



RANI CHANNAMMA UNIVERSITY

BELAGAVI

THE COURSE STRUCTURE & SYLLABUS OF UNDER GRADUATE

BACHELOR OF SCIENCE

CHEMISTRY

1ST TO 6TH Semesters

w.e.f.

Academic Year 2020-21 and Onwards
Under

CHOICE BASED CREDIT SYSTEM (CBCS)

**CHOICE BASED CREDIT SYSTEM [CBCS]
B.Sc. Program with Optional Subject: CHEMISTRY**

(With effect from the academic year 2020-21 onwards)								
Sem	Part	Paper Code	Title of the Paper	Hours / Week	Marks			Subject Credits
					IA	Exam	Total	
I	Part – 1 DSC	CHEDSCT 1.1	Chemistry-1	4	20	80	100	3
		CHEDSCT 1.1	Practicals-1	3	10	40	50	1
	Total: Hours / Credits			7			150	4
II	Part – 1 DSC	CHEDSCT 2.1	Chemistry-2	4	20	80	100	3
		CHEDSCT 2.1	Practicals-2	3	10	40	50	1
	Total: Hours / Credits			7			150	4

(With effect from the academic year 2021-22 onwards)

Sem	Part	Paper Code	Title of the Paper	Hours/Week	Marks			Subject Credits
					IA	Exam	Total	
III	Part – 1	CHEDSCT3.1	Chemistry-3	4	20	80	100	3
	DSC	CHEDSCP3.1	Practicals-3	3	10	40	50	1
	Part – 2 SEC	CHESECT3.2	Chemistry of Cosmetics & Perfumes	2	10	40	50	2
		Total: Hours / Credits			9		200	6
IV	Part – 1	CHEDSCT4.1	Chemistry-4	4	20	80	100	3
	DSC	CHEDSCP4.1	Practicals-4	3	10	40	50	1
	Part – 2 SEC	CHESECT4.2	Fuel Chemistry	2	10	40	50	2
		Total: Hours / Credits			9		200	6

(With effect from the academic year 2022-23 onwards)

Sem	Part	Paper Code	Title of Paper	Hours/Week	Marks			Subject Credits
					IA	Exam	Total	
V	Part – 1 DSE	CHESET 5.1	Chemistry-5	4	20	80	100	3
		CHESEP 5.1	Practicals-5	3	10	40	50	1
		CHESET 5.2A (Elective I)	Chemistry-5A	4	20	80	100	3
		CHESEP 5.2A (Elective I)	Practicals-5A	3	10	40	50	1
		CHESET 5.2B (Elective II)	Chemistry-5B	4	20	80	100	3
		CHESEP 5.2B (Elective II)	Practicals-5B	3	10	40	50	1
	Part – 2 SEC	CHESECT5.3	Basic Analytical Chemistry	3	10	40	50	2
	Total: Hours / Credits				17			350

Note: Students have to choose either Elective-I or Elective-II

VI	Part – 1 DSE	CHESET 6.1	Chemistry-6	4	20	80	100	3
		CHESEP 6.1	Practicals-6	3	10	40	50	1
		CHESET 6.2A (Elective III)	Chemistry-6A	4	20	80	100	3
		CHESEP 6.2A (Elective III)	Practicals-6A	3	10	40	50	1
		CHESET 6.2B (Elective IV)	Chemistry-6B	4	20	80	100	3
		CHESEP 6.2B (Elective IV)	Practicals-6B	3	10	40	50	1
	Part – 2 SEC	CHESECT 6.3	Pharmaceutical Chemistry	3	10	40	50	2
	Total: Hours / Credits				17			350

Note: Students have to choose either Elective-III or Elective-IV

T: Theory, P: Practical, CC/EA: Co-curricular/Extension Activities. AECC: Ability Enhancement Compulsory Course, DSC: Discipline Specific Course. DSE: Discipline Specific Elective, SEC: Skill Enhancement Course).

Note: Duration of examinations is 03 h for 80 Marks theory and 02 h for 40 marks theory. For practicals, duration of examination is 03 h.

Schema of Evaluation for Practical Examination

	Particulars	Marks Allotted
1	Experimental preparation involving the following *	30
2	Journal (record) assessment	05
3	Oral performance (Viva-voce)	05
Total		40
*	Brief description & tabulation	04
	Basic reactions involved & Mechanism, if any	04
	Preparation of required solutions and Experimental set-up	04
	Record of observation and performance of experiment	10
	Calculation including drawing graph	06
	Accuracy of result with unit	02

Question Paper pattern
First Semester B.Sc. Degree Examination, December 2020
(CBCS Scheme-2020-21: Regular)

Chemistry
CHEDSCT 1.1: Chemistry-1

Time: 3 Hours

Max. Marks: 80

Q. No. I. Answer any TEN of the following

2X10= 20 Marks

- 1)
- 2)
- 3)
- 4)
- 5)
- 6)
- 7)
- 8)
- 9)
- 10)
- 11)
- 12)

Q. NO. II. Answer the following questions

5X3=15 Marks

- a)
 - b)
 - c)
- OR
- d)

Q. No. III. Answer the following questions

5x3= 15 Marks

- a)
 - b)
 - c)
- OR
- d)

Q. No. IV. Answer the following questions

5x3=15 Marks

- a)
 - b)
 - c)
- OR
- d)

Q. No. V. Answer the following questions

5x3=15 Marks

- a)
 - b)
 - c)
- OR
- d)

Question Paper pattern
First Semester B.Sc. Degree Examination, December 2020
(CBCS Scheme-2020-21: Regular)
Chemistry

CHESECT 3.2: Title of the Paper

Time: 3 Hours

Max. Marks: 40

Q. No. I. Answer any **FIVE** of the following

2X5= 20 Marks

- 1)
- 2)
- 3)
- 4)
- 5)
- 6)

Q. NO. II Answer the following questions

5X3=15 Marks

- a)
 - b)
 - c)
- OR
- d)

Q. No. III. Answer the following questions

5x3= 15 Marks

- a)
 - b)
 - c)
- OR
- d)

Instruction to set the DSC/DSE question paper.

- Question number 1 has 12 sub questions consisting of 3 questions from each unit. Each question carries two marks. Student has to answer any ten questions.
- Question number II are from unit I.
- Question number III are from unit II.
- Question number IV are from unit III
- Question number V are from unit IV.

Instruction to set the SEC question paper.

- Question number 1 has 6 sub questions consisting of 3 questions from each unit. Each question carries two marks. Student has to answer any five questions.
- Question number I is from unit I.
- Question number II is from unit II.

First Semester B.Sc. (Chemistry) as per CBCS

Paper Code: CHEDSCT 1.1
Teaching Hours: 4 H / Week
Total hours:60

Paper Title: Chemistry-1
Marks: Th-80+IA-20
Credits :3

UNIT-I: Atomic Structure (15 Hours)

Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to atomic structure -Introduction to Quantum mechanics: Time independent Schrodinger equation and meaning of various terms in it (no derivation). Significance of ψ and ψ^2 . Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s . Shapes of s , p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

UNIT-II: Chemical Bonding and Molecular Structure (15 Hours)

Ionic Bonding: Ionic bonding, lattice energy, Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. **MO Approach:** Rules for the LCAO method, bonding and antibonding MOs and their characteristics for $s-s$, $s-p$ and $p-p$ combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of $s-p$ mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+ . Comparison of VB and MO approaches.

UNIT-III: Fundamentals of Organic Chemistry and Alkenes (15Hours)

Fundamentals of Organic Chemistry: Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

Alkenes: Methods of preparation of alkenes by (i) dehydration of alcohols (ii) dehydrohalogenation. Saytzeff's elimination (Formation of highly substituted alkene, 2-butene), Hofmann orientation (Formation of least substituted alkene, 1-pentene).

Chemical reactions of alkenes- Peroxide effect and its mechanism, hydroboration, oxidation, oxy-mercuration–reduction and mechanism, ozonolysis with respect to 2-butene and 2-methyl-2-butene, oxidation with KMnO_4 .

Dienes: Classification, Nomenclature and Preparation of 1,3 butadiene; Reactions of 1,2 and 1,4 addition reactions (addition of halogens and halogen acids), Diel's-Alder reaction, polymerization of 1,3 butadiene.

Alkynes: Acidity of Alkynes, reactions of acetylene –metal ammonia reduction, oxidation and polymerization

UNIT-IV: Purification of organic compounds and Stereochemistry (15 Hours)

Purification of organic compounds:

Methods of purification of solids: Crystallization, fractional crystallization and sublimation.

Method of purification of liquids: Distillation, fractional distillation, distillation under reduced pressure, steam distillation.

Chromatography: General principles, types, brief outline of thin layer chromatography, paper chromatography and column chromatography, solvent extraction.

Criteria of purity: Melting point and boiling point.

Stereochemistry:

Cycloalkanes: Baeyer's strain theory, calculation of angle strain, Sachse Mohr theory of strain less rings. Chair and boat forms of cyclohexane. Axial and equatorial bonds.

Conformational isomerism: Basic concept of conformational analysis with reference to ethane and butane.

Geometrical isomerism: definition, E and Z notation for 2-butene and butenedioic acid, rules for assigning notations. Determination of configuration of butenedioic acid by anhydride formation, dipole moment measurement, melting point and stability.

Optical isomerism: Chirality, van't Hoff-Lebel hypothesis, optical activity, D and L configurations, R and S notations, sequence and priority rules, enantiomers, distereoisomers, epimers, anomers, racemic and meso (with suitable examples like lactic and tartaric acids.), racemisation, resolution of racemic mixture by chemical method, asymmetric synthesis, Walden inversion.

References:

1. Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India, 2006.
5. Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
6. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
7. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
8. Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.
9. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
10. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
11. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.

First Semester B.Sc. (Chemistry)

Paper Code: CHEDSCP 1.1
Teaching Hours: 3 H / Week
Total hours: 45 h

Paper Title: Practicals-1
Marks: Th-40+IA-10
Credits :1

Section A: Inorganic Chemistry - Volumetric Analysis (40 Marks)

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with KMnO_4 .
3. Estimation of water of crystallization in Mohr's salt by titrating with KMnO_4 .
4. Estimation of Fe (II) ions by titrating it with $\text{K}_2\text{Cr}_2\text{O}_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $\text{Na}_2\text{S}_2\text{O}_3$ (demo only).
6. Determination of the percentage loss in weight of I) Zinc carbonate II) mixture of barium sulphate and ammonium chloride

Section B: Organic Chemistry Estimations:

7. Estimation of Phenol.
8. Estimation of Aniline.
9. Estimation of Amide.
10. Estimation of Glucose.

Reference Books:

1. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
2. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

Second Semester B.Sc. (Chemistry)

Paper Code: CHEDSCT 2.1

Teaching Hours: 4 H / Week

Total hours: 60

Paper Title: Chemistry-2

Marks: Th-80+IA-20

Credits: 3

UNIT-I Chemical Energetics and Ionic Equilibria: I

(15Hours)

Chemical Energetics: Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances. Joule-Thomson effect, derivation of Joule Thomson coefficient for an ideal gas and inversion temperature.

Ionic Equilibria-I: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect.

UNIT-II: Ionic Equilibria: II and Chemical Equilibrium

(15Hours)

Ionic Equilibria-II: Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium (VantHoff reaction isotherm). Distinction between ΔG and ΔG° , Le Chatelier's principle. Relationships between K_p , K_c and K_x for reactions involving ideal gases. Variation of equilibrium constants with temperatures.

UNIT-III: Spectroscopy, Alkyl and Aryl Halides

(15 Hours)

Spectroscopy: Introduction to conventional methods of elucidation of structure of organic compounds (chemical degradation) and comparison with spectroscopic methods, electromagnetic spectrum.

UV spectroscopy: Principle, types of transitions, chromophores, concept of auxochromes and their effect on λ_{\max} , bathochromic shift, hypsochromic shift, hypochromic and hyperchromic shift. Woodward and Fieser rules and illustration of calculation of λ_{\max} taking myrcene and B-phelladrene as examples.

Alkyl and Aryl Halides

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkyl Halides: Types of Nucleophilic Substitution (S_N1 , S_N2 and S_{Ni}) reactions.

Preparation of alkyl halides from alkenes and alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis.

Aryl Halides: Preparation of aryl halides (Chloro, bromo and iodo-benzene) from phenol, Sandmeyer & Gattermann reactions.

Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by $-OH$ group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$).

Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

UNIT-IV: Aldehydes and ketones, Carboxylic Acids, Ethers and Epoxides(15Hours)

Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde) *Preparation:* from acid chlorides and from nitriles.

Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction.

Carboxylic Acids: Nomenclature, structure and bonding, acid strengths of mono, di and tri chloroacetic acids and nitro, chloro and hydroxy substituted benzoic acids, mechanism of esterification and hydrolysis of ester (Aac_2 and Bac_2). Reactions of carboxylic acids - i) Conversion into acid derivatives (acid chlorides, amides, esters and anhydrides), ii) Curtius rearrangement, iii) Reaction with organometallic compounds and iv) Hell-Volhard-Zelinsky reaction.

Ethers: Nomenclature of ethers and their methods of preparation, chemical reactions - Reaction with HI, hot and cold taking symmetric and unsymmetrical ethers. Crown ethers: Definition, examples, use of crown ethers as phase transfer catalysts.

Epoxides: Synthesis of 1,2-epoxy ethane and 1,2-epoxycyclopentane, acid catalyzed ring opening of 1,2-epoxycyclopentane in aqueous solution.

Reference:

1. Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
2. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
3. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).

4. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
5. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
6. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
7. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
8. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
9. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
10. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
11. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

Second Semester B.Sc. (Chemistry)

Paper Code: CHEDSCP 2.1
Teaching Hours: 3 H / Week
Total hours:45

Paper Title: Practicals-2
Marks: Th-40+IA-10
Credits: 1

SECTION A. Organic Spotting

Identification of following organic compounds and preparation of their derivatives and confirmation by melting points:

S. L	Name of compound	S. L	Name of compound
1	Phthalic acid	9	Acetone
2	Benzoic Acid	10	Ethyl benzoate
3	Salicylic Acid	11	Benzaldehyde
4	Aniline	12	Acetanilide
5	<i>p</i> -Nitroaniline	13	Naphthalene
6	Phenol	14	Urea
7	1-Naphthol	15	Benzamide
8	2-Naphthol		

Section B: Identification by

1. Element detection, 2. Solubility, 3. Functional group, 4. Physical constant,
5. Preparation of derivatives and finding melting points.

Reference Books

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).

Third Semester B.Sc. (Chemistry)

Paper Code: CHEDSCT 3.1
Teaching Hours: 4 H / Week
Total hours:60

Paper Title: Chemistry-3
Marks: Th-80+IA-20
Credits: 3

UNIT-I: Solutions and Liquids (15Hours)

Solutions: Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions.

Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

Liquids: Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

UNIT II: Electrochemistry and Phase Equilibrium (15Hours)

Electrochemistry: Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG , ΔH and ΔS from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge. pH determination using hydrogen electrode and quinhydrone electrode. Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).

Phase Equilibrium: Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (KI/H₂O, Bi-Cd).

UNIT-III: Orientation, Alcohols and Phenols (15Hous)

Orientation: Review of inductive, electromeric, resonance and hyperconjugation effects, activating and deactivating groups, orientation of substituent in aromatic compounds with different functional groups like -OH, -NH₂, -Cl, -NO₂, -CH₃, and -COOH in halogenation and nitration reactions (only electronic interpretation).

Alcohols: Introduction and nomenclature of dihydric and trihydric alcohols, preparation of glycol from ethene, oxidative cleavage of ethylene glycol with lead tetra acetate and per iodic acid, pinacol-pinacolone rearrangement, preparation of glycerol from propene, synthesis and uses of nitroglycerine, composition and uses of dynamite and cordite, distinction between primary, secondary and tertiary alcohols by Lucas reagent.

Phenols: Classification and nomenclature, acidic character of phenol compared to alcohol and cyclohexenol, mechanism of Fries rearrangement, Claisen rearrangement, Elbs persulphate oxidation and Lederer-Manasse reaction, synthesis and uses of n-hexyl resorcinol and picric acid, structure and uses of dettol.

Unit-IV: Spectroscopy and Aromatic Hydrocarbons. (15Hours)

Infrared spectroscopy: Principle, types of vibrations, identification of following organic compounds by stretching frequencies—Alkanes, alkenes, alkynes, benzene, aldehydes, ketone, alcohol, thiols, acids, esters, amines, problems based on molecular formula and stretching frequency.

Mass Spectroscopy: Principle, instrumentation, definitions of parent peak and base peak, McLafferty rearrangement with respect to butyraldehyde.

Aromatic Hydrocarbons: Resonance in benzene, Aromaticity—Huckel's $4n + 2$ rule with respect to benzene, furan, pyridine and [10]–annulene. Mechanism of electrophilic aromatic substitution—halogenation, nitration, sulphonation and Friedel-Craft's reaction (evidences for two step mechanism and evidences for formation of electrophile).

Poly nuclear hydrocarbons: Classification, examples, constitution of naphthalene, Haworth synthesis, nitration and sulphonation of naphthalene.

Reference Books:

1. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
2. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry*, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
4. Mahan, B.H. *University Chemistry*, 3rd Ed. Narosa (1998).
5. Petrucci, R.H. *General Chemistry*, 5th Ed., Macmillan Publishing Co.: New York (1985).
6. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Finar, I. L. *Organic Chemistry (Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry 7th Ed.*, W. H. Freeman.
10. Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.

Third Semester B.Sc. (Chemistry)

Paper Code: CHEDSCP 3.1

Paper Title: Practicals-3

Teaching Hours: 3 H / Week

Marks: Th-40+IA-10

Total hours: 45

Credits: 1

Section A: Physical Chemistry Experiments

(40 Marks)

1. To study the effect of acid strength on hydrolysis of methyl acetate using HCl and H₂SO₄.
2. To determine the rate constant of second order reaction KI+K₂S₂O₈ (a=b) and effect of concentration on rate constant of second order reaction.
3. Adsorption of acetic acid on animal charcoal.
4. Determination of surface tension and parachor of benzene series.
5. Determination of surface tension and parachor of alcohol series.
6. Determination of viscosity of liquids of Ostwald's method.
7. Determination of viscosity of binary liquid mixtures and finding the percentage composition unknown.
8. Determination of molecular weight of urea by Landbergers method.
9. Determination of degree of dissociation of KCl by Landbergers method.
10. Determination of equilibrium constant of distribution of iodine between KI and CCl₄.

Section B: Inorganic volumetric experiments:

11. Preparation of aqueous iron solutions and estimation of iron using standard K₂Cr₂O₇ (Internal indicator method).
12. Preparation of aqueous solution of copper and zinc from brass and estimation of percentage of copper using standard sodium thiosulphate solution.
13. Preparation of calcium solution from lime stone and estimation of percentage of calcium using oxalate method.
14. Estimation of zinc using standard solution of potassium ferro cyanide (Standardization of the titrant be done using standard zinc sulphate solution).

Reference Books:

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
4. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry*, Universities Press.

Third Semester B.Sc. (Chemistry) Skill Enhancement Course

Paper Code: CHESECT 3.2

Paper Title: Chemistry of Cosmetics & Perfumes

Teaching Hours: 3h / Week

Marks: Th-40+IA-10

Total hours:30

Credits: 2

CHEMISTRY OF COSMETICS & PERFUMES

15 hours

A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

Practicals

15 hours

1. Preparation of talcum powder.
2. Preparation of shampoo.
3. Preparation of enamels.
4. Preparation of hair remover.
5. Preparation of face cream.
6. Preparation of nail polish and nail polish remover.

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
2. P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
3. Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut(1996).

Fourth Semester B.Sc. (Chemistry)

Paper Code: CHEDSCT 4.1
Teaching Hours: 4 H / Week
Total hours:60

Paper Title: Chemistry-4
Marks: Th-80+IA-20
Credits :3

UNIT I: Transition Elements (3d series) and Coordination Chemistry (15Hours)

Transition Elements (3d series): General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.

Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

Coordination Chemistry: Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature.

UNIT- II: Chemistry of d-block and f-block elements, Chelates, Environmental Chemistry (15Hours)

Chemistry of d and f block elements: General characteristics of d block elements- Electronic configuration, oxidation states, metallic property, colour, reactivity, reducing property, magnetic, catalytic and complex formation properties. General characteristics of f block elements - Electronic configuration, cause and consequences of lanthanide contraction. General features of actinides- electronic configuration, oxidation state, extraction of uranium from pitchblende.

Chelates: definition, characteristics, factors influencing the stability of metal chelates and importance of chelates.

Environmental Chemistry

Air pollution: Types of pollutants, sources and control measures- CO, CO₂, SO_x, NO_x, H₂S, hydrocarbons, CFC's and particulates, pesticides, and their adverse effects.

Water pollution: Types of pollutants, sources and adverse effects (sewage, infectious agents, organic chemicals and inorganic mineral, oils and sediments) Parameters of water pollution – Dissolved oxygen (DO), biological oxygen demand (BOD) and chemical oxygen demand (COD), definitions and their determinations. Treatment of sewage and industrial effluents - Preliminary, primary and secondary treatment (Aerated lagoons, trickling filters and activated sludge).

UNIT-III Kinetic Theory of Gases and Conductance

(15Hours)

Kinetic Theory of Gases: Derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO₂. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

Conductance: Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions. Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

UNIT-IV Theory of Solids and Chemical Kinetics

(15 Hours)

Solids: Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X-Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

Chemical Kinetics: The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half-life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.

Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

Reference Books:

1. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
2. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).

3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
5. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
6. Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry*, Wiley.
7. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
8. Wulfsberg, G. *Inorganic Chemistry*, Viva Books Pvt. Ltd.
9. Rodgers, G.E. *Inorganic & Solid-State Chemistry*, Cengage Learning India Ltd., 2008.

Fourth Semester B.Sc. (Chemistry)

Paper Code: CHEDSCP 4.1
Teaching Hours: 3 H / Week
Total hours: 45

Paper Title: Practicals-4
Marks: Th-40+IA-10
Credits: 1

Section A: Inorganic Chemistry

(40 Marks)

Semi-micro Qualitative analysis of two simple inorganic Salts

ANIONS: CO_3^{-2} , S^{-2} , Cl^- , Br^- , I^- , NO_3^- , SO_4^{-2}

CATIONS: Pb^{+2} , Cu^{+2} , Al^{+3} , Fe^{+2} , Fe^{+3} , Mn^{+2} , Co^{+2} , Ni^{+2} , Zn^{+2} , Ca^{+2} , Ba^{+2} , Mg^{+2} , Na^+ , K^+ and NH_4^+

Section B: Inorganic Chemistry

1. Determination of dissolved oxygen present in water by Winkler's method.
2. Determination of C.O.D in polluted water.

Reference Books:

1. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
2. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).

Fourth Semester B.Sc. (Chemistry) Skill Enhancement Course

Paper Code: CHESEC 4.2

Teaching Hours: 3 H / Week

Total hours:30

Paper Title: Fuel Chemistry

Marks: Th-80+IA-20

Credits :2

UNIT-I: FUEL CHEMISTRY:

15 hours

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.

Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications.

UNIT-II

15 hours

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Reference:

1. Stocchi, E. *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK (1990).
2. Jain, P.C. & Jain, M. *Engineering Chemistry* Dhanpat Rai & Sons, Delhi.
3. Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996).

Fifth Semester B.Sc. (Chemistry)

Paper Code: CHEDSET 5.1
Teaching Hours: 4 H / Week
Total hours:60

Paper Title: Chemistry-5
Marks: Th-80+IA-20
Credits :3

UNIT-I: Nanomaterials, Theory of gravimetric analysis and Inorganic polymers **(15Hours)**

Nano materials: Overview of nanostructures and nanomaterials: classification. Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires. Bio-inorganic nanomaterials.

Theory of gravimetric analysis: Principles of gravimetric analysis- super saturation, von Weimar equation, conditions of precipitation, coprecipitation and post precipitation. Separation of precipitate from mother liquor, washing, properties of wash liquid, drying and ignition of precipitate, weighing form.

Inorganic polymers: Inorganic polymers, Types, comparison with organic polymers, silicones, phosphonitrilic halides- formation, structure and applications.

UNIT-II: Heterocyclic Compounds, Green Chemistry, Alkaloids (15Hours)

Heterocyclic Compounds: Classification, molecular orbital picture and Aromatic character of furan, thiophene, pyrrole and pyridine, synthesis of the following compounds.

i). Furan, thiohene and pyrrole from 1,4- diketones. ii) Pyridine by Hantzsch synthesis.

Electrophilic substitution reactions of pyrrole, furan and pyridine (chlorination and nitration), comparison of basicities of pyridine, piperidine and pyrrole.

Green Chemistry: The need for green chemistry and eco-efficiency, green methods, green products, recycling of wastes, 12 principles of green chemistry.

Alkaloids: Definition, source, classification and general characteristics, Hofmann exhaustive methylation with pyridine as an example. Isolation, constitution and confirmation by synthesis – Coniine, hygrine and nicotine.

UNIT III: Microwave Spectroscopy & Vibrational spectrum (15Hours)

Microwave Spectroscopy: Classification of molecules, rotational spectra of rigid diatomic molecules, criteria for showing the spectra, energy levels of rigid rotator, selection rules (final equations only), determination of bond length and moment of inertia of HCl molecule.

Vibrational spectrum: Simple harmonic oscillator, Hooke's law, energy level of simple harmonic oscillator model of diatomic molecule (final equations only), selection rules, zero-point energy determination of force constant and qualitative relation between force constant and bond dissociation energies. Vibrational degrees of freedom of molecules (Linear and nonlinear).

UNIT IV Retro synthesis and Properties of Polymers

(15Hours)

Retrosynthesis: Introduction to retrosynthetic analysis, synthons, synthetic equivalents, functional group interconversions, one and two group C-X disconnection (definitions and examples only). Retrosynthesis of benzocaine and 4-methoxy acetophenone.

Properties of Polymers (Physical, thermal, Flow & Mechanical Properties): Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly (vinyl chloride) and related polymers, poly (vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly (p-phenylene sulphide polypyrrole, polythiophene)].

Fifth Semester B.Sc. (Chemistry)

Paper Code: CHEDSEP 5.1
Teaching Hours: 3 H / Week
Total hours: 45

Paper Title: Practicals-5
Marks: Th-40+IA-10
Credits: 1

Section A: Organic Chemistry

(40 Marks)

Analysis of binary Organic mixture

Systematic qualitative analysis of binary mixture (solid+solid and liquid+liquid).

Type of mixture to be given

- Acid+Base: Benzoic acid+*p*-Nitroaniline / Cinnamic acid+*m*-Nitroaniline
- Acid+ Neutral: Benzoic acid+Naphthalene / Phthalic acid+Acetanilide
- Base+Neutral: *o*-Nitroaniline+Acetanilide / *p*-Nitroaniline+Naphthalene
- Phenol+Neutral: 1-Naphthol+Benzamide / 2-Naphthol+Acetanilide
- Phenol+Base: 2-Naphthol+*p*-Nitroaniline / 1-Naphthol+*m*-Nitroaniline
- Neutral+Neutral (liquid+liquid): Acetone+Ethyl benzoate / Nitrobenzene+Acetone

Section B: Organic Chemistry

- Fractional crystallization: Separation of mixture of naphthalene and biphenyl
- Fractional distillation: Separation of mixture of benzene and toluene.

Note: Only experiments in Section A are to be given in practical examination. Student shall separate the mixture and analyze one compound as suggested by examiner and he has to prepare the derivative for the same.

Fifth Semester B.Sc. (Chemistry)

Paper Code: CHEDSET 5.2A

Teaching Hours: 4 H / Week

Total hours:60

Paper Title: Chemistry-5A

Marks: Th-80+IA-20

Credits :3

UNIT-I: Industrial Chemistry-I

(15Hours)

Alloys-Significance, types of alloys (ferrous and non-ferrous alloys), preparation (fusion and electro-deposition) and their applications.

Abrasives- Classification, Mohr scale of hardness, Manufacture and application of carborundum, alundum, tungsten carbide.

Glass - physical and chemical properties of glass, raw materials, manufacture using tank furnace, annealing of glass, types, composition and uses of glasses.

Industrial Chemistry-II

Cement: Raw materials, composition of Portland cement, manufacture by rotary kiln method, mechanism of setting.

Fuels: characteristic and calorific values of fuels, advantages of gaseous fuels, Manufacture of water gas and biogas.

UNIT-II Reagents and Reactions and Dyes

(15Hours)

Reagents and Reactions: Preparation, mechanism of action and applications DCC (Amide formation), LiAlH_4 (reduction of aldehyde, carboxylic acid and ester), DDQ (Benzylic oxidation of tetralin, aromatization of tetralin), Lead Tetra Acetate(oxidation of 1,2-diols), NBS(allylic bromination), OsO_4 (hydroxylation of alkenes), PCC(Pyridinium chlorochromate) in the oxidation of primary alcohols.

Dyes: Classification, requirement of a dye, colour and constitution. The synthesis of each of the following Class of dyes: Azo dyes-Congo red, Vat dyes-Indigo, Anthraquinone dyes-Alizarin Triphenylemethane dyes-Malachite green, Crystal violet, Phthalein dyes-Fluorescein, Eosin; Synthesis of each dyes.

UNIT-III Surface Chemistry and Second law of thermodynamics (15Hours)

Surface Chemistry: Adsorption, derivation of Freundlich and Langmuir's adsorption isotherms. Forms of Langmuir's adsorption isotherms at high- and low-pressure regions, BET equation (No derivation), determination of surface area using BET equation.

Catalysis-Theories of catalysis-intermediate and adsorption theory, enzyme catalysis-Michaelis-Menten equation, industrial applications of catalysis.

Second law of thermodynamics: Statement, cyclic process, Carnot's cycle, heat engine and its efficiency, Carnot's theorem, entropy and its significance, entropy changes in reversible and irreversible process for ideal gases, free energy, dependence of free energy on pressure

and temperature, Gibb's–Helmholtz equation, Clausius-Clapeyron equation and its applications, problems on above, partial molal quantities, chemical potential of on ideal gas.

UNIT IV: Simple collision theory of reaction rates and Industrial Metallurgy (15hours)

Simple collision theory of reaction rates: Derivation of rate constants of unimolecular (Lindemann hypothesis) and bimolecular reaction rates, limitations of collision theory.

Transition state theory: Theory Comparison of transition state theory and collision theory, steric factor.

Chemical kinetics of complex reactions-first order reaction, opposing, consecutive and parallel reactions.

Industrial Metallurgy

General Principles of Metallurgy: Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent. Hydrometallurgy, Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond's process. Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

Reference

1. Industrial chemistry B.K. Sharma
2. Engineering Chemistry Jain and Jain
3. Reaction Mechanism P.S. Kalsi
4. Mass Spectroscopy Y.R. Sharma
5. Synthetic Organic Chemistry Gurdeep Chatwal
6. Organic Chemistry P.L. Soni
7. Organic syntheses Jagadamba Singh and Yadav
8. Fundamentals of Organic Synthesis (Retrosynthesis) Ratan Kumar Kar
9. Electrochemistry Glasstone
10. Physical Chemistry Atkins
11. Engineering Chemistry Jain

Fifth Semester B.Sc. (Chemistry)

Paper Code: CHEDSEP 5.2A

Teaching Hours: 3 H / Week

Total hours:45

Paper Title: Practicals-5A

Marks: Th-40+IA-10

Credits: 1

Physical Chemistry experiments:

1. Determination of the concentration of HCl by conductometric titration using the standard NaOH.
2. Determination of the concentration of CH₃COOH by conductometric titration using the standard NaOH.
3. Verification of Beer–Lambert’s Law by colorimetric method and calculation of molar extension coefficient of FeCl₃.
4. Determination of dissociation constant of (weak acid) acetic acid conductometrically.
5. Determination of concentration of strong acid HCl by potentiometric titration against strong solution of NaOH.
6. Determination of heat of neutralization of strong acid by strong base by water equivalent calorimetric method.
7. Determination of specific rotation of glucose solution by polarimeter.
8. Determination of solubility of sparingly soluble salt (BaSO₄) Conductometrically.

Section B: Instrumental Analysis

1. Estimation of Fe⁺³ spectrophotometrically through phenanthroline complex.
2. Determination of pH of biological fluids like milk, orange juice, citric acid, solution and sodium carbonate solution.

Note: Only experiments in Section A are to be given in practical examination.

Fifth Semester B.Sc. (Chemistry)

Paper Code: CHEDSET 5.2B
Teaching Hours: 4 H / Week
Total hours:60

Paper Title: Chemistry-5B
Marks: Th-80+IA-20
Credits :3

UNIT-I (15 Hours)

Basics: Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

UNIT-II Numerical methods: (15 Hours)

Roots of equations: Numerical methods for roots of equations: Quadratic formula, iterative method, Newton-Raphson method, Binary bisection and Regula-Falsi.

UNIT-III (15 Hours)

Differential calculus: Numerical differentiation.

Integral calculus: Numerical integration (Trapezoidal and Simpson's rule), probability distributions and mean values.

UNIT-IV (15 Hours)

Simultaneous equations: Matrix manipulation: addition, multiplication. Gauss-Siedal method.

Interpolation, extrapolation and curve fitting: Handling of experimental data.

Conceptual background of molecular modelling: Potential energy surfaces. Elementary ideas of molecular mechanics and practical MO methods.

Reference:

1. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
2. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific dataanalysis*, Cambridge Univ. Press (2001) 487 pages.
3. Noggle, J. H. *Physical chemistry on a Microcomputer*. Little Brown & Co. (1985).
4. Venit, S.M. *Programming in BASIC: Problem solving with structure and style*. JaicoPublishing House: Delhi (1996).

Fifth Semester B.Sc. (Chemistry)

Paper Code: CHEDSET 5.2B

Teaching Hours: 3 H / Week

Total hours: 45

Paper Title: Practicals-5B

Marks: Th-40+IA-10

Credits: 1

APPLICATIONS OF COMPUTERS IN CHEMISTRY (60 Hours)

1. Computer programs based on numerical methods for Roots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, pH of a weak acid).
2. Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).
3. Numerical integration (e.g. entropy/ enthalpy changes from heat capacity data), probability distributions (gas kinetic theory) and mean values.
4. Matrix operations. Application of Gauss-Siedel method in colourimetry.
5. Simple exercises using molecular visualization software.

Reference Books:

1. McQuarrie, D. A. *Mathematics for Physical Chemistry* University Science Books(2008).
2. Mortimer, R. *Mathematics for Physical Chemistry*. 3rd Ed. Elsevier (2005).
3. Steiner, E. *The Chemical Maths Book* Oxford University Press (1996).
4. Yates, P. *Chemical Calculations*. 2nd Ed. CRC Press (2007).
5. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
6. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific dataanalysis*, Cambridge Univ. Press (2001) 487 pages.

Fifth Semester B.Sc. (Chemistry) Skill Enhancement Course

Paper Code: CHESECT 5.3
Teaching Hours: 3 H / Week
Total hours:30

Paper Title: Basic Analytical Chemistry
Marks: Th-40+IA-10
Credits :2

UNIT-I

15 Hours

Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators. Determination of pH of soil samples. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. Determination of pH, acidity and alkalinity of a water samples. Determination of dissolved oxygen (DO) of a water sample.

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration. Identification of adulterants in some common food items like coffee powder, asafetida. chili powder, turmeric powder, coriander powder and pulses, etc. Analysis of preservatives and colouring matter.

UNIT-II

15 Hours

Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}). To compare paint samples by TLC method

Ion-exchange: Column, ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

Analysis of cosmetics: Major and minor constituents and their functional. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, subphases. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration

Suggested Applications (Any one):

a. To study the use of phenolphthalein in trap cases.

- b. To analyze arson accelerants.
- c. To carry out analysis of gasoline

Suggested Instrumental demonstrations

Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.

1. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
2. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Reference Books:

1. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis. 7th Ed. Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.
2. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
3. Skoog, D.A.; West, D.M. & Holler, F.J. Fundamentals of Analytical Chemistry 6thEd., Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. Quantitative Chemical Analysis, W. H. Freeman.
5. Dean, J. A. Analytical Chemistry Notebook, McGraw Hill.
6. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India.
7. Freifelder, D. Physical Biochemistry 2nd Ed., W.H. Freeman and Co., N.Y. USA (1982).
8. Cooper, T.G. The Tools of Biochemistry, John Wiley and Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall.
10. Vogel, A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Prentice Hall.

Sixth Semester B.Sc. (Chemistry)

Paper Code: CHEDSET 6.1
Teaching Hours: 4 H / Week
Total hours:60

Paper Title: Chemistry-6
Marks: Th-80+IA-20
Credits :3

UNIT-I Coordination compounds –II and Bioinorganic Chemistry (15 hours)

Coordination compounds –II: Crystal field theory(CFT) with reference to octahedral, distorted octahedral(Jahn- Teller distortion), tetrahedral and square planar complexes, calculation of crystal field stabilization energy, factors affecting $10Dq$, consequences of crystal field splitting on ionic radii of M^{+2} ions, enthalpy of hydration of M^{+2} ions, explanation of colour and magnetic properties of magnetic complexes, limitations of crystal field theory, calculation of magnetic moment using Gouy's method.

Bioinorganic Chemistry: Essential and trace elements in biological process, metalloporphyrins with respect to haemoglobin and chlorophyll (structure and function), biological role of Na, K, Fe and Zn. **(4 hours)**

UNIT-II Carbohydrates, Vitamins and Amino acids, Peptides and Proteins (15 hours)

Carbohydrates: Haworth and conformational formulae of glucose and fructose, mutarotation and its mechanism, osazone formation, Killani's synthesis, Ruff's degradation, epimers and epimerisation with respect to monosaccharides, interconversions of glucose and fructose.

Vitamins: Classification and importance of vitamin-A, B6, B12, C, D and E. Synthesis of Vitamin-C from D(+)-glucose, synthesis of vitamin-A by Vandropetal.

Amino acids, Peptides and Proteins: Classification, structure and stereochemistry(D and L) of amino acids, acid-base behaviour, iso-electric point and electrophoresis, peptides-nomenclature and structure of peptides, synthesis of a dipeptide(Bergmann synthesis), Classification of proteins, levels of protein structure(primary, secondary and tertiary structure), protein denaturation and renaturation.**(06 hours)**

UNIT-III Electronic Spectrum, Physical properties and molecular structure and Quantum Chemistry (15 hours)

Electronic Spectrum: Concept potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules, energy levels and respective transitions, Frank–Condon principle. **(06 hours)**

Physical properties and molecular structure: Introduction-dipole moment, induced dipole moment, measurement of dipole moment by temperature variation method and its applications. **(04 hours)**

Quantum Chemistry: Photoelectric effect - Einstein's photoelectric equation, wave particle duality, de- Broglie hypothesis, de-Broglie equation(derivation), experimental verification- Davisson-Germer experiment. **(05 Hours)**

UNIT-IV: Terpenoids, Organometallic Chemistry, Organic Synthesis via enolates and Organic reagents in inorganic analysis. (15 hours)

Terpenoids: Introduction, classification of terpenes, Ingold's isoprene rule, constitution of citral with synthesis, synthesis of α and β ionones, synthesis of α -terpeniol.

Organometallic Chemistry: Introduction, classification of organotransition metal complexes, 18 electron rule with respect to $[\text{Fe}(\text{CO})_5]$, $[\text{Ni}(\text{CO})_5]$, $[\text{Mn}(\text{CO})_5]^+$, ferrocene, structure and bonding in metal olefins (Zeise's Salt).

Organic Synthesis via enolates: Acidity of α -hydrogens, synthesis of ethyl acetoacetate (EAA) by Claisen condensation and its mechanism, synthesis of diethyl malonate, keto-enol tautomerism of EAA

Synthesis of following compounds using EAA and diethyl malonate:

i) ketones ii) carboxylic acids iii) heterocyclic compounds iv) dicarboxylic acids.

Organic reagents in inorganic analysis: Sensitivity, selectivity and specificity, advantages of organic reagents over inorganic reagents - Dimethyl glyoxime, 8-hydroxyquinoline(oxime).

Sixth Semester B.Sc. (Chemistry)

Paper Code: CHEDSET 6.2A

Teaching Hours: 4 H / Week

Total hours:60

Paper Title: Chemistry-6A

Marks: Th-80+IA-20

Credits :3

UNIT-I Analytical Chemistry, Soil Analysis and Fertilizer (15 Hours)

Chromatography: Principle, types, stationary and mobile phases, physical factors of separation, brief account of paper chromatography, calculation of R_f value, brief account of column chromatography and its applications.

Flame photometry: Principle, Limitations, Instrumentation, Flame photometric determination of Na and K.

Thermogravimetry: Principle and applications of thermogravimetric methods (TG and DTA).

Electrogravimetry: Principle, Instrumentation, Electrogravimetric determination of Copper.

Soil Analysis: Macro nutrients, trace metals and organic matter in soil. Determination of pH, Determination of nitrogen by alkaline permanganate method and phosphorus by Bray's and Olsen's method present in the soil.

Fertilizers: Different types of fertilizers, manufacture of the following fertilizers: Urea, ammonium nitrate, superphosphate of lime.

UNIT-II: Electronic spectra of transition metal complexes and Acids and Bases (15 Hours)

Electronic spectra of transition metal complexes: Russel-Sandar's coupling in defining ground states of spectrochemical series, derivation of spectroscopic ground terms(d₁ to d₁₀ without J values), types of electronic transitions(d-d transitions, charge transfer transitions-MLCT and LMCT), selection rule for d-d transitions, Orgel- energy level diagram-d₁ and d₂ states, discussion of the electronic spectrum of [Ti(H₂O)₆]³⁺ complex ion.

Acids and Bases: Arrhenius, Bronsted-Lowry, Lux-Flood, solvent system and Lewis concepts of acids and bases. Hard and soft acids and bases (HSAB) - classification of acids and bases as hard and soft, Pearson's HSAB concept.

UNIT-III: Chemotherapy, Soaps and Detergents, Reaction Mechanism (15 Hours)

Chemotherapy: Introduction, requirement of an ideal synthetic drug, classification, synthesis and uses of the following-

Antipyretics—antipyrine, paracetamol Anaesthetics-novacaine (local) and pentothal sodium(general) Antihistamines—chlorpheniramine maleate (CPM) Antimalarials—paludrine, chloroquine Antibiotics-chloromycetin, penicillin, tetracyclin.

Para pharmaceutical reagents—Benedict's reagent, sodium citrate, Barfoed reagent.

Soaps and Detergents:

Soaps: Introduction, manufacture by modern process, cleaning action of soap.

Detergents: anionic, cationic, nonionic, with suitable examples, distinction between soaps and detergents, emulsifiers, stabilisers and builders.

Reaction Mechanism

- a) Beckmann rearrangement
- b) Favorskii rearrangement
- c) Benzidine rearrangement
- d) Benzilic acid rearrangement

UNIT-IV: NMR Spectroscopy, Photochemistry and Solvents (15 Hours)

NMR Spectroscopy: Principle of Proton Magnetic Resonance(^1H NMR) spectroscopy, nmr spectrum, chemical shift, nuclear shielding and deshielding, spin-spin coupling(n+1) rule, intensity(height) of the signal, TMS as internal standard-advantages, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, n-propyl bromide, iso propyl bromide, ethanol, acetaldehyde and benzene

Photochemistry: Photochemical reactions, laws of photochemistry – Beer's law, Lambert's Law, Beer- Lambert's Law, Grothus-Draper Law and Einstein's Law of photochemical equivalence, quantum efficiency or yield, reasons for high and low quantum efficiencies with examples, fluorescence, phosphorescence, photosensitization and chemiluminescence.

Solvents: Types, properties of good solvents, non-aqueous solvents - Liquid NH_3 and liquid HF, (properties like solvation, acid-base, redox, complex formation and precipitation), water as universal solvent, leveling effect.

Reference:

1. Advance Inorganic Chemistry Vol-I and II Gurudeep Raj
2. Advance Inorganic Chemistry Satya Prakash
3. Modern Inorganic Chemistry R.D. Madan
4. Inorganic Chemistry James Huheey
5. Concise Inorganic Chemistry J.D. Lee

• **Sixth Semester B.Sc. (Chemistry)**

Paper Code: CHEDSEP 6.2A

Teaching Hours: 3 H / Week

Total hours: 45

Paper Title: Practical-6A

Marks: Th-40+IA-10

Credits: 1

Section A: Inorganic Chemistry:

Gravimetric experiments:

(30 Marks)

1. Estimation of barium as Barium sulphate.
2. Estimation of aluminium as aluminium oxide.
3. Estimation of Iron as ferric oxide.
4. Estimation of lead as lead sulphate.

Section B:

Dissertation/Tour report/Project report

(10Marks)

The Dissertation/Tour report/Project Report should be submitted at the time of **Chemistry**

Practical Examination.

Student shall be assigned either dissertation /Tour report/Project report. The topics for dissertation shall be selected either from the V and VI semester theory syllabi or general topics related to chemistry. For Tour report, student shall visit an Industry or Academic/Research institutions like BARC, IISc etc.

Note: For examination: Gravimetric experiments and Dissertation/Tour report/Project work are Compulsory.

Sixth Semester B.Sc. (Chemistry)

Paper Code: CHEDSET 6.2B
Teaching Hours: 4 H / Week
Total hours: 60

Paper Title: Chemistry-6B
Marks: Th-80+IA-20
Credits: 3

UNIT-I Literature Survey: (15 Hours)

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.

Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, Chem-Industry, Wiki- Databases, Chem-Spider, Science Direct, Sci-Finder, Scopus.

UNIT-II Methods of Scientific Research and Writing Scientific Papers: 15 Hours

Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation. Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism

UNIT-III Chemical Safety and Ethical Handling of Chemicals: 15 Hours

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

UNIT-IV Data Analysis 15 Hours

The Investigative Approach: Making and Recording Measurements. SI Units and their use. Scientific method and design of experiments.

Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals,

General polynomial fitting, linearizing transformations, exponential function fit, r and its abuse. Basic aspects of multiple linear regression analysis.

Reference:

1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) *Practical skills in chemistry*. 2nd Ed. Prentice-Hall, Harlow.
2. Hibbert, D. B. & Gooding, J. J. (2006) *Data analysis for chemistry*. Oxford University Press.
3. Topping, J. (1984) *Errors of observation and their treatment*. Fourth Ed., Chapman Hall, London.
4. Harris, D. C. *Quantitative chemical analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
5. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*. Cambridge Univ. Press (2001) 487 pages.
6. Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.OSU safety manual 1.01

Sixth Semester B.Sc. (Chemistry)

Paper Code: CHEDSEP 6.2B

Teaching Hours: 3 H / Week

Total hours: 45

Paper Title: Practical-6B

Marks: Th-40+IA-10

Credits: 1

Section A: Physical Chemistry

(40 Marks)

1. Determination of concentration of given acids mixture ($\text{HCl} + \text{CH}_3\text{COOH}$) conductometrically using standard NaOH .
2. Determination of percentage composition of unknown mixture of A & B liquids using Abbe's refractometer by formula method.
3. Determination of percentage composition of unknown mixture of A & B liquids using Abbe's refractometer by graphical method.
4. Verification of Beer-Lamberts Law by colorimetric method and calculation of molar extension coefficient of copper sulphate.
5. Potentiometric titration of FeSO_4 against $\text{K}_2\text{Cr}_2\text{O}_7$.
6. Determination of the solubility and solubility product of sparingly soluble salts (Silver halides) by potentiometrically.
7. Conductometric precipitation titration of NaCl vs AgNO_3 .
8. Determination of dissociation constant of weak acid (acetic acid) Potentiometrically.

Section B: Organic Preparations (Two step)

(40 Marks)

1. Preparation of phthalimide from phthalic anhydride and Urea.
2. Preparation of p-bromoaniline from acetanilide.
3. Preparation of p-nitroaniline from acetanilide.
4. Preparation of Benzidine from Nitrobenzene.

Sixth Semester B.Sc. (Chemistry) Skill Enhancement Course

Paper Code: CHEDSET 6.3
Teaching Hours: 3 H / Week
Total hours: 30

Paper Title: Pharmaceutical Chemistry
Marks: Th-40+IA-10
Credits: 2

Unit-I

15 Hours

Drugs & Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of therepresentative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, Ibuprofen); antibiotics (Chloramphenicol);antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide,Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital,Diazepam),Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS relateddrugs (AZT- Zidovudine).(18Hours)

UNIT-II

15 Hours

Fermentation

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.(11 Hours)

Practical's (04Hours)

1. Preparation of Aspirin and its analysis.
2. Preparation of magnesium bisilicate (Antacid).

Reference Books:

1. G.L. Patrick: Introduction to *Medicinal Chemistry*, Oxford University Press, UK.
2. Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan, Pitampura, New Delhi.
3. William O. Foye, Thomas L., Lemke , David A. William: *Principles of Medicinal Chemistry*, B.I. Waverly Pvt. Ltd. New Delhi.
