



**JAI HIND COLLEGE
BASANTSING INSTITUTE OF SCIENCE
&
J.T.LALVANI COLLEGE OF COMMERCE
(AUTONOMOUS)**

"A" Road, Churchgate, Mumbai - 400 020, India.

**Affiliated to
University of Mumbai**

Program : B.Sc.

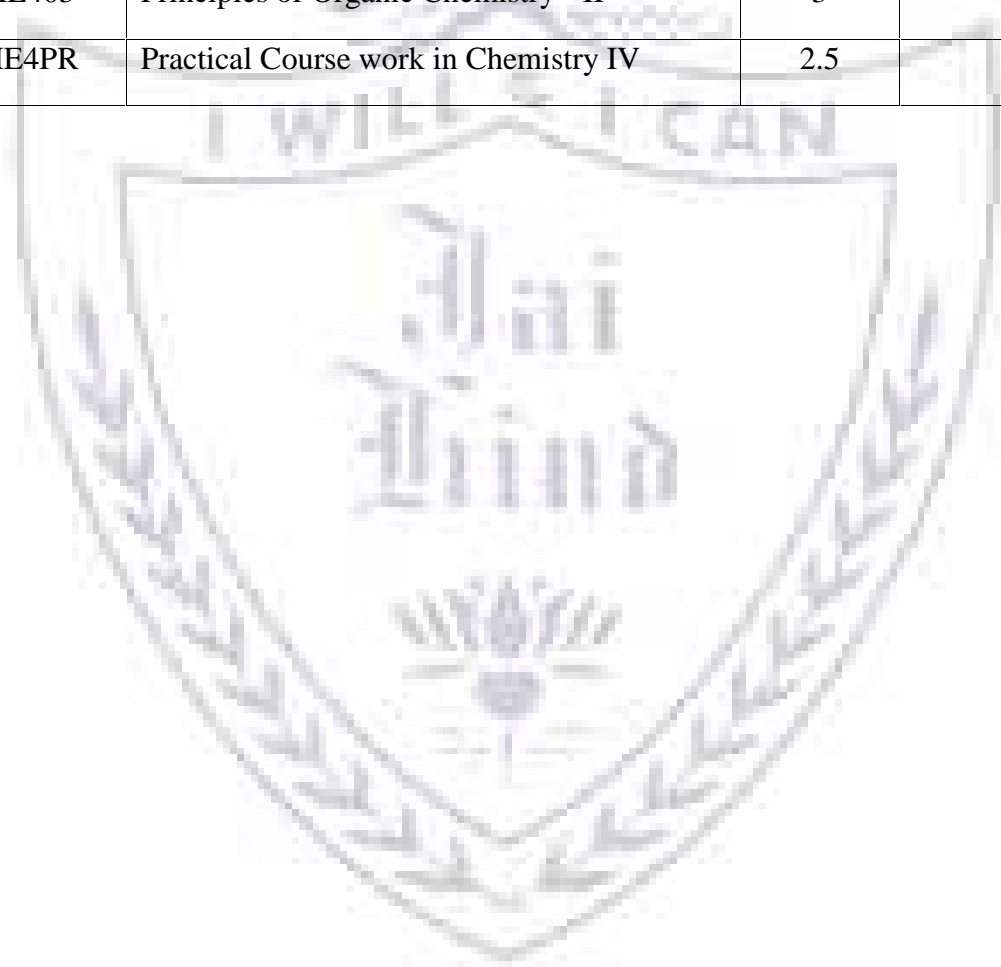
Proposed Course : S.Y. B.Sc. Chemistry

**Credit Based Semester and Grading System (CBCS) with effect from
the academic year 2019-20**

S.Y. B.Sc. Chemistry Syllabus

Academic year 2019-2020

Semester IV			
Course Code	Course Title	Credits	Lectures /Week
SCHE401	Principles of Physical & Analytical Chemistry- II	3	3
SCHE402	Principles of Inorganic Chemistry- II	3	3
SCHE403	Principles of Organic Chemistry - II	3	3
SCHE4PR	Practical Course work in Chemistry IV	2.5	9



Semester IV – Theory

<p>Course: SCHE401</p>	<p>Principles of Physical and Analytical Chemistry II (Credits: 3) Lectures/Week: 3) <u>Course description:</u> Solutions & applications of phase equilibria,</p>	
	<p>Objectives:</p> <ul style="list-style-type: none"> ➤ To learn different types of liquid mixtures and their methods of separation. ➤ To understand the applications of Phase Rule to one, two and three component systems. ➤ To learn characteristic features of cubic crystal lattice in detail. ➤ To understand different features of catalyst and their role in catalysis. ➤ To imbibe basic instrumental techniques and their use in carrying out titrations. ➤ To learn graphical methods of determination of equivalence point for instrumental titrations. 	
<p>Unit I</p>	<p>Unit – I: Solutions & applications of phase equilibria</p> <p>1. Solutions</p> <p>a) Thermodynamics of ideal solutions:</p> <ol style="list-style-type: none"> i. Ideal solutions and Raoult's law, deviations from Raoult's law–non-ideal solutions. ii. Vapour pressure-composition and temperature - composition curves of ideal and non-ideal solutions. iii. Distillation of solutions. Lever rule. Azeotropes. <p>b) Partial miscibility of liquids:</p> <ol style="list-style-type: none"> i. Critical solution temperature; effect of impurity on partial miscibility of liquids with respect to Phenol-Water , Triethanolamine – Water and Nicotine – Water systems <p>c) Immiscibility of liquids- Principle of steam distillation.</p> <ol style="list-style-type: none"> i. Nernst distribution law and its applications, solvent extraction. <p style="text-align: right;">(Numericals expected)</p> <p>2. Applications of Phase Equilibria:</p> <p>a) Recapitulation of Phase Rule</p> <p>b) Derivation of Clapeyron equation , Clausius -Clapeyron equation and its importance in phase equilibria. (Numericals Expected)</p> <p>c) Phase diagrams of:</p> <ol style="list-style-type: none"> i. One component systems (water, carbon dioxide & sulphur) ii. Two component systems: simple eutectic system (Pb-Ag); congruent melting point (Zn-Mg); incongruent melting points (Na-K) iii. Three component systems: triangular plot phase diagram; types of systems; e.g. one pair of immiscible liquids 	<p>15L</p>

<p>Unit II</p>	<p>Unit – II: Solid State & Catalysis</p> <p>1. Solid State:</p> <p>a) Recapitulation: solid state, types of solids, amorphous and crystalline solid</p> <p>b) Properties of crystals:</p> <ol style="list-style-type: none"> i. crystal lattice & lattice points, ii. unit cell, space lattice, iii. laws of crystallography iv. Types of crystals <p>c) Characteristics of crystal lattice:</p> <ol style="list-style-type: none"> i. types of cubic lattices: fcc& bcc; simple cubic ii. interplanar distance in cubic lattices (only expression for ratio of interplanar distances are expected) <p>d) Use of X-rays in the study of crystal structure:</p> <ol style="list-style-type: none"> i. Bragg’s equation (derivation expected), ii. X-rays diffraction method of studying crystal lattice structure, iii. Structure of NaCl and KCl. iv. Determination of Avogadro’s number (Numericals expected) <p>e) Crystal defects – Schottkey and Frenkel defects.</p> <p>2. Catalysis</p> <p>a) Types of catalysis, catalytic activity, specificity and selectivity, inhibitors, catalyst poisoning and deactivation</p> <p>b) Mechanisms and kinetics of acid-base catalyzed reactions, effect of pH</p> <p>c) Mechanisms and kinetics of enzyme catalyzed reactions (Michaelis-Menten equation)</p> <p>d) Effect of particle size and efficiency of nanoparticles as catalyst</p>	<p>15L</p>
<p>Unit III</p>	<p>Unit – III: Instrumental Methods- II</p> <p>1. Potentiometry:</p> <ol style="list-style-type: none"> i. Principle. ii. Role of Reference and indicator electrodes iii. Applications in Neutralization reactions with reference to the titration of a strong acid against a strong base (using quinhydrone electrode) (Numericals expected) iv. Graphical methods for detection of equivalence points <p>2. pH metry:</p> <ol style="list-style-type: none"> i. Principle 	<p>15L</p>

- ii. Combined glass electrode- Principle, Construction, working and precautions.
- iii. Applications of pH metry method in: Titrimetry (strong acid-weak base, weak acid- strong base), biological and environmental analysis.

(Numericals expected)

2. Conductometry:

- i. Principle
- ii. Conductivity cell - construction and care
- iii. Applications in neutralization titrations with respect to:
 - a) Strong acid-strong base
 - b) Strong acid-weak base
 - c) Strong base-weak acid
 - d) Weak acid-weak base
- iv. Advantages & limitations of conductometric titrations.

References:

Unit – I

1. Barrow, G.M., *Physical Chemistry*, Tata McGraw Hill (2007)
2. Levine, I. N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill 2010.
3. B. R. Puri, L.R. Sharma, M. S. Pathania, *Physical Chemistry*, Vishal Publish Co., 45th edn.
4. Glasstone & Lewis, *Elements of Physical Chemistry*.
5. Atkins P. W., and Paula J. De, *Atkin's Physical Chemistry*, 10th edn, Oxford University, 12 press (2014).
6. Castellan, G.W., *Physical Chemistry*, 4th Ed. Narosa (2004)
7. Kotz, J.C., Treichel, P.M. & Townsend, J.R., *General Chemistry*, Cengage Learning India Pvt. Ltd., New Delhi (2009)
8. Mahan, B.H., *University Chemistry*, 3rd Ed. Narosa (1998)
9. Petrucci, R.H., *General Chemistry*, 5th Ed. Macmillan Publishing Co., New York (1985).
10. K. L. Kapoor, *A Textbook of Physical Chemistry*, Vol.1 &2, (3rd Ed.) Macmillan Publishing Co., New Delhi (2001)

Unit II:

1. Barrow, G.M., *Physical Chemistry*, (6th Edition), Tata McGraw Hill Publishing Co. Ltd. New Delhi
2. Levine, I. N., *Physical Chemistry*, (6th Ed. 2010), Tata McGraw Hill
3. Puri, B. R., Sharma, L.R., Pamanian, M.S., *Physical Chemistry*, (45th Ed.), Vishal Publish Co.
4. Glasstone & Lewis, *Principles of Physical Chemistry*
5. Atkins P. W., and Paula J. De, *Physical Chemistry*, 10th ed., Oxford University, 12 press (2014)5.
6. Kapoor, K.L. *Textbook of Physical Chemistry*, (2006) McMillan Publishers.

Unit-III

1. Principles of Instrumental analysis, D. A. Skoog, 5th edition, Chapters: 24 & 25 Page nos: 549 – 580.

2. Vogel's Text book of quantitative chemical analysis, 5th edition. [Chapter 13 (pg. no. 519-527) & chapter 15 (pg. no. 548-590)]
3. Analytical Chemistry by Gary Christian, 5th edition, chapters 11 & 12, pg. nos. 299-370



Course: SCHE402	Principles of Inorganic Chemistry II (Credits: 3 Lectures/Week: 3) <u>Course description:</u> Study of transition elements & co-ordination chemistry,	
	Objectives: <ul style="list-style-type: none"> ➤ To understand the properties of transition elements and their complexes ➤ To correlate the properties of transition metal complexes with the role in biological systems ➤ To understand the properties of the compounds of group 15 & group 18 elements. ➤ To understand the behaviour of ions in aqueous medium and chemistry of non-aqueous solvents. ➤ To introduce the learner to Analytical Separations, separation methods based on various properties of analyte. ➤ To understand principle and method of Solvent extraction and its applications. 	
Unit I	Unit – I: Chemistry of transition elements & Co-ordination Compounds 1. Study of transition elements <ul style="list-style-type: none"> a) Introduction: Electronic configuration with significance of special stability of d^0, d^5 & d^{10} b) Periodic properties: oxidation states, unusual oxidation states and their stabilities in aqueous solutions (with reference to vanadium & chromium) c) Colour: d-d transition, charge transfer (LMCT, MLCT) d) Magnetic properties: origin of magnetism, spin and orbital contribution to magnetic moment, Bohr magnetons (Numericals expected) e) Catalytic properties of d-block elements f) Difference between first series & the other two transition series 2. Coordination Chemistry <ul style="list-style-type: none"> a) Recapitulation of Coordination compounds b) Theories of coordination compounds: 	15L

	<ul style="list-style-type: none"> i. 18 electron rule & applications ii. VBT, applications & limitations <p>c) Metal carbonyls: electroneutrality & back bonding, M-M bonds</p> <p>3. Bioinorganic chemistry:</p> <ul style="list-style-type: none"> a) Biological oxygen carriers- hemoglobin & myoglobin, difference in mechanism of oxygen binding, cooperativity effect, Hill equation, pH dependence of oxygen affinity b) Application of Zn & Co complexes in biological systems 	
Unit II	<p>Unit – II: Selected Topics in p-block chemistry & ions in aqueous and non-aqueous medium</p> <p>a) Selected Topics in p-block Chemistry-II</p> <ul style="list-style-type: none"> i. Oxides & oxoacids of nitrogen, phosphorus, sulphur and chlorine <p>(Study of the above with emphasis on structure, oxidation state, acidity, preparation, properties and uses)</p> <ul style="list-style-type: none"> ii. Chemistry of Xenon and its compounds <p>Occurrence, rationalization of inertness, Nature of bonding, preparation and properties of XeF₂, XeF₄, XeF₆ and oxyhalides. Molecular shapes of noble gas compounds (VSEPR theory)</p> <p>b) Study of Ions in aqueous & non-aqueous medium</p> <ul style="list-style-type: none"> i. Acidity of cations and basicity of anions ii. Hydration and hydrolysis of cations and anions, effect of charge and radius iii. Latimer equation, relationship between pK_a, acidity and z^2/r ratios of ions iv. Classification on the basis of acidity/basicity category v. Chemistry of non-aqueous media (H₂SO₄, HClO₄) 	15L
Unit III	<p>Unit – III: Methods of Separation</p> <p>1. Separation Techniques in Analytical Chemistry</p> <ul style="list-style-type: none"> a. An Introduction to Analytical Separations and its importance in analysis. b. Estimation of an analyte without effecting separation. c. Types of separation methods <ul style="list-style-type: none"> i. Based on Solubilities (Precipitation, Filtration, Crystallization) 	15L

- ii. Based on Gravity- Centrifugation
- iii. Based on volatility-Distillation
- iv. Based on Electrical effects-Electrophoresis
- v. Based on retention capacity of a Stationary Phase-Chromatography
- vi. Based on distribution in two immiscible phases-Solvent Extraction
- vii. Based on capacity to exchange with a resin-Ion Exchange

2. Electrophoresis

- a) Principles
- b) Basic Instrumentation
- c) Working and Application in separation of biomolecules like enzymes and DNA.

3. Solvent Extraction

- a. Introduction, Nernst distribution law, Distribution Ratio, Partition Coefficient.
- b. Conditions of extraction: Equilibration time, Solvent volumes, temperature, pH.
- c. Single step and multi-step extraction, Percentage extraction for single step and multistep extraction. Separation factor. **(Numerical expected)**
- d. Batch and continuous extraction
- e. Counter current extractions –Craig's counter current apparatus

3. Chromatography

- a. Introduction to Chromatography
- b. Classification of chromatographic methods based on stationary and mobile phase
- c. Paper Chromatography: Principle, techniques and applications of Paper Chromatography in separation of cations.
- d. Thin layer Chromatography: Principle, technique and Applications in determining the purity of a given solute; following progress of a given reaction.

References:

Unit I & Unit II:

1. Bruce H. Mahan, *University Chemistry*, Narosa Publishing House,
2. R. Gopalan, *Inorganic Chemistry for Undergraduates*
3. *Chemistry of Transition Element*, Universities Press India Pvt. Ltd.
4. J.D.Lee, *Concise Inorganic Chemistry*, 4th Edⁿ, ELBS,
5. D.F. Shriver & P.W Atkins, *Inorganic Chemistry*, 3rd edn. Oxford University Press (1999)
6. James E. Huheey, *Inorganic Chemistry: Principles of Structure & Reactivity*

7. Emeleus & Anderson, *Modern Aspects of Inorganic Chemistry*
8. Cotton & Wilkinson, *Advanced Inorganic Chemistry*, 3rd Edition,
9. Gary Wulfsberg, *Inorganic Chemistry*, Viva Books Pvt. Ltd., (2002)
10. Puri, Sharma & Kalia, *Principles of Inorganic Chemistry*, Milestone publishers
11. Ramesh Kapoor and R.S. Chopra, *Inorganic Chemistry*, R. Chand publishers, New Delhi.
12. CNR Rao edited, *University General Chemistry*

Unit-III

1. D.A. Skoog, D.M. West, F.J. Holler and Stanley R. Crouch – *Fundamentals of Analytical chemistry*, 8th edition.
2. G.H. Morrison and H. Freiser, *Solvent extraction in analytical chemistry*.
3. Peter A. Sewell and B. Clarke, *Chromatographic separations*, Analytical chemistry by open Learning, John Wiley and sons, 1987.
4. *Modern Analytical Chemistry*, David Harvey (pg. nos. 215 -217 & 597 -606)



<p>Course: SCHE403</p>	<p>Principles of Organic Chemistry-II (Credits: 2 Lectures/Week: 3)</p> <p><u>Course description:</u></p> <p>Functional group chemistry of nitrogen containing compounds; Stereochemistry; Industrial Chemistry</p>	
	<p>Objectives:</p> <ul style="list-style-type: none"> ➤ To describe the mechanism of reactions of carboxylic and sulphonic acids and their derivatives ➤ To compare the acidity of carboxylic and sulphonic acids and their substituted derivatives ➤ To reproduce the chemistry of nitrogen containing organic compounds such as aromatic nitro compounds and aromatic and aliphatic amino compounds ➤ To recapitulate the configurational nomenclature of organic compounds containing two or more than two stereogenic centres; to understand the basic principles of resolution and optical purity ➤ To acquaint the learner with different parameters of a chemical manufacturing plant ➤ To introduce a few products of wide applications made by manufacturing plants 	
<p>Unit I</p>	<p>Unit I: Functional group chemistry of carboxylic and sulphonic acids and their derivatives</p> <p>1. Carboxylic acids & their derivatives:</p> <ol style="list-style-type: none"> a) Applications of carboxylic acid and their derivatives b) Structure & physical properties- effect of substituents on acid strength (aliphatic & aromatic) c) Preparation <ol style="list-style-type: none"> i. Oxidation of alcohols & alkylbenzene ii. Carbonation of grignard iii. Hydrolysis of nitrile iv. Kolbe's reaction d) Reactions: Decarboxylation, reduction with LAH, diborane; HVZ reaction, conversion to acid chlorides, anhydrides, esters & amides and their reactivity e) Mechanism of nucleophilic acyl substitution, interconversion of acid derivatives f) Mechanism of acid catalysed esterification (A_{AC2}) & mechanism of saponification (B_{AC2}) g) Mechanism of Claisen condensation & Dieckmann condensation 	<p>15L</p>

	<p>2. Sulphonic acids</p> <p>a) Applications of sulphonic acids and their derivatives</p> <p>b) Preparation of sulphonic acids by sulphonation of benzene (with mechanism), toluene & naphthalene (thermodynamic & kinetic control)</p> <p>c) Physical properties- comparison of acidity between carboxylic and sulphonic acids</p> <p>Reactions- preparation of sulphonylchlorides, sulphonamides, sulphonic esters & their applications</p>	
Unit II	<p>Unit – II: Chemistry of nitrogen containing compounds & stereochemistry</p> <p>a) Nitro containing compounds</p> <p>i. Preparation (nitration of aromatics)</p> <p>ii. Reduction in acidic, basic, neutral medium & catalytic hydrogenation</p> <p>iii. Test for nitro group (Mulliken's test)</p> <p>b) Amines</p> <p>i. Physical properties: effect of substituent on basicity of aliphatic and aromatic amines</p> <p>ii. Preparation: reduction of nitriles, reductive ammination, Hofmann bromamide reaction</p> <p>iii. Reactions: N-alkylation, N-acylation, quaternization, Hofmann's exhaustive methylation, diazotisation and reaction of diazonium salts- Sandmeyer, Gattermann & coupling reactions, electrophilic substitution in aromatic amines (nitration & sulfonation)</p> <p>iv. Differentiating tests for primary, secondary and tertiary amines (carbylamine, hindsberg test, nitrous acid test)</p> <p>c) Stereochemistry</p> <p>i. Assigning configurational descriptor (R/S & E/Z) for molecules containing 2 or more stereogenic centres.</p> <p>ii. Recapitulation of optical purity and enantiomeric excess</p> <p>iii. Resolution of racemic mixtures- chemical & chromatographic methods</p>	15L
	<p>Unit – III: Aspects of chemical manufacturing processes</p> <p>A. Introduction to aspects of chemical manufacturing plant:</p> <p>i. Significance of location of plant</p> <p>ii. Choice of raw material</p> <p>iii. Energy requirements, availability and conservation</p>	15L

Unit III	<ul style="list-style-type: none"> iv. Capital investment v. Labour: availability; skilled/unskilled vi. Environmental compliance vii. Tax benefits <p>B. Products of Chemical Plants:</p> <p>a) Phase Transfer Catalysts:</p> <ul style="list-style-type: none"> i. Introduction ii. Mechanism of action iii. Advantages with examples <p>b) Perfumes</p> <ul style="list-style-type: none"> i. Introduction ii. Classification (ethers, esters and essential oils) iii. Composition, extraction/isolation, blending and applications iv. Synthesis of and - ionones from citral <p>c) Flavours</p> <ul style="list-style-type: none"> i. Introduction ii. Classification (natural and synthetic) iii. Applications, structure of vanillin, coumarin iv. Synthesis of vanillin <p>d) Sweeteners</p> <ul style="list-style-type: none"> i. Introduction ii. Classification (Natural & Synthetic) iii. Natural- carbohydrates (glucose & fructose) iv. Synthetic- (I) Sucralose; (II) Sulphonamide (saccharin); (III) Peptides, synthesis of aspartame v. Long term side effects of synthetic sweeteners 	
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References:

Unit I & II

1. Morrison, R. T.; Boyd, R. N. (2012). *Organic Chemistry*. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. (2012). *Organic Chemistry (Volume 1)*. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Solomons, T.W.G. (2009). *Organic Chemistry*, John Wiley & Sons, Inc.
4. Ahluwalia, V.K.; Parashar, R.K. (2006) *Organic Reaction Mechanisms*. Narosa

Publishing House.

5. Mukherji; Singh; Kapoor. (2002) *Reaction Mechanisms in Organic Chemistry*.McMillan
6. Mc Murry, J.E. (2013). *Fundamentals of Organic Chemistry, 7th Ed.* Cengage Learning India Edition.
7. Kalsi, P. S. (1990) *Textbook of Organic Chemistry 1st Ed.* New Age International (P) Ltd. Pub.
8. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P. (2012) *Organic Chemistry*. Oxford University Press.

Unit III

1. C. D. Dryden: Outlines of Chemical Technology, edited & revised by M. Gopala Rao & Marshall Sittig East West Press, New Delhi.
2. Faith Keyes and Clerk's Industrial Chemicals, 4th Edn., Wiley Inter-science 1975.
3. Foust A. S. et-al.: Principles of Unit Operations John Wiley & Sons.
4. Macabe W.L., Smith J. C. and Harriott. P. Unit Operations of Chemical Engineering (7th edition) (McGraw Hill Chemical Engineering series).
5. P. H. Groggins: Unit Processes in Organic Synthesis, McGraw Hill.
6. Kirk & Othmer: Encycloepadia of Chemical Technology, John Wiley and sons.
7. A. I. Vogel: Text book of Quantitative Analysis including Instrumental Analysis.
8. A. I. Vogel: Text book of Quantitative Organic Analysis.
9. Industrial Inorganic Chemistry-Buchner, Schliebs, Winter, translated by D. H. Tenell, VCH Publishers, New York.
10. Industrial Organic Chemistry- K. Welssermel, H. J. Arpe, VCH Publishers, New York.
11. B.Pearson- Speciality Chemical Innovations in Industrial Synthesis.
12. Text Book of Organic Medicinal and Pharmaceutical Chemistry Wilson & Giswold
13. Text Book of Pharmacology – Satoskar & Bhandarkar.
14. The Chemistry of Synthetic Dyes – Edited by K. Venkatraman. Academic press Inc. London.
15. Shreeves 'Chemical Process Industries' 5th Edition, G. T. Oustin, McGraw Hill.
16. Industrial Chemistry- B. K. Sharma, Goyal publishing house, Mirut.
17. Riegel's Hand Book of Industrial Chemistry, 9th Edition, Jems A. Kent.
18. Industrial Chemistry- E Stoch, Vol- I, Ellis Horwood Ltd. UK.
19. An Introduction to Industrial Organic Chemistry- Wiseman and Peter,
20. Unit Operations and Processes- P. H. Groggins.
21. Unit Operations I and II- P.P. Kale- Pune VidyarthigruhPrakashan.
22. Unit Operations in Chemical Engineering by W. L. McCabe and Smith.
23. Riegel's Handbook of Industrial Chemistry, J. A. Kent, CBS Publishers, New Delhi
24. Riegel's Handbook of Industrial Chemistry, James A. Kent, 7th Edition, Van Nostrand Reinhold Company.
25. Shreeves 'Chemical Process Industries' 5th Edition, G. T. Austin, McGraw Hill, 1984.

Semester IV – Practical

Course:	Practical Course work in Chemistry-IV (Credits: 2.5 Practicals/Week: 3)
SCHE4PR	<p>PRACTICAL – I</p> <p>Physical Chemistry</p> <ol style="list-style-type: none">1. Extraction of Fe(III) from aqueous medium and determine the distribution ratio and extraction efficiency.2. Compare the strengths of HCl and H₂SO₄ by studying kinetics of acid hydrolysis of methyl acetate.3. To estimate the amount of vitamin C in the given tablet pH-metrically.4. To estimate Fe(II) in the given solution by titrating against potassium dichromate potentiometrically and calculation of percentage error.5. Estimation of given acid (strong/ weak) by conductometric titration with a strong base and calculation of percentage error.6. CST <p>PRACTICAL – II</p> <p>Inorganic Chemistry</p> <p>Inorganic Preparations</p> <ol style="list-style-type: none">1. Triethylenediaminenickel (II) thiosulphate2. Hexamminenickel (II) chloride3. Trithiourea copper (II) sulphate4. Potassium trioxalatoferrate (III) <p>Volumetric Estimation</p> <ol style="list-style-type: none">1. Estimation of Zn(II) by complexometric titration2. Estimation of total hardness of water <p>PRACTICAL – III</p> <p>Organic Chemistry</p> <ol style="list-style-type: none">1. Quantitative Separation of binary mixture (Chemical Separation)<ol style="list-style-type: none">a. Solid-solid binary mixture (Water insoluble-water insoluble)<ol style="list-style-type: none">i. Detection of type of binary mixtureii. Separation of binary mixture (Chemical separation) using a fixing reagent2. Detection of Organic Compounds by Micro scale Organic Spotting

Evaluation Scheme

[A] Evaluation scheme for Theory courses

I. Continuous Assessment (C.A.) - 40 Marks

(i) C.A.-I : Test – 20 Marks

(ii) C.A.-II : Worksheets/assignments/presentations

II. Semester End Examination (SEE)- 60 Marks

[B] Evaluation scheme for Practical courses: SEE for 150 marks

