PARUL UNIVERSITY - FACULTY OF APPLIED SCIENCE

Department of Chemistry

SYLLABUS FOR 5th Sem B.Sc. PROGRAMME

Organic Chemistry -I (11105301)

Type of Course: B.Sc./IMSc
Prerequisite
Rationale:
Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/	Lab Hrs/		T	P	T	CE	P	
4	-	-	4	60	-	20	20	-	100

Lect - Lecture, **Tut**- Tutorial, **Lab**- Lab, **T** - Theory, **P** - Practical,**CE** - CE, **T** - Theory, **P** - Practical

Sr.No	Topic	Weightage	Teaching Hrs.
1	**Unit-1**:**Carboxylic Acids and its derivatives**: Nomenclature and acidity of carboxylic acids, Effects of substituents on acid strength. Preparation: Oxidation of primary alcohols, alkylbenzenes, Carbonation of Grignard reagents, Hydrolysis of nitriles. Reactions of carboxylic acids: Hell-Volhard- Zelinsky reaction, Reduction, Conversion into acid chlorides, anhydrides, esters and amides, Mechanism of esterification, trans-esterification, Reduction of carboxylic acids, Mechanism of decarboxylation. Methods of formation and chemical reactions of halo acids, Hydroxy acids: malic, tartaric and citric acids. Methods of formation and chemical reactions of unsaturated monocarboxylic acids. Preparation and chemical reactions of dicarboxylic acids e.g. oxalic acid, succinic acid and malonic acid. Effect of heat and dehydrating agents.	25%	15
2	**Unit-2: Amines** Introduction. Nomenclature of 1°, 2° and 3° amines. Physical properties of amines. Preparation of amines: reduction of nitro compounds, Ammonolysis of halides, Reductive amination, Reduction of nitriles, Reduction of amides, Hofmann degradation of amides, Gabriel phthalimide synthesis, Synthesis of secondary and tertiary amines, Structure and basicity of amines. Effect of substituent on basicity of aromatic amines; Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Hofmann bromamide reaction, Amine salts as phase-transfer catalysts, Electrophilic aromatic substitution in aryl amines.; Distinction between 1°, 2°and 3° amines with Hinsberg reagent and nitrous acid. Diazotisation and its mechanism; Synthetic applications of Diazonium salts, Azo coupling and Electrophilic substitution reactions, Sandmeyer reaction.	25%	15

3	**Unit-3**: **Oxidation and Reduction of Organic compounds** Manganese (VII) oxidants: Potassium permanganate and Manganese dioxide. Chromium (VI) oxidants: Chromic acid, Sodium or Potassium dichromate, Jones reagent, Chromium trioxide-Pyridine complex, Pyridinium chlorochromate, Pyridinium dichromate. Oxidation with Peracids; Oxygen; Ozone; Hydrogen peroxide; Lead tetra acetate; Selenium dioxide; Osmium tetraoxide; Periodic acid; Dimethyl sulfoxide and N- Bromosuccinimide. Classes of reducing agents, Reduction with molecular hydrogen, Meta reduction, Hydride transfer reduction, Reduction with low valent non-metallic compounds.	25%	15
4	**Unit-4: Aromaticity and chemistry of aromatic hydrocarbons** Aromaticity, Huckel Rule, Benzene structure and stability, Electrophilic aromatic substitution reaction and mechanism, Effect of substituent groups, Activity and orientation of substituted benzenes. Polynuclear hydrocarbons: Introduction to structure and aromaticity of Naphthalene, Anthracene and Phenanthrene. Preparation and Chemical properties of Naphthalene, Anthracene and Phenanthrene. Non-aromatic, Anti-aromatic, and Homo aromatic compounds, Aromaticity in Non-Benzenoid compounds. Frost circle and determination of aromatic character using energy level diagram of molecular orbital.	25%	15

*** Continuous Evaluation**

It consists of Assignments/Seminars/Presentations/Quiz/Surprise Tests (Summative/MCQ) etc

Reference/Recommended books

1. Organic Chemistry; Morrison, R. N. & Boyd, R. N.; Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
2. Organic Chemistry (Volume 1); Finar, I. L.; Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. A Text Book of Organic Chemistry; Arun Bahl and B.S. Bahl; Sultan Chand & Sons, New Delhi
4. Organic Chemistry; Graham Solomons, T.W.; John Wiley & Sons, Inc.
5. Organic Chemistry Volume I; S M Mukherji , S P Singh, R P Kapoor; New Age International (P) Ltd
6. Organic Chemistry Second Edition – Mehta and Mehta; PHI Learning Pvt. Ltd.

PARUL UNIVERSITY - FACULTY OF APPLIED SCIENCE

Department of Chemistry

SYLLABUS FOR 5th Sem B.Sc. PROGRAMME

Inorganic Chemistry - I (11105302)

Type of Course: B.Sc./IMSC

Prerequisite:

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/	Lab Hrs/		T	P	T	CE	P	
4	-	-	4	60	-	20	20	-	100

Lect- Lecture, **Tut**- Tutorial, **Lab**- Lab, **T** - Theory, **P** - Practical,**CE** - CE, **T** - Theory, **P** - Practical

Sr.No	Topic	Weightage	Teaching Hrs.
1	**Unit-1: Hydrogen and Hydrides, Alkali and Alkaline Earth Metals** Hydrogen and Hydrides: Electronic structure, abundance, preparation and properties, isotopes, ortho- and para hydrogen; Hydrides: ionic, covalent, metallic and intermediate hydrides; Hydrogen bonding. Alkali metals: Introduction, halides, oxides and hydroxides, salts of oxo-acids, aqueous solution chemistry, complexes and organometallic Compounds. Alkaline Earth metals: Introduction, Halides, oxides and hydroxides, Salts of oxo-acids, aqueous solution chemistry, Complexes and organometallic compounds.	25%	15
2	**Unit-2: Boron group** Introduction, diborane and hydrogen compounds of the other elements, metal borides, halides and complex halides of B, Al, Ga, In and Tl, oxides, oxo-acids, oxo-anions and hydroxides; nitrogen derivatives; Al, Ga, In and Tl salts of oxo- acids and aqueous solution chemistry, organometallic compounds.	25%	15
3	**Unit-3 Chemistry of Metallic Carbonyls and Nitrosyls** Metallic Carbonyls: General methods of preparation, general properties, Structure and nature of M-CO bonding in carbonyls, Effective atomic number (EAN) rule as applied to metallic carbonyls, 18-electron rule as applied to metallic carbonyls, Examples of metal carbonyls. Metallic Nitrosyls: Some metallic nitrosyls, Effective atomic number (EAN) rule as applied to metallic nitrosyls.	25%	15

4	**Unit-4 Halogens and Noble gases** Introduction; hydrogen halides; general considerations of halides; interhalogen compounds and polyhalogen ions; oxides and oxyfluorides of Cl, Br and I; oxo-acids of halogens and their salts; aqueous solution chemistry; organic derivatives. Noble gases: Introduction; compounds of Xe, Kr and Rn.	25%	15

*** Continuous Evaluation**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc

Reference/Recommended Books

1. Inorganic Chemistry, N. N. Greenwood A. Earnshaw., Butterworth-Heinemann
2. Basic Inorganic Chemistry, Novel F. Albert Cotton and Geoffrey Wilkinson, Wiley
3. Advanced Inorganic Chemistry (Volume-II) Satya Prakash, G. D. Tuli, S. K. Basu & R D Madan, S Chand & Co Ltd
4. Concise Inorganic Chemistry, J. D. Lee, Wiley India Pvt. Ltd.
5. Principles of Inorganic Chemistry, B. R. Puri, L. R. Sharma ; K. C. Kalia; S Chand and Company

PARUL UNIVERSITY - FACULTY OF APPLIED SCIENCE

Department of Chemistry

SYLLABUS FOR 5th Sem B.Sc. PROGRAMME

Physical Chemistry - I (11105303)

Type of Course: B.Sc./IMSC

Prerequisite:

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/	Lab Hrs/		T	P	T	CE	P	
4	-	-	4	60	-	20	20	-	100

Lect- Lecture, **Tut**- Tutorial, **Lab**- Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Sr.No	Topic	Weightage	Teaching Hrs.
1	**Unit-1: The Colloids** Introduction: Definition, Types of Colloidal systems, Lyophilic and Lyophobic sols or colloids and their characteristics, Comparison of Lyophilic and Lyophobic sols, Preparation, purification and properties of sols, Gold numbe and its significance, Associated colloids, Emulsions and its properties, Types o Gels and their properties, Applications of Colloids	25%	15
2	**Unit-2: The Phase Rule** Statement of the Phase Rule, Explanation of the terms : Phase, Component and Degrees of Freedom with Examples, Derivation of the Phase Rule – One Component System, Phase Diagram along with the Significance of its Characteristics Features, Representation of a Typical Phase Diagram of a One Component System, Metastable Equilibrium, Polymorphism, Experimenta Determination of Transition Point, Explanation of the Phase Diagrams for the Water and Sulphur Systems, Two Component System, Simple Eutectic Diagram, Explanation of the Phase Diagrams of KI-H2O and Ag-Pb System Explanation of the term Congruent Melting Point, Phase Diagram of Mg-Zn System, Numericals.	25%	15

3	**Unit-3: Thermodynamics-I** Introduction, Definition, Scope and Limitations of Thermodynamics, Explanation of various Thermodynamic Terms: System, Surroundings and Boundary, Types of System, Properties of the system, Macroscopic System Macroscopic Properties, State of a system, State Functions and its properties Thermodynamics Equilibrium, Thermodynamic Processes and their types Cyclic Process, Reversible and Irreversible Processes, Conditions fo Reversibility, First law of Thermodynamics : Work & Heat, Common Forms o Work: Gravitational, Electrical and Pressure-Volume work, Isotherma Reversible Expansion of work of an Ideal Gas, Isothermal Reversible Compression Work of an Ideal Gas, Expansion into vacuum, Isotherma Irreversible Expansion Work of an Ideal Gas, Internal Energy, Statements o First Law of Thermodynamics and its justification, Mathematical Expression o First Law of Thermodynamics, Significance of ΔE and its measurements Enthalpy and significance of ΔH, Relationship between ΔH and ΔE for reaction involving solids, liquids and gases, Heat Capacity and its types, Relation between Cp and Cv measurements, Applications and limitations of First Law o Thermodynamics, Numericals	25%	15
4	**Unit-4:Thermodynamics-II** Second law of Thermodynamics : Need for the law, Spontaneous Proces Spontaneity and its Criteria, Entropy and determination ΔS, Physica significance of Entropy , Statements of Second law of Thermodynamics and it importance, Combined forms of first and second laws of Thermodynamic Gibbs Free Energy and its physical significance, Helarholtz Free Energy Spontaneity and Free Energy change, Conditions for spontaneity of a reactio Derivation of Clapeyron-Clausis equation, Integrated form of Clapeyron-Clausius equation for liquid-vapour equilibria, Applications, Numericals	25%	15

*** Continuous Evaluation**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc

Reference/Recommended books

1. Essentials of Physical Chemistry, B. S. Bahl, G. D. Tuli, Arun Bahl , S. Chand & Company Ltd.
2. Physical Chemistry, B. K. Sharma, Goel Publishing House, Meerut
3. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma and Madan S. Pathamia, Visual Publishing Co.
4. Advanced Physical Chemistry, V. K. Gupta and R. G. Sharma , K. Nath and Company, Meerut
5. Advanced Physical Chemistry, Gurdeep Raj, Goel Publishing House, Meerut
6. A Textbook of Physical Chemistry, K. K. Sharma & L. K. Sharma, Vikas Publishing House Pvt. Ltd.
7. Heat Thermodynamics and Statistical Physics, Brijlal, N. Subrahmanyam and P. S. Hemne, S. Chand & Company Ltd.
8. Advanced Physical Chemistry, Gurdeep Raj, Goel Publishing House, Meerut
9. Thermodynamics for Chemists, Samuel Glasstone, Litton Educational Publishing, Inc.Affiliated East-West Press Pvt. Ltd.

PARUL UNIVERSITY - FACULTY OF APPLIED SCIENCE

Department of Chemistry

SYLLABUS FOR 5th Sem B.Sc. PROGRAMME

Industrial chemistry- I (11105304)

Type of Course: B.Sc./IMSC
Prerequisite:
Rationale:
Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/	Lab Hrs/		T	P	T	CE	P	
4	-	-	4	60	-	20	20	-	100

Lect- Lecture, **Tut**- Tutorial, **Lab**- Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Sr.No	Topic	Weightage	Teaching Hrs.
1	**Unit-1: Cement** Introduction - Lime and its manufacture - Gypsum Plaster - Cement - Types of cement and its Chemical Composition. Manufacture of Portland Cement, Chemical Composition of Portland Cement, Setting and Hardening of Portland Cement. Heat of Hydration of Cement, Concrete and RCC - Decay of Concrete.	25%	15
2	**Unit-2: Glass Manufacture** Basic concepts in glass making- role of network formers, network modifiers and intermediate glass making oxides. Manufacture of ordinary glass – melting, Shaping, Annealing; Varieties of glass, Special glasses	25%	15
3	**Unit-3: Paints and Inorganic Pigments** Pigments - Manufacture of white, black and basic colour Inorganic Pigments, characteristics. Constituents of paints, formulation of paints for various purposes, manufacture of paints, Special paints, Emulsion paints	25%	15
4	**Unit-4:Industrial Carbon** Manufacture of various carbon modifications - Lamp black, carbon black, Acetylene black activated carbon by chemical activation and gas activation process. Reactivation, regeneration of activated carbon, Applications. Manufacture of graphite – and amorphous carbon electrodes, carbon fibres	25%	15

*** Continuous Evaluation**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc

Reference/Recommended books

1. Industrial Chemistry – B. K. Sharma, Goel Publishing House, Merrut,1998.
2. Dryden's outlines of Chemical Technology – Gopala Rao and Sitting, East-West Press
3. Shreeve's Chemical Process Industries – George T. Austin, Mograw Hill Intl. Edn.
4. Reigel's Industrial Chemistry – James. A, Kent, CBS Publishers.
5. Chemical Approaches to Synthesis of Inorganic Materials – CNR Rao, Wiley Eastern

PARUL UNIVERSITY - FACULTY OF APPLIED SCIENCE

Department of Chemistry

Syllabus for 5 th sem B.Sc Programme

Modern Physical and Chemical methods in Chemistry - I

Type of Course: B.Sc./IMSC

Prerequisite:

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/	Lab Hrs/		T	P	T	CE	P	
2	-	-	2	60	-	20	20	-	100

Lect- Lecture, **Tut**- Tutorial, **Lab**- Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Sr.No	Topic	Weightage	Teaching Hrs.
1	**Unit-1:Introduction to NMR and ESR** NMR: Basic principles, Theory of NMR instrumentation, Introduction to chemical shift, spin-spin coupling, coupling constant, equivalent and non equivalent protons. Application of NMR in real life. ESR: Principle, Instrumentation and Applications	50%	15
2	**Unit-2: Chromatographic methods** General principles, Classification of chromatographic separation. Ion exchange chromatography (Ion Exchange equlibria, Types of Ion Exchange capacity Application of Ion Exchange resins). Gas Chromatography, Instrumentation and evolution of data. High Performance Liquid Chromatography (HPLC) Principle and Instrumentation. Principles of solvent extraction and choice o solvent	50%	15

*** Continuous Evaluation**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc

References/Recommended books

1. Analytical Chemistry, Gary D. Christian, 6th Edition, John Wiley and Sons Inc. New Jersey.
2. Principles of Instrumental Analysis, Douglas A. Skoog, 3rd Edition, Holt-Saunders International Edition.
3. Instrumental Methods of Chemical Analysis, Galen W. Ewing, 4th Edition, International Student Edition.
4. Instrumental Methods Of Chemical Analysis, Dr. G.R. Chatwal (Author), Sham Anand, Himalaya Publications

PARUL UNIVERSITY - FACULTY OF APPLIED SCIENCE

Department of Chemistry

SYLLABUS FOR 5th Sem B.Sc., IMSC PROGRAMME

Lab 1 (Organic chemistry) (11105305)

Type of Course: B.Sc., IMSC

Prerequisite:

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
Lect Hrs/	Tut Hrs/	Lab Hrs/ Week		External		Internal			
				T	P	T	CE	P	
-	-	3	2	-	30	-	-	20	50

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

List of Practical:

1. Separation & Identification :
    1. Solid+solid (3mixtures)
    2. Liquid+liquid (3mixtures)
    3. Solid+liquid (2mixtures)
2. Estimation :
    1. Aniline
    2. Phenol
    3. Amide

PARUL UNIVERSITY - FACULTY OF APPLIED SCIENCE

Department of Chemistry

SYLLABUS FOR 5th Sem B.Sc., IMSC PROGRAMME

Lab 2 (Inorganic chemistry) (11105306)

Type of Course: B.Sc., IMSC

Prerequisite:

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/	Tut Hrs/	Lab Hrs/ Week		T	P	T	CE	P	
-	-	3	2	-	30	-	-	20	50

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

List of Practical:

1. Gravimetric Analysis
2. Volumetric Analysis
3. Synthesis
4. Qualitative Analysis
5. Analysis of Brass

PARULUNIVERSITY - FACULTY OF APPLIED SCIENCE

Department of Chemistry

SYLLABUS FOR 6th Sem B.Sc. PROGRAMME

Industrial Chemistry –II (11105354)

Type of Course: B.Sc./IMSc

Prerequisite:

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/	Lab Hrs/		T	P	T	CE	P	
4	-	-	4	60	-	20	20	-	100

Lect- Lecture, **Tut**- Tutorial, **Lab**- Lab, **T** - Theory, **P** - Practical,**CE** - CE, **T** - Theory, **P** - Practical

Sr.No	Topic	Weightage	Teaching Hrs.
1	**Unit-1: Chemical Technology** Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid liquid extraction, separation by absorption and adsorption. An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills emulgators. Scaling up operations in chemical industry.	25%	15
2	**Unit-2:.Industrial Gases and Inorganic Chemicals** Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene. Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid caustic soda, common salt, borax, bleaching powder, sodium thiosulphate hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.	25%	15

3	**Unit-3: Fuel Chemistry** Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value. Coal: Uses of coal in various industries, its composition, carbonization of coal Coal gas, producer gas and water gas—composition and uses. Fractionation o coal tar, uses of coal tar bases chemicals, requisites of a good metallurgica coke, Coal gasification (Hydro Gasification and Catalytic gasification), Coa liquefaction and Solvent Refining. Petroleum and Petrochemical Industry: Composition of crude petroleum Refining and different types of petroleum products and their applications Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG,CNG, LNG bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide Isoprene, Butadiene, Toluene and its derivatives Xylene.	25%	15
4	**Unit-4: Oils and Fats** Classification of oils, fat splitting, distillation of completely miscible and non-miscible oils, hydrogenation of oils, rancidity, saponification value, iodine number, acid value, Soap and Synthetic Detergent, preparation of soap and detergent, different types of soap and their composition, surfactants, detergent binders and builders.	25%	15

*** Continuous Evaluation**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc

Reference/Recommended Books:

1. Industrial Chemistry, O. P. Vermani, A. K. Narula, Galgotia Publications Pvt. Ltd., New Delhi.
2. Chemical Process Industries, Vol. I & II, , S. C. Bhatia, CBS Publishers, New Delhi.
3. Engineering Chemistry, P. C. Jain, M. Jain, Dhanpat Rai & Sons, Delhi.
4. Engineering Chemistry, R. Gopalan, D. Venkappayya, S. Nagarajan, Vikas Publications, New Delhi.
5. Engineering Chemistry , B. K. Sharma, Goel Publishing House, Meerut

PARULUNIVERSITY - FACULTY OF APPLIED SCIENCE

Department of Chemistry

Syllabus for 6th sem B.Sc Programme

Modern Physical and Chemical methods in Chemistry - II

Type of Course: B.Sc./IMSC

Prerequisite:

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/	Lab Hrs/		T	P	T	CE	P	
2	-	-	2	60	-	20	20	-	100

Lect- Lecture, **Tut**- Tutorial, **Lab**- Lab, **T** - Theory, **P** - Practical,**CE** - CE, **T** - Theory, **P** - Practical

Sr.No	Topic	Weightage	Teaching Hrs.
1	**Unit-1:Modern Analytical Techniques** Introduction to X-ray Diffraction (XRD), Elemental Analysis: CHNOS-analysis, X- Ray Flourescence Spectrum Analysis. Atomic absorption methods of Analysis. Voltammetry, Electrochemical Impedence Spectroscopy.	50%	15
2	**Unit-2: Characterization techniques** Introduction to Particle size Analyser (Laser scattering), Introduction to Optical Microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Tunnel Microscopy (STM). Auger Emission Spectroscopy, Electron Spectroscopy for Chemical analysis (ESCA), Atomic Force Microscopy	50%	15

*** Continuous Evaluation**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc

References/Recommended books

1. Analytical Chemistry, Gary D. Christian, 6th Edition, John Wiley and Sons Inc. New Jersey.
2. Principles of Instrumental Analysis, Douglas A. Skoog, 3rd Edition, Holt-Saunders International Edition.
3. Instrumental Methods of Chemical Analysis, Galen W. Ewing, 4th Edition, International Student Edition.
4. Instrumental Methods Of Chemical Analysis, Dr. G.R. Chatwal (Author), Sham Anand
5. X-Ray Structure Determination: A Practical Guide, Stout, G.H. and Jensen, L.H., 2nd Ed., John Wiley and Sons, New York