

**Gujarat University**  
**Syllabus for Chemistry at B. Sc. Semester V**  
**( To be effective from 2013 )**

- CHE 301 Organic Chemistry  
 CHE 302 Inorganic Chemistry  
 CHE 303 Physical Chemistry  
 CHE 304 Analytical Spectroscopic Techniques  
 CHE 305 Subject Elective (Soil Composition and Analysis)  
 CHE 306 Practical:  
 (I) Inorganic Qualitative Analysis  
       &  
       Physical Chemistry (Kinetics, Solubility and Instruments)  
 (II) Organic Preparation  
       &  
       Analytical Chemistry (Estimations and Chromatography)

**Course Structure with respect to credit, hours and marks**

Type of Course	Paper No.	Credit	Total Marks	Internal	External	No. of hours per week	Exam hours
Foundation Course (FC-V)	FC - 301	2	100	30	70	3	3
Core Course	CHE 301	4	100	30	70	4	3
	CHE 302	4	100	30	70	4	3
	CHE 303	4	100	30	70	4	3
	CHE 304	4	100	30	70	4	3
Subject Elective Course (SEC)	CHE 305	2	100	30	70	3	3
Practical Core Course – I and II	CHE 306	5	200	60	140	12	12
<b>Total Credit</b>		25					

N.B.: The practical batch should be maximum of 10 students with respect to the credit.

**Gujarat University**  
**Syllabus for B. Sc. Semester V**  
**CHE - 301 (Organic Chemistry)**

**UNIT I**

**(A) Stereo Chemistry (I) [07 Marks]**

Optical activity in the absence of chiral carbon (Biphenyls, Allenes and Spirans)

**(B) Stereoselectivity and Stereospecificity [07 Marks]**

Stereoselective and stereospecific reactions. Mechanism "Addition of halogens to alkenes". Stereochemistry of E2 reaction (syn and anti elimination).

**UNIT II**

**(A) Inorganic reagents for Organic synthesis [07 Marks]**

Use of specific reagents and their synthetic applications with mechanism.

(i) Aluminium Isopropoxide (ii) Lithium Aluminium Hydride (iii) Adams's catalyst (PtO<sub>2</sub>)

(iv) Selenium Dioxide (v) Osmium Tetroxide (vi) Lead Tetraacetate

**(B) Molecular rearrangements and Name Reactions [07 Marks]**

Rearrangements occurring through Carbocations, carbenes and nitrenes Principle, Mechanism and Synthetic applications of the reactions:

(i) Wolf rearrangement (ii) Fries migration (iii) Hoffmann reaction

(iv) Oppenauer oxidation reaction (v) Diels-Alder reaction (vi) Birch Reduction

**UNIT III**

**(A) Nucleophilic Substitution at a Saturated Carbon Atom [08 Marks]**

Mechanism and scope of reaction-available mechanism, Kinetic Characteristics, Scope of reaction, Stereochemistry of S<sub>N</sub>1 and S<sub>N</sub>2 reactions, Relative reactivity in substitution, Solvent effect, variation at carbon site, Relative leaving group activity, S<sub>N</sub>i (substitution nucleophilic internal) Mechanism and Neighboring group participation. Elimination Reactions, E1, E2 and E1cB mechanism, Orientation E1 and E2 reactions, Elimination Vs Substitution.

**(B) Nucleophilic Aromatic Substitution** **[06 Marks]**

Nucleophilic aromatic substitution, Bimolecular displacement and its mechanism, Reactivity, Orientation, Electron withdrawal by resonance, Evidence for the two steps-mechanism, Elimination-addition mechanism-Benzyne.

**UNIT IV**

**(A) Carbohydrates** **[06 Marks]**

Disaccharides, structure of (+) maltose, (+) cellobiose, (+) lactose and (+) sucrose.

**(B) Purine and Pyrimidines** **[08 Marks]**

(i) Purines – Synthesis of Purines, Adenine and Guanine.

(ii) Pyrimidines – Synthesis of Pyrimidine, Uracil, Thymine and Cytosine.

### Reference Books

- (1) Organic Chemistry: I. L. Finar, Vol-II, 5<sup>th</sup> Edition, Pearson Education Ltd.
- (2) Organic Chemistry: Morrison & Boyd, 6<sup>th</sup> Edition, Prentice Hall of India Pvt. Ltd.
- (3) Stereochemistry of carbon compounds: E. L. Eliel, Wiley Eastern Ltd.
- (4) Stereochemistry and mechanism through solved problems: P. S. Kalsi, New Age International.
- (5) Stereochemistry of Organic Compounds: Principles and Applications: D. Nasipuri; New Academic Science; 4<sup>th</sup> Revised Edition.
- (6) Organic Chemistry: Hendrickson, Cram, Hammond, Mc Graw-Hill.
- (7) Organic Chemistry: 6<sup>th</sup> Edition, John McMurry, Brooks Cole, International Edition.
- (8) Organic Chemistry: T.W. Graham Solomons and Craig B. Fryhle Wiley, 8<sup>th</sup> Edition.
- (9) Organic Chemistry: Francis A. Carey, Mc Graw-Hill, 7<sup>th</sup> Edition.
- (10) Organic Chemistry: Leroy G.Wade, Prentice Hall, 6<sup>th</sup> Edition.
- (11) Organic Chemistry: Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers. Oxford University Press, USA.

**Gujarat University**  
**Syllabus for B. Sc. Semester V**  
**CHE - 302 (Inorganic Chemistry)**

**UNIT I**

**Molecular symmetry**

[14 Marks]

Introduction, symmetry operations and symmetry elements:  $C_n$ ,  $\sigma$ ,  $S_n$ ,  $i$  and  $E$ .

Point groups for the molecules (excluding  $S_{2n}$  and  $I_h$ ).

Multiplication tables of  $C_{2v}$ ,  $C_{2h}$  and  $C_{3v}$  point groups.

**UNIT II**

**(A) Chemical bonding (I)**

[07 Marks]

VB and MO treatment of  $H_2$  and  $H_2^+$ , comparison of VB and MO

MO treatment of  $[FeF_6]^{-4}$ ,  $[Fe(CN)_6]^{-4}$ ,  $[V(CN)_6]^{-3}$ ,  $[IrF_6]^{-4}$ ,  $[NiF_4]^{-2}$ ,  $[PtCl_4]^{-2}$  and  $[Ni(CN)_4]^{-2}$ .

**(B) Boron hydrides**

[07 Marks]

Preparation, properties and structure of diborane.

Types of bonds found in higher boranes.

Structure of  $B_4H_{10}$ ,  $B_5H_9$ ,  $B_5H_{11}$ ,  $B_6H_{10}$  and  $B_{10}H_{14}$ .

**UNIT III**

**(A) Co-ordination chemistry**

[07 Marks]

Reaction, kinetics and mechanism. Trans effect and trans influence, Applications of trans effect in synthesis and analysis.

Theories of trans effect: Polarisation theory,  $\pi$ -bonding theory, MO theory.

Lability, inertness, stability and instability.

**(B) Kinetics and reaction rates of substitution**

[07 Marks]

Ligand field effect and reaction rates, mechanism of substitution reaction. Nucleophilic substitution reaction ( $S_N1$  and  $S_N2$ ) in octahedral complexes.

Substitution in square planar Pt (II) complexes. Substitution in octahedral Co (III) complexes.

Acid hydrolysis, base hydrolysis. Cis effect.

Electron transfer reaction. Mechanism of redox reaction (inner-sphere and outer-sphere).

## UNIT IV

### (A) Inorganic polymers

[07 Marks]

Classification of inorganic polymers.

Polymers containing boron and silicon: methods of preparation, physical and chemical properties, structures and their uses.

### (B) Mossbauer Spectroscopy

[07 Marks]

Principle and Instrumentation.

Experimental technique

Application for iron complexes

## Reference Books

- (1) Concise Inorganic Chemistry: J.D. Lee; Wiley India, 5<sup>th</sup> Edition (1996).
- (2) 'Shriver and Atkins' Inorganic Chemistry: Atkins, Overton, Rourke, Weller, Armstrong; Oxford University Press, 5<sup>th</sup> Edition (2011).
- (3) Advanced Inorganic Chemistry: F.A. Cotton and Wilkinson G.; John Wiley, 5<sup>th</sup> Edition (1988).
- (4) Introductory Quantum Chemistry: A.K. Chandra; Tata- McGraw Hill, 4<sup>th</sup> Edition (1994).
- (5) Quantum chemistry: R.K. Prasad; New Age International, 4<sup>th</sup> Edition (2010).
- (6) Electron and chemical bonding: H. B. Grey, W.A. Benjamin. INC, New York.
- (7) Inorganic chemistry: James E. Huheey, 4<sup>th</sup> Edition, Wesley Publishing Company.
- (8) Mechanism of Inorganic reaction: Basalo and Pearson, 2<sup>nd</sup> Edition, Wiley Eastern Pvt Ltd.
- (9) Introduction to Advanced Inorganic chemistry, Durrant and Durrant, John Wiley.
- (10) Advanced Inorganic chemistry: (Vol. 1) Satya Prakash, Tuli, Basu and Madan; S. Chand
- (11) Advanced Inorganic chemistry: Gurdeep Raj; Goel Publishing House, 23<sup>rd</sup> Edition (1998).

**Gujarat University**  
**Syllabus for B. Sc. Semester V**  
**CHE - 303 (Physical Chemistry)**

**UNIT I**

**Thermodynamics**

[14 Marks]

Zeroth law of Thermodynamics, Clausius - Clapeyron equation, Trouton's Rule, Craft's equation, van't Hoff's isotherm and isochore equations.

**UNIT II**

**Electrochemistry**

[14 Marks]

Electrochemical cell and Electrolytic cell, Reversible and irreversible electrodes and cell, Poggendorff's compensation method and Weston cell, Reference electrodes (i) Saturated Calomel Electrode (ii) Standard Hydrogen Electrode (iii) Quinhydrone Electrode, Nernst's single electrode potential equation, Applications of emf measurements to calculate  $\Delta G$ ,  $\Delta G^\circ$ ,  $\Delta H$ ,  $\Delta S$ ,  $K_{eq}$ ,  $K_{sp}$ ,  $K_w$  and  $K_h$ .

**UNIT III**

**(A) Chemical Kinetics**

[07 Marks]

Prediction of reaction rate, Primary and secondary salt effect, Heterogeneous reactions, Retarded reaction.

**(B) Polymer Chemistry**

[07 Marks]

Polymerization and types of Polymerization, Co-polymers, Bio-polymers, Polymer additives, Thermodynamics of polymer solution, Molecular weight determination of polymers: Number average molecular weight, Weight average molecular weight, Viscosity and Osmotic pressure method.

## UNIT IV

### (A) Nuclear Chemistry

[07 Marks]

Detection of isotopes, Velocity focusing mass spectrograph, Bainbridge and Neiers mass spectroscopy, Double focusing mass spectroscopy, Applications of isotopes and trace technique examples

### (B) Molecular spectra

[07 Marks]

Pure rotational spectra, Equation for frequency of pure rotational spectral line, Vibrational-Rotational spectra, Equation for frequency of vibrational-rotational spectral line, Ortho and Para hydrogen.

## Reference Books

- (1) Physical Chemistry: G. M. Barrow, 5<sup>th</sup> Edition, McGraw-Hill education, India.
- (2) Advanced Physical Chemistry: Gurdeep Raj, 35<sup>th</sup> Edition (2009), Goel / Krshina Publishing House.
- (3) Principles of Physical Chemistry: Puri, Sharma and Pathania, 42<sup>nd</sup> Edition, Vishal Publishing Company.
- (4) Polymer Science: Gowariker, Viswanathan and Sreedhar, 1<sup>st</sup> Edition (2012 reprint) New Age International.
- (5) Essentials of Nuclear Chemistry: Arnikaar, 4<sup>th</sup> Edition (2012 reprint), New Age International.
- (6) Physical Chemistry: Atkins, 9<sup>th</sup> Edition. Oxford University Press.
- (7) Advanced Physical chemistry: Gurtu and Gurtu, 11<sup>th</sup> Edition , Pragati Prakashan.
- (8) Physical chemistry: Levine, 6<sup>th</sup> Edition, McGraw-Hill education, India.

**Gujarat University**  
**Syllabus for B. Sc. Semester V**  
**CHE - 304 (Analytical Spectroscopic Techniques)**

**UNIT I**

**(A) Ultraviolet Spectroscopy [08 Marks]**

Origin of UV Spectra, Principle, Electronic transition ( $\sigma\text{-}\sigma^*$ ,  $n\text{-}\sigma^*$ ,  $\pi\text{-}\pi^*$  and  $n\text{-}\pi^*$ ), relative positions of  $\lambda_{\text{max}}$  considering conjugative effect, steric effect, solvent effect, red shift (bathochromic shift), blue shift (hypsochromic shift), hyperchromic effect, hypochromic effect (typical examples). Aromatic and Polynuclear aromatic hydrocarbons.

**(B) Ultraviolet Spectroscopy (Problems) [06 Marks]**

Problems of Dienes and enones using Woodward-Fieser rules. Problems of aromatic ketones, aldehydes and esters using empirical rules.

**UNIT II**

**(A) Infrared Spectroscopy [08 Marks]**

Introduction, principle of IR spectroscopy, instrumentation, sampling technique, selection rules, types of bonds, absorption of common functional groups. Factors affecting frequencies, applications. Application of Hooke's law, characteristic stretching frequencies of O-H, N-H, C-H, C-D, C=C, C=N, C=O functions; factors affecting stretching frequencies (H-bonding, mass effect, electronic factors, bond multiplicity, ring size).

**(B) Raman Spectra [06 Marks]**

Basic principal, Instrumentation, Application of Raman spectra, Comparison of IR and Raman spectra.

**UNIT III**

**(A) Nuclear Magnetic Resonance [07 Marks]**

Principal, Magnetic and non magnetic nuclei, absorption of radio frequency. Equivalent and non equivalent protons, chemical shifts, anisotropic effect, relative strength of signals, spin-spin coupling, long range coupling, coupling constant, Deuterium labelling, applications to simple structural problems.

**(B) Problems based on Spectral data [07 Marks]**

Structural problems based on UV, IR and NMR



## UNIT IV

### (A) Visible Spectroscopy

[06 Marks]

Introduction, Beer Lambert's law, instrumentation (light source, optical system, wavelength selector, light sensitive device), Accuracy and error of Spectrophotometry.

### (B) Atomic Spectroscopy

[08 Marks]

Introduction, Principle, Flame Emission Spectroscopy (FES) and Atomic adsorption Spectroscopy (AAS), Principal, comparison and applications, Burners (Total consumption burner and Premix burners), Inductively coupled plasma Emission Spectroscopy (ICPES)

## Reference Books

- (1) Introduction to Spectroscopy: Donald L. Pavia, Gary M. Lampman, George S. Kriz  
Cengage Learning; 4<sup>th</sup> Edition.
- (2) Spectrometric Identification of Organic Compounds: Robert M. Silverstein, Francis X. Webster, David Kiemle Wiley; 7<sup>th</sup> Edition.
- (3) Infrared spectra of Complex molecules: J. Bellamy, John Wiley & Sons, Inc., 3<sup>rd</sup> Edition.
- (4) Spectroscopic Method in Organic Chemistry: Dudley Williams, Ian Fleming McGraw-Hill Education; 6<sup>th</sup> Edition.
- (5) Applications of spectroscopic techniques in Organic Chemistry: P.S. Kalsi, New Age International; 6<sup>th</sup> Edition.
- (6) Elementary Organic Spectroscopy; Principles And Chemical Applications: Y. R. Sharma, S. Chand & Co Pvt Ltd.
- (7) Fundamentals of Molecular Spectroscopy: C. M. Banwell and E. McCash, Tata McGraw Hill, 4<sup>th</sup> Edition.
- (8) Modern Raman Spectroscopy: A Practical Approach; Ewen Smith, Geoffrey Dent., Wiley; 1<sup>st</sup> Edition.

**Gujarat University**  
**Syllabus for B. Sc. Semester V**  
**CHE – 305 (Subject Elective)**  
**Soil Composition and Analysis**

**Unit I**

**Introduction to Soil Chemistry** [14 Marks]

Importance of soil, soil formation, composition of soil, the soil profile, types of soil, micro and macro plant nutrients.

**Unit II**

**Analysis of Primary Nutrients** [14 Marks]

Soil fertility and productivity, techniques for the analysis of soil, soil reaction, determination of total nitrogen in soil, determination of phosphorus in soil, determination of potassium in soil by flame photometry.

**Unit III**

**Analysis of Secondary Nutrients** [14 Marks]

Determination of total sulphur in soil, determination of calcium in soil, determination of magnesium in soil, determination of lime and liming material in soil. Mechanical analysis of soil.

**Unit IV**

**Analysis of Micro Nutrients** [14 Marks]

Determination of total manganese in soil, determination of Fe (II) and Fe (III) in soil, determination of silica in soil, determination of soluble salts in soil, determination of sodium in soil by flame photometry.

**Reference Books**

- (1) Environmental Chemistry: H. Kaur, Pragati Prakashan, 2<sup>nd</sup> Edition.
- (2) Soils in our Environment: Raymond W. Miller, Duane T. Gardiner, Prentice Hall, 8<sup>th</sup> Edition.

**GUJARAT UNIVERSITY**  
**Syllabus for B. Sc. Chemistry Semester V**  
**CHE - 306**  
**Practical [I] (Inorganic and Physical Practicals)**

**[A] Inorganic Qualitative Analysis:**

Inorganic Qualitative Analysis of mixture containing six radicals only.  
(Minimum 08 mixtures to be done)

**[B] Physical Chemistry (Kinetics, Solubility & Instruments)**

**(1) Kinetics and solubility:**

Investigate the order of reaction in experiments no. 1, 2 and 3 by graphical method.

Exp 1: Reaction between  $K_2S_2O_8$  and  $KI$  ( $a \neq b$ )

Exp 2: Reaction between  $KBrO_3$  and  $KI$  ( $a = b$ )

Exp 3: Reaction between  $H_2O_2$  and  $HI$  ( $a \neq b$ )

Exp 4: Determine the heat of solution of a given substance (Oxalic acid and Benzoic acid) by solubility method.

**(2) Instruments:**

Exp 1: Determine dissociation constant of monobasic acid ( $CH_3COOH$ ) using pH meter.

Exp 2: Determine the amount of bases in given mix ( $NaOH+NH_4OH$ ) Conductometrically using standard solution of  $HCl$

Exp3: Determine the amount of ferrous in the given solution of Ferrous Ammonium Sulphate potentiometrically using standard  $KMnO_4$  solution.

Exp 4: Determine the concentration of  $Cu^{2+}$  and  $Fe^{3+}$  in the given solution by Colourimetry.

**Reference Books**

- (1) Vogel's "Textbook of Quantitative Chemical Analysis": Pearson Education Ltd. 6<sup>th</sup> Edition, 2008.
- (2) Vogel's "Qualitative Inorganic Analysis": Pearson Education Ltd. 7<sup>th</sup> Edition, 2009.
- (3) Gurdeep Raj, "Advanced Practical Inorganic Chemistry": Krishna Prakashan, Meerut, 21<sup>st</sup> Edition, 2009.
- (4) J. B. Yadav, "Advanced Practical Physical Chemistry": Krishna Prakashan, Meerut, 29<sup>th</sup> Edition, 2010.
- (5) P. H. Parsania, "Experiments in Physical Chemistry": Neminath Printers Rajkot 1<sup>st</sup> Edition 2004.
- (6) A. M. James and F. E. Prichard, "Practical Physical Chemistry": Longman Group Limited London 3<sup>rd</sup> Edition Reprinted 1979.

**Semester V**  
**CHE - 306**  
**Practical [II] (Organic and Analytical Practicals)**

**[A] Organic Preparation:**

- (i) Nitration of Acetanilide
- (ii) Acetanilide from Aniline (Green Preparation)
- (iii) Benzilic Acid from Benzil (Green Preparation)
- (iv) 1,5-Diphenyl-penta-1,4-diene-3-one from Benzaldehyde and Acetone (Green Preparation)
- (v) Diels-Alder reaction between furan and maleic acid (Green Preparation)

**[B] Analytical:**

**(B-1) Organic Estimation:**

- (i) Unknown Acid (e.g., Oxalic, Succinic, Citric, Tartaric, Benzoic, Phthalic and Cinnamic acid)
- (ii) Ketone (Acetone)
- (iii) Ester

**(B-2) Chromatography [TLC]**

Analysis of the following drugs by Thin Layer Chromatography.

- (i) Aspirin      (ii) Paracetamol      (iii) Ibuprofen

**Reference Books**

- (1) A. I. Vogel, "Elementary Practical Organic Chemistry Part-II, Qualitative Organic Analysis": CBS Publishers & Distributors, New Delhi, 2<sup>nd</sup> Edition, 2004.
- (2) A. I. Vogel, "Elementary Practical Organic Chemistry Part III Quantitative Organic Analysis": CBS Publishers & Distributors, New Delhi, 2<sup>nd</sup> Edition, 2004.
- (3) Hand book of Organic qualitative analysis by H. T. Clarke.
- (4) Practical Organic Chemistry: F. G. Mann and B. C. Saunders. Low – priced Text Book. ELBS, Longman.
- (5) V.K. Ahluwalia, Sunita Dhingra, "Comprehensive Practical Organic Chemistry – Qualitative Analysis": University Press (India) Private Limited, Hyderabad, 1<sup>st</sup> Indian Edition, 2010.
- (6) "Advanced Practical Organic Chemistry": Stanley Thornes Publishers Ltd., J Leonard, B Lygo, G Procter, 1<sup>st</sup> Indian Edition, 2004.
- (7) "Quantitative Analysis": R. A. Day, A. L. Underwood, Prentice-Hall of India Pvt. Ltd., New Delhi, 6<sup>th</sup> Edition, 2004.