

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

- CHE 307 Organic Chemistry
 CHE 308 Inorganic Chemistry
 CHE 309 Physical Chemistry
 CHE 310 Analytical Chemistry
 CHE 311 Subject Elective (Nanomaterials and Nanotechnology)
 CHE 312 Practical:
 (I) Inorganic Quantitative Analysis
 &
 Physical Chemistry (Kinetics and Instruments)
 (II) Organic (Separation and Identification)
 &
 Analytical Chemistry (Volumetric Analysis)

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-VI)	FC - 302	2	100	30	70	3	3
Core Course	CHE 307	4	100	30	70	4	3
	CHE 308	4	100	30	70	4	3
	CHE 309	4	100	30	70	4	3
	CHE 310	4	100	30	70	4	3
Subject Elective Course (SEC)	CHE 311	2	100	30	70	3	3
Practical Core Course – I and II	CHE 312	5	200	60	140	12	12
Total Credit		25					

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

Gujarat University
Syllabus for B. Sc. Semester VI
CHE - 307 (Organic Chemistry)

UNIT I

(A) Stereo Chemistry (II) [08 Marks]

Concept of prostereo isomerism and chiral synthesis (Asymmetric Induction), Cram's rule, Prelog's generalization, Prelog's rule and assignment of configuration.

(B) Stereochemistry of compounds other than Carbon [06 Marks]

Stereo chemistry of the compounds containing Nitrogen. Phosphorus and Sulphur

UNIT II

(A) Alkaloids [07 Marks]

Classification, General method of determining structure, analytical and synthetic methods, structure of Coniine, Nicotine, Atropine and Papaverine.

(B) Isoprenoids (Terpenoids) [07 Marks]

Classification, General method of determining structure, Isoprene rule, Chemistry of Citral, α -Terpineol, Camphor and their synthesis, study of reactions of β -carotene (No Synthesis).

UNIT III

(A) Synthetic Dyes [06 Marks]

Classification of Dyes- Anionic and Cationic dyes, Mordant and Vat dyes, Reactive and Dispersed dyes, Synthesis of Alizarin, Malachite green, Indigo, Congo red, Eosin.

(B) Explosives [04 Marks]

Preparation of RDX, PETN, Nitroglycerine, Tetryl.

(C) Pesticides [04 Marks]

Preparation of Aldrine, Malathion, Parathion, Methoxychlor.

UNIT IV

(A) Synthetic Drugs

[08 Marks]

General Classification, Chemotherapy, Antipyretics, Analgesics, Hypnotics, Sedatives, Anaesthetics, Antimalerials, Antiseptics, Cardiovascular drugs. (Minimum two illustrations of each, only names without structures). Methods of preparation and uses of Antipyrine, Phenacetin, n-Hexyl resorcinol, Alprazolam, Zaleplon, Benzocaine, Lidocaine, Chloroquine, Atenolol, Sulphadiazine, Trimethoprim and Tolbutamide.

(B) Vitamins

[06 Marks]

Structure and Biochemistry of Vitamin-A (A_1) (Retinol), Vitamin-B₆ (Pyridoxine).

Reference Books

- (1) Organic Chemistry: I. L. Finar, Vol-II, 5th Edition, Pearson Education Ltd.
- (2) Organic Chemistry: Morrison & Boyd, 6th 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; 4th Revised Edition.
- (6) Organic Chemistry: Hendrickson, Cram, Hammond, Mc Graw-Hill.
- (7) Organic Chemistry: 6th Edition, John McMurry, Brooks Cole, International Edition.
- (8) Organic Chemistry: T.W. Graham Solomons and Craig B. Fryhle Wiley, 8th Edition.
- (9) Organic Chemistry: Francis A. Carey, Mc Graw-Hill, 7th Edition.
- (10) Organic Chemistry: Leroy G.Wade, Prentice Hall, 6th Edition.
- (11) Organic Chemistry: Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers. Oxford University Press, USA.

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Syllabus for B. Sc. Semester VI
CHE - 308 (Inorganic Chemistry)

UNIT I

(A) Term symbol

[07 Marks]

Russel Saunders coupling and determination of Term symbols of the ground state. Calculation of number of microstates. Pigeon hole diagram of p^2 and d^2 configurations. Hund's rule. Hole formulation.

(B) Electronic spectra of metal complexes

[07 Marks]

Electronic spectra of transition metal complexes, Laporte orbital and spin selection rules. Orgel energy level diagram of d^5 and combined diagrams of $d^1 - d^9$, $d^2 - d^8$, $d^3 - d^7$, $d^4 - d^6$ and their spectra. Jahn Teller distortion. Spectrochemical series.

UNIT II

Quantum chemistry

[14 Marks]

Setting up of operators for different observables, Hermitian operator, important theorems concerning Hermitian operator, Particle in a three dimensional box, The rigid Rotator, The Schrodinger equation in spherical polar coordinates for hydrogen atom, separation of variables, solution of R, Θ and Φ equations.

UNIT III

Chemical bonding (II)

[14 Marks]

The Huckel Molecular Orbital (HMO) theory, variation principle, solution of Secular equation, HMO treatment to ethylene molecule, allylic cation, allylic free radical and allylic anion, Hybridization: Hybridization wave functions of sp , sp^2 and sp^3 .

UNIT IV

(A) Metal carbonyls

[07 Marks]

Mono and poly-nuclear metal carbonyls: $\text{Ni}(\text{CO})_4$, $\text{Fe}(\text{CO})_5$, $\text{Cr}(\text{CO})_6$, $\text{Fe}_2(\text{CO})_9$, $\text{Fe}_3(\text{CO})_{12}$, $\text{Co}_2(\text{CO})_8$, $\text{Mn}_2(\text{CO})_{10}$, $\text{Ir}_4(\text{CO})_{12}$, $\text{Co}_4(\text{CO})_{12}$.

Metal nitrosyl and metal carbonyl hydrides. Application of IR spectra in the determination of structure of metal carbonyls.

(B) Organometallic compounds

[07 Marks]

Definition, classification, synthesis (general methods), properties, structure and application of organometallic compounds of Mg, Al and Be, Structure of Ferrocene and dibenzene chromium.

Reference Books

- (1) Concise Inorganic Chemistry: J.D. Lee; Wiley India, 5th Edition (1996).
- (2) 'Shriver and Atkins' Inorganic Chemistry: Atkins, Overton, Rourke, Weller, Armstrong; Oxford University Press, 5th Edition (2011).
- (3) Advanced Inorganic Chemistry: F.A. Cotton and Wilkinson G.; John Wiley, 5th Edition (1988).
- (4) Introductory Quantum Chemistry: A.K. Chandra; Tata- McGraw Hill, 4th Edition (1994).
- (5) Quantum chemistry: R.K. Prasad; New Age International, 4th Edition (2010).
- (6) Electron and chemical bonding: H. B. Grey, W.A. Benjamin. INC, New York.
- (7) Inorganic chemistry: James E. Huheey, 4th Edition, Wesley Publishing Company.
- (8) Mechanism of Inorganic reaction: Basalo and Pearson, 2nd 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, 23rd Edition (1998).

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Syllabus for B. Sc. Semester VI
CHE – 309 (Physical Chemistry)

UNIT I

Thermodynamics

[14 Marks]

Colligative properties: Boiling point elevation and freezing point depression. Molal elevation constant (K_b) and Molal depression constant (K_f), Calculation of absolute value of entropy using third law of thermodynamics, Law of mass action using chemical potential, Partial molar quantity.

UNIT II

Electrochemistry

[14 Marks]

Concentration cell: Cell with and without transference, Electrode concentration cell, Gas electrode concentration cell, Activity and activity coefficient determination, Define liquid junction potential and how it can be avoided, Equation for liquid junction potential, Decomposition potential, Overvoltage, Tafel equation

UNIT III

(A) Phase Rule

[07 Marks]

Binary system : Zn-Cd and Pb-Ag ,Zeotropic and azeotropic mixtures, Steam distillation, Zone refining.

(B) Osmosis

[07 Marks]

Desalination and reverse osmosis, Electrodialysis, Electrochemistry and pollution control, Removal of Cu, Ag and Fe from waste water.

UNIT IV

(A) Photochemistry

[07 Marks]

Laws of Photochemistry : Grotthuss-Draper Law, Einstein Law, Quantum yield ,Reasons for high and low quantum yield, Fluorescence and Phosphorescence, Chemiluminescence, Photosensitized reactions.

(B) Metallic Corrosion

[07 Marks]

Types of corrosion, Electrochemical series, Corrosion in acidic and neutral medium, Differential aeration principle, Atmospheric corrosion, Prevention of corrosion by various factor.

Reference Books

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

Gujarat University
Syllabus for B. Sc. Semester VI
CHE - 310 (Analytical Chemistry)

UNIT I

(A) Errors and treatment of Analytical data: [08 Marks]

Significant figures, Accuracy and precision, Types of errors and minimization of errors. Ways of expressing accuracy and precision. Rejection of a result, Test of significance (Q-Test, Student t-Test and F-Test) correlation coefficient. Literature of Analytical Chemistry.

(B) Organic reagents used in quantitative Analysis [06 Marks]

Separation of methods with 8-Hydroxy Quinoline, Cupferron and DMG

UNIT II

(A) Chromatographic methods: [08 Marks]

General principle, classification of chromatographic separation. Ion exchange chromatography (Ion Exchange equilibria, 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.

(B) Solvent Extraction Separation: [06 Marks]

Principles of solvent extraction, choice of solvent, distribution coefficient, distribution ratio, percentage (%) extraction. The extraction process, solvent extraction of metals, selective extraction and separation efficiency.

UNIT III

Electro analytical Techniques:

(A) Polarography: [07 Marks]

Introduction, Principle, electrode, Types of currents, Determination of half wave potential, Ilkovic equation, methods of determining concentration (Standard addition method and Calibration method)

(B) Potentiometry:**[07 Marks]**

The scope of potentiometric titrations, Precipitation and neutralization titrations, Graphical method including Gran's plot for selecting end point, Differential titration, Dead stop titration, Ion selective Electrode, various types of Ion selective Electrodes and use of Calcium ion selective electrode.

UNIT IV**Miscellaneous Titrations:****(A) Acid Base Titrations:****[07 Marks]**

Titration of polyprotic acid and mixture of acids, titration of salts, Differential Alkali titration.

(B) Redox titration:**[04 Marks]**

Titration involving Iodine: iodimetry and iodometry, Titration with reducing agents and oxidising agents, metallic reductors.

(C) Complexometric titration:**[03Marks]**

EDTA titration techniques-Direct, Back, Displacement and Indirect Titration, Masking, Demasking agent, ligand effect and Hydrolysis of EDTA complex, Auxiliary complexing agent- EDTA titration with an auxiliary complexing agent.

Reference Books

- (1) Analytical Chemistry: Gary D. Christian, 6th Edition; Wiley & Sons
- (2) Fundamentals of Analytical Chemistry: D. A. Skoog, D. M. West and F. J. Holler, 9th Edition, Cengage Learning.
- (3) Instrumental Methods of analysis: (CBS) H.H . Willard, L.L. Mirrit, J.A. Dean
- (4) Solvent extraction in Analytical Chemistry: G.H. Morrison, F. Friese, John Wiley & Sons, NY.
- (5) Instrumental Methods of Inorganic Analysis: A.I. Vogel, ELBS
- (6) Chemical Instrumentation: A Systematic approach- H.A. Strobel
- (7) The principals of ion-selective electrodes and membrane transport: W.E.Morf
- (8) Principles of Instrumental Analysis: Douglas A. Skoog., F. James Holler, Stanley R. Crouch, Cengage Learning; 6th Edition.
- (9) Quantitative Chemical Analysis: Daniel C. Harris, W H Freeman, New York.
- (10) Ion exchange and solvent extraction of metal compounds: Y. Macros, A.S.Kertes, Wiley, Interscience.

Gujarat University
Syllabus for B. Sc. Semester VI
CHE – 311 (Subject Elective)
Nanomaterials and Nanotechnology

Unit I

Introduction and preparation [14 Marks]

Introduction to Nanomaterials, Optical, magnetic and chemical properties of Nanomaterials, Preparation of Nanoparticles: Chemical Approaches: Chemical reduction; Sonochemical synthesis; Sol-Gel Synthesis; Self assembly. Physical Approaches: Aerosol spray; Gas condensation; Laser vaporization and vapour deposition; Sputtering.

Unit II

Nanostructured materials [14 marks]

Quantum dots, wells & wires; Carbon Nanotubes (CNTs): Single walled carbon nanotubes (SWNTs), Multiwalled carbon nanotubes (MWNTs), Graphenes, Fullerenes, Metal/Oxide nanoparticles (NPs), Nanorods, Nanotubes and Nanofibres, Semiconductor quantum dots, Polymer NPs.

Unit III

Characterization techniques for Nanomaterials-I [07 marks]

Particle size Analyser (Laser scattering), Optical Microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Tunnel Microscopy (STM).

Characterization techniques for Nanomaterials-II [07 marks]

X-ray Diffraction (XRD), Auger Emission Spectroscopy, Electron Spectroscopy for Chemical analysis (ESCA)

Unit IV

Application of Nanomaterials: [14 marks]

Applications Solar energy conversion and catalysis, Polymers with a special architecture, Liquid crystalline systems, Applications in displays and other devices, Advanced organic materials for data storage, Photonics, Chemical and biosensors, Nanomedicine and Nanobiotechnology.

Reference Books

- (1) Introduction to Nanotechnology: Charles P. Poole, Jr. and Frank J. Owens; Wiley Student Edition, 2008
- (2) Nanostructures and Nanomaterials: Synthesis, Properties and Applications: G. Cao, ICP, London, 2004.
- (3) Nanobiotechnology, Concepts, Applications and perspectives: C. M. Niemeyer and C. A. Mirkin, WILEY-VCH, Verlag GmbH & Co, 2004.
- (4) Nanotechnology - Molecularly Designed Materials: G. M. Chow and K. E. Gonslaves; (American chemical society)
- (5) Optical Properties of semiconductor nanocrystals: S. P. Gaponenko, Cambridge University Press, 1980.
- (6) Nanostructures & Nanomaterials: Synthesis, Properties & Applications: G. Cao, Imperial College Press, 2004.
- (7) Nano - The essentials: T. Pradeep, Tata Mc Graw Hill, New Delhi, 2007.
- (8) Nano materials: J. Dutta & H. Hofman.
- (9) “NANOTECHNOLOGY-basic science and emerging technologies: Mick Wilson, Kamali Kannagara et.al., University of new south wales press ltd,2008.
- (10) Nanotechnology: Mark Ratner and Daniel Ratner, Pearson Education.
- (11) Nanomaterials: A.K. Bandyopadhyay; New Age International Publishers.

GUJARAT UNIVERSITY
Syllabus for B. Sc. Chemistry Semester VI
CHE - 312
Practical [I] (Inorganic and Physical Practicals)

[A] Inorganic Quantitative Analysis:

(I) Gravimetric determination of the radicals:

(After removal of interfering radicals in mixed solution)

- (a) BaCl₂, FeCl₃ and HCl (Determination of Ba as BaSO₄)
- (b) CuCl₂, MnCl₂ and HCl (Determination of Mn as Mn₂P₂O₇)
- (c) CuSO₄, FeSO₄(NH₄)₂ SO₄ and H₂SO₄ (Determination of Fe as Fe₂O₃)
- (d) CuSO₄, Al₂(SO₄)₃ and H₂SO₄ (Determination of Al as Al₂O₃)

(II) Analysis of Alloy:

- (a) Brass (Cu → Volumetrically, Zn → Gravimetrically)
- (b) German Silver (Cu → Volumetrically, Ni → Gravimetrically)

[B] Physical: (Kinetics and Instruments)

(1) Kinetics:

Investigate the order of reaction in the following experiments by graphical method .

Exp 1: Reaction between K₂S₂O₈ and KI (a = b)

Exp 2: Reaction between KBrO₃ and KI (a ≠ b)

Exp 3: Reaction between H₂O₂ and HI (a = b)

(2) Instruments:

Exp 1: Titration of unknown strength of HCl with standard NaOH solution using pH meter.

Exp 2: Conductometric titration involving precipitation of BaCl₂ with K₂CrO₄.

Exp 3 : To determine the concentration of CrO₄²⁻ and Ni²⁺ in solution by colourimetry.

Exp 4 : To determine specific rotation of glucose and hence to find out unknown concentration of glucose in given solution by optical (polarimetric) measurements.

Reference Books

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

Semester VI

CHE - 312

Practical [III] (Organic and Analytical Practicals)

[A] Organic:

Organic separation and Identification:

Separation of Binary Mixtures and Identification (Minimum 8 Mixtures)

- (i) Solid + Solid (4 Mixtures)
- (ii) Solid + Liquid (2 Mixtures)
- (iii) Liquid + Liquid (2 Mixtures)

One Mixture from each of the following should be given Acid-Base, Acid-Phenol, Acid-Neutral, Phenol-Base, Phenol-Neutral, Base-Neutral, and Neutral-Neutral. Water soluble compounds are included.

Identification of separated organic compound must be done by physical and chemical tests, sodium fusion test, M.P / B.P., derivatives and crystallization.

[B] Analytical:

Volumetric Analysis:

- (1) Estimation of Fe^{3+} by EDTA (Back Titration)
- (2) Estimation of Bi^{3+} by EDTA
- (3) Estimation of Chloride by silver nitrate (Mohr's Method)
- (4) Estimation of Zn^{2+} and Cd^{2+} in a mixture by EDTA
- (5) Estimation of Ca^{2+} and Mg^{2+} in a mixture by EDTA
- (6) Determination of percentage purity of H_2O_2 solution by Iodometry method.

Reference Books

- (1) A. I. Vogel, "Elementary Practical Organic Chemistry Part-II, Qualitative Organic Analysis": CBS Publishers & Distributers, New Delhi, 2nd Edition, 2004.
- (2) A. I. Vogel, "Elementary Practical Organic Chemistry Part III Quantitative Organic Analysis": CBS Publishers & Distributers, New Delhi, 2nd 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, 1st Indian Edition, 2010.
- (6) "Advanced Practical Organic Chemistry": Stanley Thornes Publishers Ltd., J Leonard, B Lygo, G Procter, 1st Indian Edition, 2004.
- (7) "Quantitative Analysis": R. A. Day, A. L. Underwood, Prentice-Hall of India Pvt. Ltd., New Delhi, 6th Edition, 2004.