclature of drugs, generic name, brand name, systematic name.

1.1.3: Definition of the following medicinal terms: Pharmacon, Pharmacophore, Prodrug, Half-life efficiency, LecturesD_{50}, ED_{50}, Therapeutic index.

1.1.4: Brief idea of the following terms: receptors, drug-receptor interaction, drug potency, Bioavailability, drug toxicity, drug addiction, spurious drugs, misbranded drugs, Adulterated drugs, Pharmacopoeia.

1.2 Routes of drug administration and dosage forms: **(3 Lecture)**

1.2.1: Oral and parenteral routes with advantages and disadvantages.

1.2.2: Formulations, different dosage forms (emphasis on sustained release formulations.)

1.3 Synthesis of following drugs. **(5 Lectures)**

Paracetamol, Aceclofenac, Salbutamol, Ciprofloxacin, Metronidazole, Mebendazole, Ethambutol , 5-Fluorouracil, Atenolol, Dapsone and Trimethadione.

UNIT II **(15 Lectures)**

2.1 Pharmacodynamic agents **(9 Lectures)**

A brief introduction of the pharmacodynamic agents and study of their chemical class, Chemical structure, therapeutic uses and side effects.

2.1.1: Analgesics (Narcotics and non-narcotics) and Antipyretics: Classification of analgesics: narcotics and non narcotics. Morphine(phenanthrene alkaloids), Tramadol, Aspirin(salicylates) , Paracetamol (p-amino phenol)

2.1.2: Anti-inflammatory drugs: Mechanism of inflammation and various inflammatory conditions: Prednisolone, Betamethasone (steroids), Aceclofenac (aryl acetic acid), Mefenamic acid (N-aryl anthranilic acid.)

2.1.3: Drugs for respiratory system: General idea of Expectorant, Mucolyte, Bronchodilators, Decongestants and Antitussives. Bromhexine (phenyl methyl amines), Salbutamol, Pseudoephedrine (phenyl ethyl amines), Oxymetazoline (imidazolines), Codeine phosphate (opiates)

2.1.4: Drug metabolism: Introduction, absorption, distribution, biotransformation, excretion, different types of chemical transformation of drug with specific examples .

2.2 Chemotherapeutic agents **(6 Lectures)**

A brief introduction of the chemotherapeutic agents and study of their chemical class, chemical structure, therapeutic uses and side effects.

2.2.1: Antibiotics: Definition, characteristics and properties: Amoxicillin, Cloxacillin (β-lactam antibiotic), Cephalexin (cephalosporins), Doxycycline (tetracyclines), Ciprofloxacin (quinolone)

2.2.2: Antitubercular and antileprotic drugs: Study of tuberculosis – types, symptoms, and diagnosis of tuberculosis.

Types of leprosy: General idea of antibiotics used in their treatment: PAS (aminosalicylates), Isoniazid (hydrazides), Pyrazinamide (pyrazine), (+) Ethambutol (aliphatic diamines), Ethionamide (thioamides), Dapsone(sulfonamides), Clofazimine(phenazines) .Combination therapy to be discussed.:

i) Rifampicin + Ethambutol +Pyrazinamide.
ii) Rifampicin + Isoniazid + Pyrazinamide.
iii) Rifampicin + Clofazimine + Ethionamide.

Unit III: **(15 Lectures)**

3.1 : Introduction to dyestuff chemistry **(3 Lectures)**

3.1.1 : Definition of dyes, properties (colour and fastness).

3.1.2 : Important milestones in the development of synthetic dyes.

3.1.3 : Nomenclature of commercial dyes with at least one example.
Suffixes – G, O, R, B, 6B, L, S; colour index and colour index number.

3.2 : Classification of dyes based on constitution **(3 Lectures)**
(Examples as mentioned below with structures)

I : Nitro dyes – Naphthol Yellow S
II : Nitroso dyes – Gambine Y
III : Azo dyes –
  a) Monoazo dyes – Orange IV
  b) Disazo dyes – Congo Red
  c) Trisazo dyes – Direct Deep Black
IV : Diphenylmethane dyes – Auramine O
V : Triphenylmethane dyes –
  a) Diamines – Malachite Green
  b) Triamines – Crystal Violet
  c) Phenols – Phenolphthalein
VI : Heterocyclic dyes –
  a) Xanthenes – Eosine
  b) Azines – Safranine T
  c) Thiazines – Methylene Blue
VII : Anthraquinone dyes - Alizarin, Alizarin Cyanine Green G, Indanthrone
VIII : Indigoid dyes - Indigo
IX : Phthalocyanines - Monastral Fast Blue BS

3.3 : Classification of dyes based on application (6 Lectures)

Definition, fastness properties and applicability on substrates, examples with structures.

a) Acid dyes – Orange II, Alizarin Cyanine Green G.
b) Basic dyes – Crystal Violet, Bismark Brown.
c) Direct Cotton Dyes – Chrysophenine G.
d) Azoic dyes – Diazo components: Fast Red B Base, Fast Blue B Base; Coupling components: Naphthol AS, Naphthol AS-G.
e) Mordant dyes – Eriochrome Black T, Alizarin.
f) Vat dyes – Indigo, Indanthrene.
g) Disperse dyes–Celliton Scarlet B, Disperse Yellow 6G

3.4 : Colour and chemical constitution of dyes (3 Lectures)

3.4.1 Absorption of visible light, colour of wavelength absorbed and complementary colour, chromogen, chromophore, auxochrome, bathochromic and hypsochromic shifts.

3.4.2 : Relation of colour to resonance in the following classes of dyes : Azo, Triphenylmethane, Anthraquinone.

Unit IV:
(15Lectures)

4.1 : Organic Pigments (2 Lectures)

General idea, difference between dyes and pigments. Important characteristics of organic pigments, toners and lakes. Classification of organic pigments with suitable examples, i.e. ionic pigments (lakes of acid and basic dyes), nonionic pigments (azo, indigoids, anthraquinone), uses of pigments.

4.2 : Synthesis of specific dyes and their uses (7 Lectures)

i) Orange IV from sulphanilic acid
ii) Bismark Brown from m-phenylenediamine
iii) Malachite Green by using benzaldehyde and N,N-dimethylaniline
iv) Methylene Blue by using 4-amino-N,N dimethylaniline and N,N dimethylaniline
v) Congo Red from nitrobenzene
vi) Eriochrome Black T from β – naphthol
vii) Alizarin from anthraquinone
viii) Indigo from aniline
ix) Indanthrene from anthraquinone

x) Disperse Yellow 6G from benzanthrone

4.3 : Types of fibres and classes of dyes applicable to it (2 Lectures)
Introduction to the following types of fibres with structures and classes of dyes applicable to these fibres : Cotton, wool, silk, polyester.

4.4 : Forces binding dyes to the fibres: Ionic forces, hydrogen bonds, Van der Waals forces, covalent linkages. **(2 Lectures)**

4.5 : Basic operations involved in a dyeing process (1 Lecture)
Preparation of fibre for dyeing, preparation of the dye bath, application of the dye And finishing

4.6 : Ecology and toxicity of dyes (1 Lecture)
Brief idea of environmental pollution and health effects due to dyes.

REFERENCES

1) Pharmacology and pharmaceutics Vol.I and II, Satoskar
2) Textbook of organic, medicinal, and pharmaceutical chemistry, Wilson and Gisvold
3) Textbook of medicinal chemistry, William O. Foye and David A. William
4) Medicinal chemistry, G. R . Chatwal
5) Chemistry of synthetic dyes, Vol. I to VI, K. Venkataraman
6) Chemistry of synthetic dyes and pigments, H. A. Lubs
7) Colour Chemistry, H. Zollinger
8) Colour Chemistry, R. L. M. Allen
9) Unit process, Groggins
10) Synthetic dyes, M. S. Yadav
11) Physical Chemistry of dyeing, Thomas Vickerstaff
12) Chemistry of dyes and principles of dyeing, V. A. Shenai
13) Practical Organic Chemistry, A. I. Vogel

CIA I : Short answer questions 20 MARKS

CIA II: Questions on syntheses of drugs and dyes 20 MARKS

Template of Question Paper

DRUGS AND COLOUR CHEMISTRY **COURSE: S.CHE.6.AC.01**

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 OBJECTIVES	24	24	12	60
% WEIGHTAGE	40	40	20	100

End Semester Paper Pattern :

Total marks : 60 **Maximum time : 2 hours**

Total no. of questions: 4 [all compulsory] of 15 marks each

1 question per unit:

Questions set out of 22 marks [50 % internal choice]

Sub questions will not exceed 5 marks

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SYLLABUS UNDER AUTONOMY
CHEMISTRY

PRACTICAL COURSE IN T.Y.B.Sc. **COURSE: S.CHE.6.AC.01.PR**

I. **PREPARATIONS**

1. Aspirin from Salicylic acid.
2. p-Nitroacetanilide from Acetanilide.
3. p-Nitroaniline from p-Nitroacetanilide.
4. m-Dinitrobenzene from Nitrobenzene
5. Fluorescein from Phthalic Anhydride
6. Anthraquinone from Anthracene

II. **ESTIMATIONS**

1. Estimation of Iodine in Tincture Iodine
2. Estimation of Ibuprofen
3. Estimation of Methyl Orange/Eriochrome Black T/Congo Red by colorimetry

CIA : ESTIMATION OF DRUG/DYE **15 MARKS**

JOURNAL **5 MARKS**

END SEMESTER PRACTICAL EXAMINATION **30 MARKS**

PREPARATION OF DRUG/DYE

The practical exam will be conducted for 1 session of 3 hours duration.

BATCH SIZE FOR:

REGULAR PRACTICALS **20 STUDENTS PER IN-CHARGE**

EXAMINATIONS **MAXIMUM 20 STUDENTS PER BATCH**

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4th Semester Syllabus for Core Component Course in Chemistry, St. Xavier's College – Autonomous, Mumbai.

SYLLABUS UNDER AUTONOMY
CHEMISTRY (CROSS FACULTY)

SEMESTER IV **COURSE: SPC.4.01**

CHEMISTRY IN CONTEXT: APPLYING CHEMISTRY TO SOCIETY

[45 LECTURES]

LEARNING OBJECTIVES

Course Objectives

The goal of ***'Chemistry in Context'*** is to establish a relationship of chemical principles with significance to social, political, economic, and ethical issues. This introductory chemistry course for non-science majors explores the intersection of chemistry with everyday life.

The course includes topics such as nuclear energy and energy alternatives; health, food and nutrition, kitchen chemistry, plastics, chemicals in the environment, synthetics, and applications of chemistry to the visual arts.

- This course is intended for non-science students to

1. Develop an appreciation for the importance of the role of chemistry in everyday life.
2. Improve their ability to think critically and logically.
3. Make students more aware of the chemicals found in all aspects of daily life.
4. Become knowledgeable about the connection between chemistry and pollution, health care, energy, nutrition and life, and visual arts.
5. Apply knowledge of chemistry to improve quality of life.

UNIT I: History And Relevance Of Chemistry (15 L)

1.1: Life without Chemistry

1.1.1: Chemistry matters.

1.2: Chemistry of Life

1.2.1: Introduction.

1.2.2: Chemical basis of life, Periodic table, Elements in the human body, Essential, Non-essential elements, Criteria of essentiality.

1.3: Food Chemistry

1.3.1: Food processing-colouring and flavouring agents.

1.3.2: Food preservation-viscosity builders-bulking agents and artificial sweeteners.

1.3.3: Food additives and Food colours –permitted and non-permitted.

UNIT II: Chemistry In Everyday Life (15 L)
(Applications, Uses And Impact Of Chemistry)

2.1: Pharmaceuticals

2.1.1: Introduction.

2.1.2: Contribution of chemistry to human health and historical developments in medicine.

2.1.3: Classification of drugs and some common drugs used in our daily life.

2.2: Plastics and Polymers

2.2.1: Introduction to polymers, types of polymers.

2.2.2: Plastic in daily use: HDPE, LDPE, PVC, PET, PP. Environmental Hazards of plastics.

2.2.3: Recycling of plastics International universal recycling codes and symbols for identification.

2.2.4: Biodegradable plastics. Alternatives: Paper news print, writing paper, paper boards, cardboards and Natural materials: Wood, cotton, jute, coir.

2.3: Cosmetics

2.3.1: Basic concepts-composition and classification of creams-sunscreen and suntan lotions-deodorants, talcum powder- dentifiers, lipsticks, oils, face creams, toilet powder, skin products, dental cosmetics, hair dyes, shaving cream, shampoo.

2.4: Soaps and detergents

2.2.1: Soaps - Basic chemical compositions of soaps, Surface active agents, builders, additives, fillers and fragrance, toilet soap, bathing bars, washing soaps. Bio-degradability.

2.4.2: Detergents– Introduction, Detergent action, Significance of acidity and alkalinity.

2.4.3: Common detergent chemicals. Environmental hazards.

UNIT III: Impact Of Chemistry In Other Fields (15 L)

3.1: The Chemistry & Art Connection

3.1.1: The earliest use of colour

3.1.2: Use of colour to decorate the body and surroundings.

3.1.3: Relationship between light and colour

3.1.4: Electromagnetic Spectrum, Cause of colour in objects, Properties of Light. The Nature and Behavior of Light, Mixing Colors: Light vs. Pigments
3.1.5: Colorants: Pigments and Dyes.
3.1.6: Chemistry of art conservation and restoration, Fakes and Forgeries in art.

3.2: The Chemistry and Sports connection
3.2.1: Chemistry of sports materials
3.2.2: Use of performing enhancing drugs in sports.

Mode of Evaluation: (No end semester examination)
Poster Presentation/Model Making/Presentation/Assignment/ Crossword/MCQs

Maximum number of seats: 40

Template of Question Paper

CHEMISTRY IN CONTEXT: APPLYING CHEMISTRY TO SOCIETY
COURSE : SPC.4.01

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	8	8	4	20
II	8	8	4	20
III	8	8	4	20
TOTAL MARKS PER OBJECTIVE	24	24	12	60
% WEIGHTAGE	40	40	20	100

ASSESSMENT GRID AS QUALITY MECHANISMS

St Xavier's College, Mumbai

ASSESSMENT OF POSTER PRESENTATION

Dept. of Chemistry Course Code _____ Date: _____

UID No. _____ Roll No. _____ Marks: _____/20

NAME OF STUDENT: _____

TITLE OF POSTER: _____

Assessment Grid: Place one tick in the appropriate box of a row. Each row should have at least one box ticked. In boxes that have more than one set of marks, cancel out the marks that are not applicable and circle the correct marks. Overall marks should reflect the total of marks in all ticked boxes. Figures in parentheses in each box indicate marks.

Poster: 50%

50%	PRESENTATION	80-100%	60-80%	40-60%	20-40%	0-20%
20% **(4)**	**Content** Summarisation of objectives of the concept, relevance to the concept	Excellent **(4)**	Good **(3)**	Average **(2)**	Poor **(1)**	Very Poor **(0.5)**
20% **(4)**	**Creativity** Choice of materials /accessories, props used for display	Excellent **(4)**	Good **(3)**	Average **(2)**	Poor **(1)**	Very Poor **(0.5)**
10% **(2)**	**Visual Impact** Appeal and Aesthetics	Excellent **(2)**	Good **(1.5)**	Average **(1)**	Poor **(0.5)**	Very Poor **(0)**

Individual Assessment: **20%**

20%	PRESENTATION	80-100%	60-80%	40-60%	20-40%	0-20%
10% (2)	**Presentation Skills**	Excellent (2)	Good (1.5)	Average (1)	Poor (0.5)	Very Poor (0)
10% (2)	**Ability to answer questions** Clarity of thought and confidence	Excellent (2)	Good (1.5)	Satisfactory (1)	Poor (0.5)	Very Poor (0)

Group Assessment: **30%**

30%	PRESENTATION	80-100%	60-80%	40-60%	20-40%	0-20%
15% **(3)**	**Knowledge and Understanding**	Excellent impression of wide reading, good knowledge and awareness **(3)**	Good **(2)**	Satisfactory **(1.5)**	Poor **(1)**	Very Poor **(0.5)**
15% **(3)**	**Content(Structure of presentation)** Key points/ Themes	Excellent **(3)**	Good **(2)**	Satisfactory **(1.5)**	Poor **(1)**	Very Poor **(0.5)**

TOTAL FOR POSTER: _____OUT OF 20 MARKS

COMMENTS :

NAME OF FACULTY MEMBER_____

SIGNATURE: _____

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