DAV UNIVERSITY

Syllabus

Chemistry for B.Sc (Hons)- Physics

2020-2021

Syllabus for B.Sc (Hons) Physics

(Semester 1)

Course Title: Organic Chemistry

Course Code: CHE153

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Organic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following graduation in the course.

Instruction for candidates (Theory Paper)

- The question paper for end-semester examination will have a weightage of 25%. It will consist of 100 objective questions of equal marks. All questions will be compulsory.
- Two preannounced test will be conducted having a weightage of 25% each. Each preannounced test will consist of 20 objective type, 5 short questions/problems on the UGC-NET (objective type) pattern as well as one long answer type question. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt all question. Choice will be given only in long answer type. The question paper is expected to contain problems to the extent of 40% of total marks.
- Four objective/MCQ type surprise test will be taken. Two best out of four objective/MCQ type surprise test will be considered towards final each of 12.5% weightage to the final. Each surprise test will include 20-25 questions.

- The books indicated as text-book(s) are suggestive However, any other book may be followed.

PART A

Compounds of Carbon **(8 Hrs)**

Differences in chemical and physical behavior as consequences of structure. Discussion (with mechanism) of reactions of hydrocarbons' ranging from saturated acyclic and alicyclic, unsaturated dienes and aromatic systems. Huckel rule; as applied to 4n+2 systems. Industrial sources and utility of such compounds in daily life for medicine clothing and shelter.

PART B

Stereochemistry **(15 Hrs)**

Structure, reactivity and stereochemistry. Configuration and conformation. Optical activity due to chirality; d, l, meso and diasteroisomerism, sequence rules. Reactions involving stereoisomerism. Geometrical isomerism – determination of configuration of geometric isomers. E & Z system of nomenclature. Conformational isomerism – conformational analysis of ethane and n-butane; conformations cyclohexane, axial and equatorial bonds, conformations of monosubstituted cyclohexane derivatives. Newman projection and Sawhorse formula, Fischer and flying wedge formulae.

PART C

Alkyl Halides **(8 Hrs)**

Structure of alkyl halides and their physical properties. Preparation from alcohols, hydrocarbons, alkenes and by halide exchange method.

Reactions : (i) Nucleophilic substitution (SN2 and SN1) kinetics, mechanism, stereochemistry, steric and electronic factors, reactivity of alkyl halides, rearrangement, dependence on nucleophile, role of solvent (ii) Elimination E2 and E1 mechanism, stereochemistry, kinetics, rearrangement.

Alcohols **(4 Hrs)**

Structure, physical properties (Hydrogen bonding), Methods of preparation: Grignard synthesis (scope and limitations),

Reactions: Reactions with hydrogen halides. Mechanism and rearrangement, Reaction with Phosphorous trihalides, mechanism of Dehydration rearrangement.

PART D

Ethers **(2 Hrs)**

Structure, Physical properties, preparation (Williamson synthesis). Reactions: Cleavage, by acids, Electrophilic substitution in ethers.

Aldehydes and Ketones **(8 Hrs)**

Structure, Physical Properties; Methods of Preparation: Oxidation of Primary and secondary alcohols, Oxidation of methylbenzenes, Reduction of acid chlorides, Friedel- Crafts Acylation, Reactions; Nucleophilic addition, Addition of Grignard reagents, Addition of cyanide. Addition of Bisulphite, Addition of derivatives of ammonia. Acetal Formation, Cannizzaro reaction, Aldol Condensation.

Suggested Books:

1. Morrison R.N. and Boyd, R.N. *Organic Chemistry*, Pearson Education, Dorling Kindersley (India) Pvt. Ltd.
2. Finar, I.L. *Organic Chemistry* (Volume 1), Pearson Education, Dorling Kindersley (India) Pvt. Ltd.
3. Eliel, E.L. and Wilen, S.H. *Stereochemistry of Organic Compounds*, London: Wiley, 1994.
4. March, Jerry. *Advanced Organic Chemistry: Reactions, Mechanism and Structure*, John Wiley, 6th edition, 2007.

Syllabus for B.Sc (Hons) Physics

(Semester 1)

L	T	P	Credits	Marks
0	0	3	2	50

Course Title: ORGANIC CHEMISTRY LAB

Course Code: CHE154

Time: 04 Hours

Course Objectives:

This course is intended to learn the basic concepts of Organic Chemistry Laboratory. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various experiments have been designed to enhance laboratory skills of the undergraduate students.

Expected Prospective:

The students will be able to understand the basic objective of experiments in organic chemistry, properly carry out the experiments, and appropriately record and analyze the results through effective writing and oral communication skills. They will know and follow the proper procedures and regulations for safe handling and use of chemicals and solvents.

1. Calibration of Thermometer

80-82^o (Naphthalene), 113-114^o (acetanilide).

132.5-133^o (Urea), 100^o (distilled Water)

2. Determination of melting point

Naphthalene 80-82^o, Benzoic acid 121.5-122^o

Urea, 132.5-133^o, Succinic acid 184-185^o

Cinnamic acid 132.5-133^o, Salicylic acid 157-5-158^o

Acetanilide 113-5-114^o, m-Dinitrobenzene 90^o

P-Dichlorobenzene 52^o. Aspirin 135^o.

3. Determination of boiling points

Ethanol 78^o, Cyclohexane 81.4^o, Toluene 110.6^o, Benzene 80^o.

4. Mixed melting point determination

Urea-Cinnamic acid mixture of various compositions (1:4, 1:1, 4:1)

5. Distillation

Simple distillation of ethanol-water mixture using water condenser,

Distillation of nitrobenzene and aniline using air condenser.

6. Crystallization

Concept of induction of crystallization

Phthalic acid from hot water (using fluted filter paper and stemless funnel), Acetanilide from boiling water,

Naphthalene from ethanol,

Benzoic acid from water.

7. Decolorisation and crystallization using charcoal

Decolorisation of brown sugar (sucrose) with animal charcoal using gravity filtration.

Crystallization and Decolorisation of impure naphthalene (100g of naphthalene mixed with 0.3g of Congo Red using 1g decolorising carbon) from ethanol.

8. Sublimation (Simple and Vacuum)

Camphor, Naphthalene, Phthalic acid and Succinic acid.

9. Extraction: the separatory funnel, drying agent:

Isolation of caffeine from tea leaves

10. Steam distillation

Purification of aniline/nitrobenzene by steam distillation.

Suggested Books:

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. and Smith, P.W.G. *Vogel's Text Book of Practical Organic Chemistry*, 5th edition, ELBS, 1989.

2. Pavia, D.L., Lampanana, G.M. and Kriz, G.S. Jr. *Introduction to Organic Laboratory Techniques,* Thomson Brooks/Cole, 3rd edition, 2005.

3. Mann, F.G. and Saunders. P.C. *Practical Organic Chemistry,* London: Green & Co. Ltd., 1978.

4. Svehla, G. *Vogel's Qualitative Inorganic Analysis (revised),* Orient Longman, 7th edition, 1996.

5. Bassett, J., Denney, R.C., Jeffery, G.H. and Mendham, J. *Vogel's Textbook of Quantitative Inorganic Analysis (revised),* Orient Longman, 4th edition, 1978.

Syllabus for B.Sc (Hons) Physics

(Semester 2)

Course Title: Spectroscopy

Course Code: CHE155

Time: 04 Hours

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic of spectroscopy. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the spectroscopy and its applications. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following graduation in the course.

- The books indicated as text-book(s) are suggestive However, any other book may be followed.

PART A

Pure Rotational Spectra (12 Hrs)

Classification of molecules according to their moment of inertia. Rotational energy levels of hydrogen chloride. Determination of molecular geometry by rotational spectrum, isotopic substitution effects. Stark effect, Estimation of molecular dipole moments, Selection rules, Rotational Raman Spectra, anisotropic polarizabilty, specific selection rule in Raman Spectra, Stokes and anti – Stokes lines.

PART B

Vibrational Spectra (12 Hrs)

Diatomic molecules, Force constants, Fundamental vibration frequencies, anharmonicity of molecular vibrations and its effect on vibrational frequencies, second and higher harmonies.

Frequencies of the vibrational transitions of HCl. Vibrational rotation spectra of CO. P, Q and R branches.

PART C

Infrared and Raman Spectra (9 Hrs)

Vibrations of polyatomic molecules. Examples of CO_2, H_2O.Mechanics of measurement of infrared and Raman spectra absorption of common functional groups. Their dependence on chemical environment (bond order, conjugation, hydrogen bonding), the number of active infrared and Raman active lines. Fermi resonance, combination bands and overtones, complications due to interactions of vibrations of similar frequency. Application of IR in structure elucidation of organic compounds.

PART D

UV and Visible Spectroscopy (12 Hrs)

Measurement technique, Beer – Lambert's Law, molar extinction coefficient, oscillator strength and intensity of the electronic transition, Frank Condon Principle, Ground and first excited electronic states of diatomic molecules, relationship of potential energy curves to electronic spectra. Chromophores, auxochromes, electronic spectra of polyatomic molecules. Woodward rules for conjugated dienes, unsaturated carbonyl groups, extended conjugation. Red shift, blue shift, hypo and hyperchromic effects.

Suggested Books:

1. Silverstein, R.M. and Webster, F.X. *Spectrometric Identification of Organic Compounds*, Wiley, 6th edition, 2007.

2. Kemp, W. *Organic Spectroscopy*, ELBS, 1996.

3. Banwell, C.N. *Fundamentals of Molecular Spectroscopy*, Tata McGraw Hill, 4th edition, 1995.

4. Sharma, Y.R. *Elementary Organic Spectroscopy; Principle and Chemical Applications*, S. Chand & Company Ltd., 2005.

Syllabus for B.Sc (Hons) Physics

(Semester 2)

Course Title: Chemistry Lab

Course Code: CHE156

Time: 04 Hours

L	T	P	Credits	Marks	Pass marks
0	0	3	2	50	20

Course Objectives:

This course is intended to learn the basic concepts of Chemistry Laboratory. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various experiments have been designed to enhance laboratory skills of the undergraduate students.

Expected Prospective:

The students will be able to understand the basic objective of experiments in chemistry, properly carry out the experiments, and appropriately record and analyze the results through effective writing and oral communication skills. They will know and follow the proper procedures and regulations for safe handling and use of chemicals and solvents.

1. Determine the strength of HCl solution by titrating against NaOH solution conductometerically.
2. Determination of total hardness of water (tap) using standard EDTA solution and Eriochrome black T indicator.
3. Determination of alkalinity of water.
4. Determination of surface tension of given liquid by using Stalagmometer.
5. Determination of residual chlorine in a water sample.
6. To determine the specific and molecular rotations of an optically active substance by using polarimeter.
7. To determine the composition of an unknown solution with a polarimeter.
8. Determination of the viscosity of given lubricating oil by using Redwood Viscometer.
9. Determination of distribution coefficient of I_2 between CCl_4 and Water.
10. To study the kinetics of hydrolysis of methyl acetate in the presence of hydrochloric acid.

Suggested Books:

1. Levitt, B.P. *Findlays Practical Physical Chemistry,* London & New York: Longman Group Ltd. 8th edition, 1978.

2. Khosla, B.D., Garg, V.C. and Gulati, A. *Senior Practical Physical Chemistry,* New Delhi: R.Chand & Co., 11thedition, 2002.

3. Das, R.C. and Behra, B., *Experimental Physical Chemistry,* Tata McGraw Hill Publishing Co. Ltd., 1983.

4. *Vogel's Textbook of Quantitative Chemical Analysis* (revised by Jeffery, Bassett, Mendham and Denney), 5th edition, ELBS, 1989.

5. Svehla, G. *Vogel's Qualitative Inorganic Analysis (revised),* 6th edition, New Delhi: Orient Longman, 1987.

6. Christian G.D. *Analytical Chemistry,* John Wiley & Sons Inc.

Syllabus for B.Sc (Hons) Physics

(Semester 3)

Course Title: Inorganic Chemistry

L	T	P	Credits	Marks
4	0	0	4	100

Course Code: CHE253

Time: 04 Hours

Course Objectives:

This course is intended to learn the basic concepts of Inorganic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following graduation in the course.

PART A

Atomic Structure and periodic properties (12 Hrs)

Wave mechanical model of Hydrogen atom, The de Broglie relationship, The uncertainty principle, Schrodinger wave equation and its derivation, Significance of Ψ and Ψ^2, Quantum numbers, Normal and orthogonal wave functions, Pauli's exclusion principle, Hund's rule of maximum multiplicity, Aufbau principle and its limitations. Concept of extra stability of half and completely filled electronic configuration, Electronic configuration of elements, Penetration and shielding (The Slater's rules). The origin and distribution of the elements, The structure of the periodic table, Atomic parameters and their variation in periodic table, Electronegativity and various scales.

PART B

Ionic Compounds (Bonding and structures) (12 Hrs)

Properties of ionic substances, Occurrence of ionic bonding, The radius ratio rules, Efficiency of packing, Hexagonal close packing, Cubic close packing, Structures of different crystal lattices, Sodium chloride, Cesium chloride, Wurtzite, Zinc blende, Fluorite, Rutile, Cristobalite, Nickel arsenide, Calcium carbide, Lattice energy, Born-Haber cycle, The calculations of the lattice energy on the basis of Born-Lande equation, Covalent character in predominantly ionic compounds, Imperfections of crystals, Polarizing power and polarizabilty of ions, Fajan's rule.

PART C

Covalent Bond (12 Hrs)

The Lewis theory, Valence bond theory - A mathematical approach, Resonance, Valence Shell Electron Pair Repulsion Model (VSEPR theory), Prediction of structures and variation of bond angles on the basis of VSEPR theory, Shortcomings of VSEPR theory. Concept of hybridization, Rules for obtaining hybrid orbitals, Extent of d-orbital participation in molecular bonding (SO_2, PCl_5, SO_3), Molecular orbital theory (LCAO method), Symmetry of molecular orbitals, Applications of MOT to homo- and hetero-nuclear diatomic molecules, Molecular orbital energy level diagrams (Be_2, N_2, O_2, F_2, NO, CO, HCl, NO_2, BeH_2).

PART D

Coordination chemistry (8 Hrs)

Werner's theory, nomenclature of coordination complexes, isomerism in coordination complexes, chelating agents, metal chelates and chelate effects, names and abbreviations of important ligands, polydenate ligands, polypyarzolyborates, macrocylic ligands, macrocylic effect, ketoenolates, troplonates, tripod ligands, conformation of chelate rings, factors determining kinetic and thermodynamic stability.

Suggested Books:

1. Shriver, D.F.C., Atkins, P.W. and Langford, C.H. *Inorganic Chemistry,* ELBS Oxford, 1991.

2. Huheey, J.E. Keiter, E.A. and Keiter, R.L. *Inorganic Chemistry,* 4th edition, Singapore: Pearson Education, 1999.

3. Lee, J.D. *Concise Inorganic Chemistry,* ELBS, Oxford, 1994.

BSc (Physics)

Syllabus for B.Sc (Hons) Physics

(Semester 3)

Course Title: Inorganic Chemistry Lab

L	T	P	Credits	Marks
0	0	3	2	50

Course Code: CHE254

Time: 04 Hours

Course Objectives:

This course is intended to learn the basic concepts of Inorganic Chemistry Laboratory. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various experiments have been designed to enhance laboratory skills of the undergraduate students.

Expected Prospective:

The students will be able to understand the basic objective of experiments in inorganic chemistry, properly carry out the experiments, and appropriately record and analyze the results through effective writing and oral communication skills. They will know and follow the proper procedures and regulations for safe handling and use of chemicals and solvents.

Qualitative Analysis

Identification of cations and anions in a mixture which may contain combinations of acid ions. These must contain interfering acid anions and one, the insoluble.

a) Special Tests for Mixture of anions

I. Carbonate in the presence of sulphate.

II. Nitrate in the presence of nitrite

III. Nitrate in the presence of bromide and iodide.

IV. Nitrate in the presence of chlorate.

V. Chloride in the presence of bromide and iodide.

VI. Chloride in the presence of bromide.

VII. Chloride in the presence of iodide.

VIII. Bromide and iodide in the presence of each other and of chloride.

IX. Iodate and iodide in the presence of each other.

X. Phosphate, arsenate and arsenite in the presence of each other.

XI. Sulphide, sulphite, thiosulphate and sulphate in the presence of each other.

XII. Borate in the presence of copper and barium salts.

XIII. Oxalate in the presence of fluoride.

XIV. Oxalate, tartrate, acetate, citrate in the presence of each other.

b) Separation and identification of cations in mixtures

i) Separation of cations in groups.

ii) Separation and identification of Group I, Group II (Group IIA and IIB), Group III, Group IV, Group V and Group VI cations.

Suggested Books:

1. Svehla, G. and Sivasankar, B. *Vogel's Qualitative Inorganic Analysis (revised)*, Pearson, 7th edition, 1996.
2. Bassett, R. C., Denney, G. H. and Jeffery, J. Mendham, *Vogel's Textbook of Quantitative Inorganic Analysis (revised)*, 4th edition, Orient Longman, 1978.

Syllabus for B.Sc (Hons) Physics

(Semester 5)

Course Title: PHYSICAL CHEMISTRY

Course Code: CHE353

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Time: 04 Hours

Course Objectives:

This course is intended to learn the basic concepts of Physical Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of physical chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following graduation in the course.

PART A

Chemical Thermodynamics (15Hrs)

Objectives and limitations of Chemical Thermodynamics, State functions, thermodynamic equilibrium, work, heat, internal energy, enthalpy.

First Law of Thermodynamics: First law of thermodynamics for open, closed and isolated systems. Reversible isothermal and adiabatic expansion/compression of an ideal gas. Irreversible isothermal and adiabatic expansion, .Enthalpy change and its measurement, standard heats of formation and absolute enthalpies. Kirchhoff's equation.

Second and Third Law: Various statements of the second law of thermodynamics. Efficiency of a cyclic process (Carnot's cycle), Entropy, Entropy changes of an ideal gas with changes in P,V, and T, Free energy and work functions, Gibbs-Helmholtz Equation., Criteria of spontaneity in terms of changes in free energy, Third law of thermodynamics, Absolute entropies.

PART B

Chemical Equilibrium (5 Hrs)

General characteristics of chemical equilibrium, thermodynamic derivation of the law of chemical equilibrium, Van't Hoff reaction isotherm. Relation between Kp, Kc and Kx. Temperature dependence of equilibrium constant-Van't Hoff equation, homogeneous & heterogeneous equilibrium, Le Chetalier's principle.

PART C

Chemical Kinetics (15 Hrs)

Rates of reactions, rate constant, order and molecularity of reactions. Chemical Kinetics: Differential rate law and integrated rate expressions for zero, first, second and third order reactions. Half-lifetime of a reaction, Methods for determining order of reaction, Effect of temperature on reaction rate and the concept of activation energy, Reaction mechanism, Steady state hypothesis

Catalysis

Homogeneous catalysis, Acid-base catalysis and enzyme catalysis (Michaelis-Menten equation). Heterogeneous catalysis, Unimolecular surface reactions.

PART D

Electro-Chemistry (5 Hrs.)

Specific conductance, molar conductance and their dependence on electrolyte concentration, Ionic Equilibria and conductance, Essential postulates of the Debye-Huckel theory of strong electrolytes, Mean ionic activity coefficient and ionic strength, Transport number and its relation to ionic conductance and ionic mobility, Conductometry titrations, pH scale, Buffer solutions, salt hydrolysis, Acid-base indicators.

Electrochemical cells (5Hrs.)

Distinction between electrolytic and electrochemical cells, Standard EMF and electrode potential, Types of electrodes, Reference electrode, Calculation of NG, NH, NS and equilibrium constant from EMF data, Potentiometric determination of pH, Potentiometric titrations.

Suggested Books:

1. Atkins, P.W. *Physical Chemistry*, Oxford University Press, 8th edition, 2006 (Indian Print).

2. Engel, T. and Reid, P. *Physical Chemistry*, Pearson Education, 1st edition, 2006.

3 Castellan, G. W. *Physical Chemistry*, Wisley/Narosa, 3rd edition, 1985 (Indian Print).

4. Barrow, G. M. *Physical Chemistry*, New York: McGraw Hill, 6th edition, 1996.

5. Silbey, R. J., Albert, R. A. and Bawendi, Moungi G. *Physical Chemistry,* 4th edition, New York: John Wiley, 2005.

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Syllabus for B.Sc (Hons) Physics

(Semester 5)

Course Title: Physical Chemistry Lab

Course Code: CHE354

L	T	P	Credits	Marks	Pass marks
0	0	3	2	50	20

Time: 04 Hours

Course Objectives:

To teach the fundamental concepts of Physical Chemistry and their applications. The syllabus pertaining to B.Sc. (Other branches.) in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Expected Prospective:

The students will be able to understand the basic objective of experiments in organic chemistry, properly carry out the experiments, and appropriately record and analyze the results through effective writing and oral communication skills. They will know and follow the proper procedures and regulations for safe handling and use of chemicals and solvents.

1. Treatment of experimental data

Recording of experimental data. Significant number, accuracy and precision, error analysis.

2. Liquids and Solutions

(i) To determine relative viscosities of aqueous solutions of glycerol at different concentrations.

(ii) Calculate partial molar volume of glycerol at infinite dilution from density measurement.

(ii) To determine viscosity-average molecular weight, number-average molecular weight and mean diameter of polyvinyl alcohol molecule from intrinsic viscosity data.

3. Thermochemistry

(i) To determine heat capacity of a calorimeter and heat of solution of a given solid compound.

(ii) To determine heat of solution of Solid calcium chloride and calculate lattice energy of calcium chloride using Born-Haber cycle.

(iii) To determine heat of hydration of copper sulphate.

4. Distribution Law

(i) To determine distribution (i.e. partition) coefficient of a solute between water and a non-aqueous solvent.

5. Surface Phenomena

To study the adsorption of acetic acid/oxalic acid from aqueous solution on charcoal. Verify Freundlich and Langmuir adsorption isotherms.

6. Colorimetery

(i) To verify Lambert-Beer law.

7. pH-metry

(i) To titrate a strong acid against a strong base pH-metrically.

(ii) To titrate a weak acid against a strong base and determine the ionization constant of the weak acid.

Suggested Books

1. Levitt, B.P. *Findlays Practical Physical Chemistry,* London & New York: Longman Group Ltd., 8th edition, 1978.

2. Khosla, B.D., Garg, V.C. and Gulati, A. *Senior Practical Physical Chemistry,* New Delhi: R. Chand & Co., 11thedition, 2002.

3. Das, R.C. and Behra, B. *Experimental Physical Chemistry,* Tata McGraw Hill Publishing Co. Ltd. 1983.

4. *Vogel's Textbook of Quantitative Chemical Analysis* (revised by Jeffery, Bassett, Mendham and Denney), ELBS, 5th edition, 1989.

5. Svehla, G. *Vogel's Qualitative Inorganic Analysis (revised),* 6th edition, New Delhi: Orient Longman, 1987.

6. Christian, G.D. *Analytical Chemistry,* Wiley, 6th edition.