



Kuvempu University

Bachelor of Science (B.Sc.) Semester Scheme

Curriculum Structure of Undergraduate Programme for the year 2024-25

Course / Examination Pattern for One Major Subject (CHEMISTRY)

Sl. No.	Course Code	Title of the Course (Paper)	Subject Category	Teaching Hours/ week	Semester End Examination	Internal Assessment	Total Marks	Credits	Examination Duration
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
I-Semester									
I	CHET1	Chemistry-I	Major Course	04	80	20	100	03	3Hrs.
	CHEP1	Chemistry Practical-I	Major Course	04	40	10	50	02	3Hrs.
	Total			07	120	30	150	05	---
II-Semester									
II	CHET2	Chemistry-II	Major Course	04	80	20	100	03	3Hrs.
	CHEP2	Chemistry Practical-II	Major Course	04	40	10	50	02	3Hrs.
	Total			07	120	30	150	05	---
III-Semester									
III	CHET3	Chemistry-III	Major Course	04	80	20	100	03	3Hrs.
	CHEP3	Chemistry Practical-III	Major Course	04	40	10	50	02	3Hrs.
	CHEL3.1 CHEL3.2	Medicinal Chemistry Essence of Chemistry in day-to-day Life	Elective-3.1 Elective-3.2	02	40	10	50	02	2Hrs.
	Total			10	160	40	200	07	---
IV-Semester									
IV	CHET4	Chemistry-IV	Major Course	04	80	20	100	03	3Hrs.
	CHEP4	Chemistry Practical-IV	Major Course	04	40	10	50	02	3Hrs.
	CHEL4.1 CHEL4.2	Electrochemistry, Corrosion and Metallurgy Agricultural and Fuel Chemistry	Elective-4.1 Elective-4.2	02	40	10	50	02	2Hrs.
	CHEC4.1	Chemistry Practical Knowledge/Skill-1	Compulsory Course - 1	04	40	10	50	02	3Hrs.
	Total			14	200	50	250	09	---
V-Semester									
V	CHET5	Chemistry-V	Major Course	04	80	20	100	03	3Hrs.
	CHET6	Chemistry-VI	Major Course	04	80	20	100	03	3Hrs.
	CHEP5	Chemistry Practical-V	Major Course	04	40	10	50	02	4Hrs.
	CHEC5.1	Chemistry Practical Knowledge/Skill-2	Compulsory Course-2	04	40	10	50	02	3Hrs.
	Total			16	240	60	300	10	---
VI-Semester									
VI	CHET7	Chemistry-VII	Major Course	04	80	20	100	03	3Hrs.
	CHET8	Chemistry-VIII	Major Course	04	80	20	100	03	3Hrs.
	CHEP6	Chemistry Practical-VI	Major Course	04	40	10	50	02	4Hrs.
	CHEC6.1	Chemistry Practical Knowledge/Skill-3	Compulsory Course-3	04	40	10	50	02	3 Hrs.
	Total			16	240	60	300	10	---
	Grand Total			---	1080	270	1350	46	---

Course Pattern for CHEMISTRY (Major Subject) at Under Graduate Level:

I-Semester:	: CHET1–Chemistry-I : CHEP1–Chemistry Practical-I
II-Semester	: CHET2–Chemistry-II : CHEP2–Chemistry Practical-2
III-Semester	: CHET3–Chemistry-III : CHEP3–Chemistry Practical-III : *CHEL3.1–Chemistry Elective-III.1 (Medicinal Chemistry) : *CHEL3.2–Chemistry Elective-III.2 (Essence of Chemistry in day-to-day Life)
IV-Semester	: CHET4–Chemistry-IV : CHEP4–Chemistry Practical-IV : CHEC4.1–Chemistry Practical Knowledge/Skill–1 : *CHEL4.1–Chemistry Elective-IV.1 (Electrochemistry, Corrosion and Metallurgy) : *CHEL4.2–Chemistry Elective-IV.2 (Agricultural and Fuel Chemistry)
V-Semester	: CHET5–Chemistry-V : CHET6–Chemistry-VI : CHEP5–Chemistry Practical–V : CHEC5.1–Chemistry Practical Knowledge/Skill–2
VI-Semester	: CHET7–Chemistry–VII : CHET8–Chemistry–VIII : CHEP6–Chemistry Practical–VI : CHEC6.1–Chemistry Practical Knowledge/Skill–3

Note: There shall be two elective papers offered in Semester-III and Semester-IV by every major subject offering department. Out of this, a student shall choose/select/opt One Elective Paper in each semester (i.e., Semester-III and Semester-IV, respectively).

FIFTH SEMESTER

PAPER-V: CHEMISTRY - V

Total Hours: 64

UNIT - I: ANALYTICAL CHEMISTRY

Total Hours: 16

(Note: Numerical problems must be solved wherever necessary)

Chapter-1: Principles of Gravimetric Analysis

9 hours

General principles, conditions for precipitation, choice of precipitation, advantages of using organic precipitation, factors influencing the solubility of the precipitate, theories of precipitation, post precipitation, co-precipitation, effect of digestion, precipitation from homogeneous solution (PFHS), pH change, ion release reagents, change in oxidation state (taking Fe, Cu and Al as examples). Gravimetric estimations of chloride as silver chloride, calcium as calcium oxalate, iron as ferric oxide. Comparison with volumetric analysis.

Chapter-2: Organic Reagents in Inorganic Analysis

7 hours

Theoretical basis for the use of organic reagents in inorganic analysis. Advantages of organic reagents in inorganic analysis. Application of the following reagents in inorganic analysis: dimethylglyoxime, salicylaldehyde, cupferron, benzoin, 1,10-phenanthroline, 8-hydroxyquinoline, pyridine, 8-hydroxyquinoline, dithizone, acetylacetone, trifluoroacetone.

References:

1. Vogel's Text book of Quantitative Chemical Analysis- Revised by, G. H. Jaffery, J. Bassett, J. Mendham and R. C. Denney, ELBS V Edition (1989), John Wiley and Sons. Inc. New York.
2. Introduction to Instrumental Analysis – R.D. Braun 1986.
3. Principles of Inorganic Chemistry (UGC Syllabus) by B.R. Puri, L.R. Sharma, K.C. Kalia, Milestone Publishers, New Delhi, India, 2018.
4. Theoretical Principles of Inorganic Chemistry by G.S. Manku, Tata McGraw-Hill Publishing Company Ltd. 2006.
5. Modern Inorganic Chemistry by R.D. Madan, S. Chand & Company Ltd. 2012.
6. Advanced Inorganic Chemistry by Sathyaprakash, Volume-II, S. Chand Publishers, 2000.

UNIT - II: INORGANIC CHEMISTRY

Total Hours: 16

Chapter-1: d-Block elements

6 hours

Electronic configuration, general characteristics of transition elements, oxidation states, atomic size, ionization potential, colour, complex formation, magnetic properties and acidic & basic properties of oxides- explanation with reference to 3d-series.

Chapter-2: f-Block elements

10 hours

Lanthanide series: Definition, electronic configuration, oxidation states, colour, complex formation and magnetic properties, lanthanide contraction, its causes and consequences, separation of lanthanides by ion-exchange method, applications of lanthanides.

Actinide series: General survey of actinides, properties of actinides, comparison between lanthanides and actinides with reference to oxidation state, complex formation, colour and magnetic properties.

References:

1. Principles of Inorganic Chemistry (UGC Syllabus) by B.R. Puri, L.R. Sharma, K.C. Kalia, Milestone Publishers, New Delhi, India, 2018.
2. Inorganic Chemistry; Principles of structure and reactivity, III Edition, James E Huheey, Ellen E. Keither and Richard L. Keither, Harper Collins college Pub., 1983.
3. Inorganic Chemistry 3rd ed., Shriver and Atkins, Oxford University Press, 1999.
4. Advanced Inorganic Chemistry, V Edition, F.A. Cotton and G. Wilkinson; John Willey and sons, 1988.
5. A text book of Industrial Chemistry by B.K. Sharma
6. A concise Inorganic Chemistry, J .D. Lee, ELBS Ed., 1991
7. Modern aspects of Inorganic Chemistry, H. J. Emeleus and A. G. Sharpe, ELBS.
8. Theoretical Principles of Inorganic Chemistry, IV ed., G. S. Manku, Tata, McGraw Hill, 1990

UNIT - III: ORGANIC CHEMISTRY

Total Hours: 16

Chapter-1: Purification of organic compounds

4 hours

Methods for purification of solids- crystallization, fractional crystallization and sublimation. Methods for purification of liquids- Distillation, Fractional distillation, distillation under reduced pressure, steam distillation. Criteria of purity- Melting point and boiling point.

Chapter-2: Heterocyclic compounds**4 hours**

Definition, Preparation and reactions of pyrrole, furan, thiophene, pyridine, pyrimidine. Aromaticity of pyrrole, furan and thiophene. Basicity of pyrrole and pyridine.

Chapter-3: Dyes**4 hours**

Classification of dyes with example. Chromophore theory, Modern theory. Synthesis of Congo Red, Malachite Green, Methyl Orange and Indigo. Structural elucidation and synthesis of Alizarin.

Chapter-4: Polymer Chemistry**4 hours**

Classification of polymers- Types of polymerizations, Mechanism of Free radical and ionic polymerization. Addition polymers and condensation polymers with examples. Zeigler-Natta catalyst. Thermoplastics and thermosetting plastics with examples. Synthesis of Styrene, Teflon, Nylon-6, Nylon-6,6, Bakelite, PVC, polythene and Natural rubber.

References:

1. Heterocyclic Chemistry by Raj K. Bansal, New Age International, New Delhi.
2. S. H. Pine, Organic Chemistry, 5th Edition, McGraw Hill International Edition, Chemistry Series, New York, 1987.
3. Bill Meyer Text Book of Polymer Science, F.W. Jr. John Wiley & Sons 1984.
4. Gowarikar. V.R. Viswanathan, N.V. Jayader Sreedhar. "Polymer Science".
5. Sharma. B. K., Polymer Chemistry, Goel Publishing House, Meerut- 1989.
6. Arora M.G. Vadar M.S., Polymer Chemistry. Anmol Publications Pvt. Ltd., New Delhi 1989.
7. Medicinal Chemistry by G.R. Chatwal Himalaya Publishing House.
8. Organic Chemistry, B. Y. Paula, III Edition, Pearson Education, Inc. (Singapore), New Delhi, reprint, 2002.
9. Textbook of Organic Chemistry, P S Kalsi, Mac Millan, 2000.
10. Organic Chemistry, Bahl and Arun Bahl, S. Chand and Sons, New Delhi, 2005.
11. Polymer Composite by M. C. Gupta and A. P. Gupta New Age International Limited, Publishers New Delhi.
12. Degradable polymers, Principles and Applications by Gerald Scott. Kluwer Academic Publications.
13. Polymer Science - A Text Book by V. K. Ahluvalia and Anuradha, Ane Books India, New Delhi.

UNIT - III: PHYSICAL CHEMISTRY

Total Hours: 16

Chapter-1: Electrochemistry II

6 hours

Reference electrodes: Calomel electrode quinhydrone electrode and Ag/AgCl electrode. EMF of a cell and its measurements. Computation of cell EMF. Relation between G and K for a cell reaction, decomposition potential and its applications and hydrogen overvoltage. Concentration cell with and without transport, Liquid Junction potential, Application of concentration cells- determination of valency of ions and solubility product, potentiometric titrations. Determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods.

Chapter-2: Liquid-liquid mixtures

5 hours

Ideal liquid mixtures, Non-ideal system: Azeotropes: HCl-H₂O and ethanol-water systems. Partially miscible liquids: Phenol-water, trimethyl amine and water and nicotine - water systems. Lower and upper consolute temperature. Effect of impurity on consolute temperature.

Chapter-3: Phase Equilibrium

5 hours

Two component system- classification with examples, simple eutectic system (lead-silver system)- phase diagram and explanation, desilverisation of lead (Pattinson's Process). Solid solutions-compound formation with congruent melting point (Mg-Zn system) phase diagram and explanation. Compound formation with incongruent melting point (NaCl + water system)-phase diagram and explanation.

References:

1. Physical chemistry; R. L. Madan, G. D. Tuli, S. Chand & Co.
2. Principles of Physical Chemistry: Puri, Sharma and Pathania, Vishal Publishing Co.
3. Textbook of Physical Chemistry, Gurdeep Raj, Goel Publications House, New Delhi.
4. Elements of Physical Chemistry, B.R. Puri, L.R. Sharma, M.S. Pathania, I Edition, Vishal Publishing House, Jalandhar, India, 2013.
5. A Textbook of Physical Chemistry, Volume 2, K.L. Kapoor, McMillan Publishers, India Limited.
6. A Textbook of Physical Chemistry, Volume 2, K L Kapoor, McMillan McMillan Publishers, India Limited.

FIFTH SEMESTER

PAPER-VI: CHEMISTRY - VI

Total Hours: 64

UNIT - I: ANALYTICAL CHEMISTRY

Total Hours: 16

Chapter-1: Radio Chemical Methods of Analysis

9 hours

Radiation dose, G-value primary and secondary processes, radiolysis of water vapour, Dosimeter-Fricke dosimeter and ceric sulphate dosimeter, Introduction, nature of radioactivity, radiometric units, detection and measurement of radioactivity, radioactive traces, tracer techniques, applications in analytical chemistry, isotopic dilution analysis, activation analysis, radiometric analysis and applications.

Chapter-2: Thermogravimetry

7 hours

Introduction, Principle, Factors affecting the results, instrumentation. Application with special reference to $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, $\text{CaC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$.

Different Thermal Analysis – Principle, instrumentation, difference between TG and DTA, applications with special reference to the clays and minerals.

Different scanning calorimetry –principle, and applications to inorganic materials like chlorates and perchlorates, ammonium nitrate.

References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch VIII Edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, V Edition, 2001 John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, VI Edition, 1993 prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, VI Edition.
5. Analytical Chemistry Principles, John H. Kennedy, II Edition, Saunders College Publishing, California, 1990.
6. Instrumental Methods of Analysis by H.H. Willard, L.L. Merritt and J.A. Dean, VII Edition, CBS Publishers, New Delhi, 1988.
7. Principles and Practice of Analytical Chemistry, F. W. Fifield and Kealey III Edition, 2000, Blackwell Sci., Ltd. Malden, USA.
8. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
9. Introduction to Instrumental Analysis, Braun, Pharm. Med. Press. India.

UNIT - II: INORGANIC CHEMISTRY

Total hours: 16

Chapter-1: Electroplating

3 hours

Theory, purpose of electroplating, nature of good deposit, factors influencing electroplating (concentration of metal ion, pH, temperature, current density), electroplating of chromium, nickel and gold.

Chapter-2: Industrial materials

7 hours

Ceramics- Classification, raw materials and their role, varieties of clay, production of ceramic ware, glazing insulators.

Refractories- Classification, properties, hardness, pyrometric cone equivalent values.

Abrasives- Classification, properties, hardness of abrasives, Moh's scale, manufacture and importance of carborundum.

Chapter-3: Alloys

6 hours

Definition, purpose of making alloys, preparation of alloys by electro deposition method and powder metallurgy method, advantages of powder metallurgy, influence of carbon, manganese, nickel, chromium, tungsten, silicon and cobalt on the properties of steel, heat treatment of steel, hardening, tempering and annealing, case hardening of steel-carbiding and nitriding.

References:

1. Advanced Inorganic Chemistry, V Edition, F.A. Cotton and G. Wilkinson; John Wiley and sons, 1988.
2. Inorganic Chemistry; Principles of structure and reactivity, III Edition, James E Huheey, Ellen E. Keither and Richard L. Keither, Harper Collins college Pub., 1983.
3. Inorganic Chemistry 3rd ed., Shriver and Atkins, Oxford University Press, 1999.
4. Organometallic Chemistry, A Unified approach R.C. Mehrotra and A. Singh. Willey Eastern, New Delhi.
5. A text book of Industrial Chemistry by B.K. Sharma
6. A concise Inorganic Chemistry, J .D. Lee, ELBS Ed., 1991
7. Modern aspects of Inorganic Chemistry, H. J. Emeleus and A. G. Sharpe, ELBS.
8. Theoretical Principles of Inorganic Chemistry, IV ed., G. S. Manku, Tata, McGraw Hill, 1990.
9. Engineering Chemistry-B. K. Sharma,2001.

UNIT – III: ORGANIC CHEMISTRY

Total hours: 16

Chapter-1: Ethers and Epoxides

3 hours

Chemical reactions of ethers - Cleavage and auto-oxidation with examples. Zeisel's method. Synthesis of epoxides, Acid and Base catalyzed ring opening of epoxides, Orientation of epoxide ring opening with energy profile diagram.

Chapter-2: Organo Sulphur Compounds

8 hours

Thiols (Mercaptans): Methods of preparation (any two). Reactions-action of sodium, formation of salts, formation of thiol esters and oxidation. Uses of mercaptans. Thioethers: Methods of preparation (any two). Reactions-Addition of halogens and alkyl halides, Oxidation and hydrolysis. Structure and uses of sulphonals.

Aromatic Sulphonic acids: Methods of preparation (any two). Reactions of benzene sulphonic acid- i) involving H atom of $-SO_3H$ group ii) involving $-OH$ group of SO_2OH group iii) involving $-SO_3H$ group iv) involving benzene ring. (One example each). Preparation and uses of Tosyl chloride. Synthesis of Chloramine-T and Saccharin.

Chapter-3: Diazonium Compounds

5 hours

Preparation of diazomethane by Pechmann's and Becker's method. Reactions of diazomethane (methylation of carboxylic acids, alcohols and phenols).

Preparation, mechanism of preparation and synthetic applications of benzene diazonium chloride (Conversion to phenol, aryl chloride, aryl bromide, aryl nitrile, phenyl hydrazine and diazo coupling reaction).

References:

1. S. H. Pine, Organic Chemistry, 5th Edition, McGraw Hill International Edition, Chemistry Series, New York, 1987.
2. Organic Chemistry, B. Y. Paula, III Edition, Pearson Education, Inc. (Singapore), New Delhi, reprint, 2002.
3. Textbook of Organic Chemistry, P S Kalsi, Mac Millan, 2000.
4. Organic Chemistry, Bahl and Arun Bahl, S. Chand and Sons, New Delhi, 2005.

UNIT - IV: PHYSICAL CHEMISTRY

Total hours: 16

(Note: Numerical problems must be solved wherever necessary)

Chapter- 1: Thermodynamics - I

16 hours

Review of the thermodynamics terms; system, surroundings etc, types of systems, state and path functions. Work done in isothermal expansion and compression of an ideal gas. Heat capacity of a gas at constant pressure and constant volume: relationship between C_p and C_v . Derivation of Kirchoff's equation. Limitations of I law of thermodynamics with illustrations. Need for II-law of thermodynamics, different ways of stating II-law with respect to heat and spontaneity. Heat engine - Carnot's cycle and derivation of the expression for its efficiency. II-law in terms of efficiency (η). Concept of entropy and its physical significance. Entropy changes in reversible isothermal process. Entropy changes of an ideal gas in different processes; entropy of mixing, standard entropies. Free energy: Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities. Variation of G and A with pressure, volume and temperature.

References:

1. Physical chemistry; R. L. Madan, G. D. Tuli, S. Chand & Co.
2. Principles of Physical Chemistry: Puri, Sharma and Pathania, Vishal Publishing Co.
3. Textbook of Physical Chemistry, Gurdeep Raj, Goel Publications House, New Delhi.
4. Elements of Physical Chemistry, B.R. Puri, L.R. Sharma, M.S. Pathania, I Edition, Vishal Publishing House, Jalandhar, India, 2013.
5. Molecular Structure and Spectroscopy, Aruldas, Printice Hall, India Pvt. Ltd.
6. A Textbook of Physical Chemistry, Volume 2, K.L. Kapoor, McMillan Publishers, India Limited.
7. Physical Chemistry, K. J. Laidler and J. M. Meiser, III Edition, Houghton Mifflin Comp., New, York, International Edition.
8. Molecular Energy Transfer, R. Levine and J. Jortner, eds., J. Wiley, New York.
9. A Textbook of Physical Chemistry, Volume 2, K L Kapoor, McMillan McMillan Publishers, India Limited.

FIFTH SEMESTER - PRACTICALS (4 HOURS PER WEEK)

PAPER – V:

Part-A: Gravimetric Analysis

1. Estimation of Barium (from barium chloride solution) as Barium sulphate.
2. Estimation of Iron (from Mohr's salt solution) as Iron oxide.
3. Estimation of Aluminium (from potash alum solution) as Aluminium oxide.
4. Estimation of Nickel (from Nickel ammonium sulphate solution) as Nickel dimethyl glyoximate.
5. Estimation of Copper (from copper sulphate solution).as Cuprous thiocyanate.
6. Estimation of Zinc (from zinc sulphate solution) as Zinc oxinate.
7. Estimation of zinc as zinc oxide.
8. Estimation of sulphate (from barium chloride solution) as Barium sulphate.
9. Estimation of Magnesium (from magnesium sulphate solution) as Magnesium oxinate.

Part-B: Organic Preparation

1. Preparation of azo dye from aniline. (Example for coupling reaction)
2. Preparation of tribromoaniline from aniline
3. Preparation of acetanilide from aniline.
4. Preparation of p-nitroacetanilide from acetanilide.
5. Preparation of p-bromo acetanilide from acetanilide. (Example for bromination reaction)
6. Preparation of aspirin from Salicylic acid
7. Preparation of m-dinitro benzene from nitrobenzene. (Example for nitration reaction)
8. Preparation of benzoic acid from Toluene or Benzyl alcohol or Benzaldehyde. (Example for oxidation reaction)

Note: Minimum six experiments must be performed from each part and recorded.

V – Semester

Practical Knowledge/Skill based Course – V (Compulsory Course)

CHEC5.1: Chemistry Practical / Skill based Course

List of Experiments:

1. The distribution of iodine between water and carbon tetrachloride.
2. The distribution of benzoic acid between benzene and water.
3. Comparison of the catalytic strengths of HCl and H₂SO₄ by studying the kinetics of hydrolysis of ethyl acetate.
4. Rate of decomposition of potassium iodide by hydrogen peroxide.
5. Determination of calcium in fertilizer.
6. Separation of amino acids by paper chromatography and measuring R_f values.
7. To determination of pH of aerated drinks, fruit juices, shampoos and soaps.
8. Determination of K_a (dissociation constant of a weak acid) using digital conductometer.
9. Verification of Ostwald's dilution law and determination of ionisation constant (K_a) of a weak acid by conductometric method.
10. Determination the equivalent conductivity of a strong electrolyte conductrometrically.
11. To determine the equivalent conductance of strong electrolyte at infinite dilution and verification of Debye-Huckel Onsagar equation.
12. Separation of Ni(II) and Fe(II) by complexation with DMG, extraction of Ni(II)-DMG complex in chloroform and determination of its concentration by colorimetry.

Note: Minimum of eight experiments must be performed and recorded.

SIXTH SEMESTER

PAPER-VII: CHEMISTRY – VII

Total hours: 64

UNIT – I: ANALYTICAL CHEMISTRY

Total hours: 16

Chapter-1: Spectroscopy

3 hours

General introduction to Spectroscopy: Nature and Interaction of electromagnetic radiation, energies corresponding to various kinds of radiations, atomic and molecular transitions, selection rules, spectral width, factors influencing positions and intensity of spectral lines

Chapter-2: Electronic spectroscopy

6 hours

Qualitative description of electronic transition in σ , π and n molecular orbital's and their energy levels, selection rules and Franck-Condon principle. Electronic spectra of diatomic and polyatomic molecules, types of electronic transitions and their theoretical interpretation, ligand field and charge transfer spectra, Beer's law, Lambert's law, Beer-Lambert law, limitations: Chromophores, auxochromes.

Comparison of λ_{max} for following organic compounds

- | | |
|---|-------------------------------|
| 1. CH_3CHO and $\text{C}_6\text{H}_5\text{CHO}$ | 2. Ethylene and 1,3-butadiene |
| 3. Cis and trans stilbene | 4. Cis-trans cinnamic acid |

Chapter-3: IR and Raman Spectroscopy

7 hours

IR Spectroscopy: Range, frequency and energy of IR radiations, interaction of IR radiation with organic molecules, degrees of freedom for linear and non-linear molecules, molecular vibrations – stretching and bending vibrations, Hook's law, Calculation of vibrational frequencies using Hook's law derived for the motion of a spring. Finger print region, Stretching frequency of functional groups in benzaldehyde, acetophenone, ethyl acetate, aniline and methyl amine.

Raman Spectroscopy: Concept of Polarizability. Raman spectra, Stokes and anti-Stokes lines, selection rules. Instrumentation. Applications of Raman spectroscopy, comparison of Raman and IR spectroscopies.

References:

1. Electronic absorption spectroscopy and related techniques-DN Sathyanarayana, University Press
2. Introduction to Instrumental Analysis – R.D. Braun 1986.
3. Instrumental method of chemical analysis – B.K. Sharma, Goel publishing House, Meerut 2000.

4. Instrumental method of analysis – Willard, merit and Dean, VII Edition 1998.
5. Analytical Chemistry- Gray D. Christian, V Edition John Wiley and Sons, Inc.
6. Instrumental Methods of Chemical Analysis-B.K.Sharma, Goel publishing House, Meerut, 2000.

UNIT - II: INORGANIC CHEMISTRY

Total hours: 16

Chapter-1: Co-ordination Chemistry

9 hours

Double salts, complex salts, definition of terms-complex ion, ligand, co-ordination number, coordination sphere. Types of ligands with example-monodentate, bidentate, polydentate, Ambidentate and macrocyclic ligands (crown ethers, porphyrins). Methods of detection of complex formation- conductivity, pH, colour, EAN rule for stabilising of Complexes. Nomenclature of complex compounds. Isomerism in complex compounds: a) Structural isomerism- Ionization isomerism, hydrate isomerism, linkage isomerism and coordinate isomerism, b) Optical and geometrical isomerism in complex compounds with coordination number 4 and 6.

Chapter-2: Valence Bond Theory of Co-ordination compounds

4 hours

Valence bond theory as applied to complexes- inner and outer orbital complexes. The structure and geometry of the following complexes to be discussed: 1. $[\text{Fe}(\text{CN})_6]^{3-}$ 2. $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ 3. $[\text{MnCl}_4]^{2-}$ 4. $[\text{Ni}(\text{CN})_4]^{2-}$ 5. $[\text{Cu}(\text{NH}_3)_4]^{2+}$ Modification of VBT: Back bonding effect with respect to $[\text{Ni}(\text{CO})_4]$.

Chapter-3: Crystal Field Theory (CFT)

3 hours

Splitting of d-orbitals in octahedral and tetrahedral fields, effect of weak and strong field ligands, spectrochemical series of ligands, crystal field stabilization energy and calculation of CFSE for different systems.

References:

1. Principles of Inorganic Chemistry (UGC Syllabus) by B.R. Puri, L.R. Sharma, K.C. Kalia, Milestone Publishers, New Delhi, India, 2018.
2. Theoretical Principles of Inorganic Chemistry by G.S. Manku, Tata McGraw-Hill Publishing Company Ltd. 2006.
3. Modern Inorganic Chemistry by R.D. Madan, S. Chand & Company Ltd. 2012.
4. Advanced Inorganic Chemistry by Sathyaprakash, Volume-II S. Chand Publishers, 2000.
5. J.E. Huheey, E.A. Keiter and R.L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, IV Ed., Pearson Education, India, 2006.

6. F.A. Cotton, G. Wilkinson, C.M. Murillo and M. Bochmann, Advanced Inorganic Chemistry, VI Ed., John Wiley and Sons, Inc., New York, 1999.

UNIT - III: ORGANIC CHEMISTRY

Total hours: 16

Chapter - 1: Stereochemistry of organic compounds

11 hours

Concept of isomerism, elements of symmetry, molecular chirality. Enantiomers, properties of enantiomers, Optical isomerism, Condition for optical activity, optical isomerism in Lactic acid and tartaric acid. Relative and absolute configuration, sequence rules, R & S systems of nomenclature.

Diastereomers. Threo and erythron diastereomers. Racemisation, resolution of racemic modifications (chemical and biological methods), Walden inversion, asymmetric synthesis.

Geometrical isomerism: Geometric isomerism in maleic acid and fumaric acid. Determination of their configurations. E and Z notations. Geometrical isomerism of oximes, Determination of configuration of oximes. Beckmann rearrangement. Conformational isomers of ethane and cyclohexane.

Chapter-2: Reactive Methylene Compounds

5 hours

Preparation and synthetic applications of diethyl malonate (monocarboxylic acids, dicarboxylic acids, amino acids, barbituric acid)

Preparation and synthetic applications of ethyl acetoacetate (monocarboxylic acids, dicarboxylic acids, amino acids, α - β unsaturated acids (Crotonic acid), 4- Methyl uracil and antipyrine) Keto-enol tautomerism of ethyl acetoacetate and diethyl malonate, Reactions supporting keto and enol forms.

References:

1. Advanced Organic Chemistry- Reactions, Mechanism and Structure, Jerry March, John Wiley, 2008.
2. Advanced Organic Chemistry, FA Carey and RJ Sundberg Plenum, 1990.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman, 2000. Structure and mechanism of Organic Chemistry, CK Ingold, Cornell University Press, 1999.
4. Organic Chemistry, RT Morrison and RN Boyd, Prentice-Hall, (1998).
5. Modern Organic Reactions, HO House, Benjamin, 1972.
6. Principles of Organic Synthesis, ROC Norman and JM Coxon, Blackie Academic and Professional, 1996.

7. Stereochemistry of Organic Compounds, D Nasipuri, New-Age International, 1999.
Stereochemistry of Carbon Compounds, E L Eliel, S H Wilen and L N Mander, John Wiley, 1994.
8. Stereochemistry, Potapov, MIR, Moscow, 1984.
9. Organic Chemistry, Volumes I and II, I L Finar, Longman, 1999.
10. Organic Chemistry, Bahl and Arun Bahl, S. Chand and Sons, New Delhi, 2005.
11. Organic Chemistry, R. T. Morrison and R. N. Boyd, VI Edition, Printice-Hall of India Limited, New Delhi, 1992.
12. Organic Chemistry, B. Y. Paula, III Edition, Pearson Education, Inc. (Singapore), New Delhi, reprint, 2002.
13. Textbook of Organic Chemistry, P S Kalsi, Mac Millan, 2000.
14. R. K. Bansal, Organic Reaction Mechanism, Wiley Eastern Limited, New Delhi, 1993.
15. P.S. Kalsi, Stereochemistry and mechanism through solved problems, New Age International Publications.
16. Stuart Warren, Paul Wyatt, Organic Synthesis: The Disconnection Approach, John Wiley & Sons.

UNIT - IV: PHYSICAL CHEMISTRY

Total hours: 16

(Note: Numerical problems must be solved wherever necessary)

Chapter - 1: Physical Properties and Chemical Constitution

6 hours

Additive and constitutive properties (definitions). Polarization: Induced, orientation and molar polarization. Clausius-Mossotti equation. Dipole moment and structure of molecules - planar and non-planar, differentiating between cis and trans isomers. Molar refraction and its application in elucidating molecular structure. Brief account of magnetic properties - paramagnetic, diamagnetic and ferromagnetic systems. Magnetic susceptibility and its importance.

Chapter-2: Nanomaterials and Polymers

5 hours

Nanomaterials: General characteristics, a brief and elementary account of synthetic methods; bottom-up method, top-down method, examples (detailed mechanism is not required), general applications of nanomaterials.

Polymers: Definition, classification, properties, degree of polymerization, expressions for number average and weight average molecular weights. Determination of molar mass of polymers by viscosity method (Ostwald's viscometric method).

Chapter-3: Surface and Interfacial Chemistry

5 hours

Adsorption; types of adsorption and adsorption isotherms, Solid-liquid interfaces: Gibbs adsorption isotherm (expression only). Solid-gas interfaces. – Langmuir isotherm (derivation), Temkin and BET isotherm (expression only). Determination of surface concentration of adsorbents using BET isotherm. Kinetics of enzymatic reactions: Michaelis-Menten equation, effect of temperature and pH.

References:

1. Physical chemistry; R. L. Madan, G. D. Tuli, S. Chand & Co.
2. Principles of Physical Chemistry: Puri, Sharma and Pathania, Vishal Publishing Co.
3. Textbook of Physical Chemistry, Gurdeep Raj, Goel Publications House, New Delhi.
4. Elements of Physical Chemistry, B.R. Puri, L.R. Sharma, M.S. Pathania, I Edition, Vishal Publishing House, Jalandhar, India, 2013.
5. Molecular Structure and Spectroscopy, Aruldas, Printice Hall, India Pvt. Ltd.
6. A Textbook of Physical Chemistry, Volume 2, K.L. Kapoor, McMillan Publishers, India Limited.
7. Physical Chemistry, K. J. Laidler and J. M. Meiser, III Edition, Houghton Mifflin Comp., New, York, International Edition.
8. Molecular Energy Transfer, R. Levine and J. Jortner, eds., J. Wiley, New York.
9. A Textbook of Physical Chemistry, Volume 2, K L Kapoor, McMillan McMillan Publishers, India Limited.

SIXTH SEMESTER

PAPER-VIII: CHEMISTRY - VIII

Total hours: 64

UNIT - I: ANALYTICAL CHEMISTRY

Total hours: 16

Chapter-1: NMR Spectroscopy

8 hours

Introduction to NMR spectroscopy: Basic principle, theory and types of NMR active nuclides. Instrumentation. Relaxation process- Spin-Spin relaxation, Spin-lattice relaxation, number of signals, shielding and deshielding effects, factors influencing chemical shifts. [Inductive effect, vander Waal's deshielding, anisotropic effects, hydrogen bonding] Solvents used. Spectra of CH_3OH , $\text{C}_2\text{H}_5\text{OH}$, and $\text{C}_6\text{H}_5\text{CH}_3$, peak area and proton counting, splitting of the signals (Pascal's triangle), spin-spin coupling, spin-spin splitting. Applications of NMR spectroscopy.

Chapter-2: Mass Spectrometry

4 hours

Basic principles, theory and instrumentation, mass spectrum, the molecular ion peak, base peak, determination of molecular formula, Mc-Lafferty rearrangement. Retro-Diel's Alder reactions, Metastable ion peaks and their importance. Nitrogen rule.

Chapter-3: Electrogravimetry

4 hours

Basic principle, Theory, electrode reactions, over-voltage, characteristics of a good deposit, completeness of deposition, separation of metals at controlled cathode potential. Determination of copper and nickel in Cu-Ni alloy.

References:

1. Vogel's Text book of Quantitative Chemical Analysis, Basselt, Denmy, Jaffery and Merdhan, ELBS, Orientlong- Manan, 5th Ed.1990.
2. Analytical Chemistry, Gary D. Christian, John Laliley and Senes, New York, 6th Ed., 2007.
3. Fundamentals of Analytical Chemistry, Skoog, West, Holler; 7th Editin 2001
3. Fundamentals of Analytical Chemistry, D.A. Skoog & D.M. West, Holf-Saunderrs, 5th Ed., 1991.
4. Principles and Methods Chemical Analysis: H.F. Walton, Prentice Hall, New Delhi.
5. Chemical Analysis, H.A. Laitinan, Mc.Graw Hill Book Company.
6. Technical methods of analysis – Griffin, Mc Graw Hill Book Co.

UNIT - II: INORGANIC CHEMISTRY

Total hours: 16

Chapter-1: Inorganic polymers

4 hours

Silicones: Types, preparation (Linear, branched and cyclic), properties and applications. Fluorocarbons: Definition, examples, properties, manufacture of Teflon and uses. Phosphazenes: Preparation, properties and nature of bonding in triphosphazenes. S-N ring compounds (S_4N_4 and S_2N_2): Preparation, properties and uses.

Chapter-2: Organometallic compounds

6 hours

Definition and classification with examples based on Hapticity and based on Group, 18-electron rule, Structure of ferrocene and Chromocene

Metal carbonyls: Types, nomenclature, preparation, and properties. electron count in metal carbonyls of Cr, Mn, Fe, Co and Ni, Uses of metal Carbonyls. Structure of mononuclear carbonyls ($Cr(CO)_6$, $Fe(CO)_5$ & $Ni(CO)_4$) using VBT. Applications of coordination/organometallic compounds: cis-platin in cancer therapy, Wilkinson's Catalyst in alkene hydrogenation.

Chapter-3: Bio-Inorganic Chemistry

6 hours

Elements in biological systems- metals and nonmetals, bulk metals and trace metals. Iron: Coordination environment in Heme, Role of haemoglobin in oxygen transportation. Zinc: Zinc containing metalloenzymes- role of carbonic anhydrase and carboxy peptidase. Magnesium: Co-ordination environment in chlorophyll, skeletal structure of chlorophyll, role of chlorophyll in photosynthesis. Cobalt: Vitamin B₁₂, Molybdenum: Nitrogenase.

References:

1. Concise Inorganic Chemistry-J. D. Lee, 5th Edn, New Age International (1996)
2. Modern Inorganic Chemistry Sathya Prakash's by R. D. Madan, S. Chand and Co. Ltd, New Delhi.
3. Inorganic Chemistry-Principles of Structure and Reactivity, 4thEdn-J. E. Huheey, E.A. Keiter, R. L. Keiter and O.K. Medhi. Pearson Education (2009).
4. Advanced Inorganic Chemistry-Agarwal & Keemtilal, 11th edition, Pragathi publication, 2012.
5. Principles of Inorganic Chemistry (UGC Syllabus) by B.R. Puri, L.R. Sharma, K.C. Kalia, Milestone Publishers, New Delhi, India, 2018.
6. A text book of Bioinorganic Chemistry by Hussain Reddy,

UNIT - III: ORGANIC CHEMISTRY

Total hours: 16

Chapter-1: Carbohydrates

7 hours

Classification and nomenclature of carbohydrates. Monosaccharides- Glucose: reactions of glucose (with $\text{H}_2\text{N-OH}$, HCN , Br_2 water, Conc. HNO_3 , reductions with HI/red P , methanol/dry HCl , acetic anhydride and reduction reactions. Mechanism of formation of osazone from glucose and fructose. Inter-conversion of glucose and fructose. Chain lengthening and chain shortening of aldoses, configuration of glucose and fructose. Epimerization (conversion of glucose into mannose). Formation of glycosides. Determination of ring size of D (+) glucose. Elucidation of cyclic structure of D (+) glucose. Disaccharides- Structure of maltose and sucrose. Polysaccharides- Partial structural formulae of starch and cellulose and their uses.

Chapter-2: Amino acids and proteins

4 hours

Definitions and classification of amino acids, synthesis of amino acids by Gabriel phthalimide, malonic ester and Strecker's method of synthesis. Properties and reactions- Zwitter ion and isoelectric points. Ninhydrin and Biuret tests. Peptides: peptide bond, carbobenzoxy method of synthesis of peptides.

Proteins: Classification based on composition and structure: primary and secondary structures of proteins. Denaturation of proteins.

Chapter-3: Alkaloids

3 hours

Definition, method of isolation, structural elucidation of nicotine and its synthesis by Spath process. Structure and uses of atropine and cocaine.

Chapter-4: Terpenes

2 hours

Classification and isolation. isoprene rule, structure of menthol, camphor, geraniol, α -terpineol and zingiberene. Structural elucidation of Citral and its synthesis from methyl heptanone.

References:

1. O. P. Agarwal, Chemistry of Organic Natural Products, Vol 1 and 2, Goel Pub. House, 2002.
2. Gurdeep Chatwal, Chemistry of Organic Natural Products, Vol 1 and 2, Goel Pub. House, 2002.
3. Bahl and Arun Bahl, Advanced Organic Chemistry, S. Chand and Sons, New Delhi, 2005.
4. Lubert Stryer, Biochemistry, W. H. Freeman and company, New York, 1975.

5. Robert L. Caret, Katherine J. Denniston, Joseph J. Topping, Principles and Applications of organic and biological chemistry, WBB publishers, USA, 1993.
6. J. L. Jain, Biochemistry, Sultan Chand and Co.1999
7. A. Mazur and B. Harrow, Text book of Biochemistry, 10th Edition, W.B. Saunders Co., Philadelphia, 1971.
8. Paula Yurkanis Bruice, Organic Chemistry, III Edition, Pearson Education, Inc. (Singapore), New Delhi, reprint, 2002.

UNIT - IV: PHYSICAL CHEMISTRY

Total hours: 16

(Note: Numerical problems must be solved wherever necessary)

Chapter-1: Thermodynamics-II:

6 hours

Clausius-Clapeyron equation (derivation) and its applications. Nernst heat theorem; statement and concept of residual entropy, evaluation of absolute entropy. Third law of thermodynamics. Partial molar quantities; Concept of chemical potential, variation of chemical potential with temperature and pressure, derivation of Gibbs-Duhem equation, Duhem-Margules equation and its application.

Chapter-2: Elementary Quantum Mechanics

5 hours

Physical interpretation of the wave function. Postulates of quantum mechanics, Schrödinger wave equation based on the postulates of quantum mechanics and its importance. Eigen values and Eigen functions, Operators and algebra of operators, Hamiltonian operator. Application of Schrödinger equation to Particle in a one-dimensional box (derivation).

Chapter-3: Statistical Thermodynamics

5 hours

Energy states: macro and microstates, Limitation of classical thermodynamics, Distinguish between classical mechanics and statistical mechanics. Sterling approximation, derivation of Maxwell-Boltzmann statistics, statistical interpretation of entropy, application of statistics to gases-monoatomic ideal gas (No derivations). Partition functions and thermodynamic parameters, expressions for translational, rotational, vibrational and electronic partition functions, enthalpy, energy, Gibbs free energy.

References:

1. Physical chemistry; R. L. Madan, G. D. Tuli, S. Chand & Co.
2. Principles of Physical Chemistry: Puri, Sharma and Pathania, Vishal Publishing Co.
3. Textbook of Physical Chemistry, Gurdeep Raj, Goel Publications House, New Delhi.

4. Elements of Physical Chemistry, B.R. Puri, L.R. Sharma, M.S. Pathania, I Edition, Vishal Publishing House, Jalandhar, India, 2013.
5. A Textbook of Physical Chemistry, Volume 2, K.L. Kapoor, McMillan Publishers, India Limited.
6. Physical Chemistry, K. J. Laidler and J. M. Meiser, III Edition, Houghton Mifflin Comp., New, York, International Edition.

SIXTH SEMESTER - PRACTICALS (4 HOURS PER WEEK)

PAPER – VI: Chemistry Practical - VI

Part-A: Instrumental Methods

1. Conductometric titration of strong acid vs strong base.
2. Conductometric titration of mixture of weak acid and strong acid vs strong base.
3. Potentiometric titration of Mohr's salt solution v/s Potassium dichromate solution.
4. Potentiometric titration of Mohr's salt solution v/s Potassium permanganate solution.
5. Potentiometric titration of Hydrochloric acid v/s Sodium hydroxide.
6. Estimation of Cu(II) in the given solution by colorimetric method.
7. Estimation of Fe(III) in the given solution by colorimetric method.
8. Determination of percentage composition of a binary mixture of organic liquids by using Abbe's Refractometer
9. Determination of rate constant of inversion of cane sugar by Polarimeter.
10. Determination of cell constant (0.1N KCl solution to be prepared by students) and determine the equivalent conductance at infinite dilution for weak electrolyte of given solution.
11. Conductometric titration of tertiary mixture of CuSO_4 + Acetic acid + HCl using NaOH solution.

Part-B: Organic Estimation

1. Estimation of Phenol.
2. Estimation of Aniline.
3. Estimation of Glycine.
4. Estimation of Citric acid.
5. Estimation of ascorbic acid
6. Estimation of Amide.

7. Estimation of carboxylic acid by titrimetric method.
8. Determination of saponification value of oils.

Note: Minimum six experiments must be performed from each part and recorded.

VI – Semester

Practical Knowledge/Skill based Course – VI (Compulsory Course)

CHEC6.1: Chemistry Practical / Skill based Course

List of Experiments:

1. To estimate the amount of tin in solder using EDTA.
2. To estimate the amount of aluminium in Duralumin.
3. To estimate the amount of magnesium in dolomite by EDTA method.
4. To determine the total hardness of water
5. To determine enthalpy of neutralisation of a weak acid by strong base. (acetic acid vs sodium hydroxide).
6. To determine enthalpy of solution of the given substance
7. To find out heat of dilution of sulphuric acid
8. To determine the COD of different water samples.
9. To determine the amount of Aspirin present in tablets by titrimetric method.
10. Preparation of phenol formaldehyde Resin.
11. Preparation of urea formaldehyde resin.

Note: Minimum eight experiments must be performed and recorded.

Theory Examination Question Paper Pattern

Major Subject (Chemistry)

B.Sc. Semester-I/II/III/IV/V/VI Degree Examination: 2024-25

(Semester Scheme; New Syllabus: 2024-25)

Subject: Chemistry

Paper Code: _____ : Title: _____

Time: 3 Hours.

Max. Marks: 80

Instructions to candidates:

- 1) All sections are compulsory.
- 2) Draw neat and labelled diagrams wherever necessary.
- 3) Figures to the right indicate marks.

Section-A

I. Answer **any ten** of the following questions: **(10×2=20)**

(THREE questions from each unit)

- a)
- b)
- c)
- d)
- e)
- f)
- g)
- h)
- i)
- j)
- k)
- l)

Section-B

II. Answer **any Six** of the following: (TWO Questions from each Unit) **(6×5=30)**

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.

(Note: 5 Marks question may be divided into 2+3, if required)

Section-C

Answer **any Three** of the following: **(3×10=30)**

- 9. From Unit-I
- 10. From Unit-II
- 11. From Unit-III
- 12. From Unit-IV

(Note:10 Marks question may be divided into 3+7 or 4+6 or5+5, if required)
