KARNATAK UNIVERSITY, DHARWAD
ACADEMIC (S&T) SECTION
ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಧಾರವಾಡ
ವಿದ್ಯಾಮಂಡಳ (ಎಸ್&ಟಿ) ವಿಭಾಗ

Tele: 0836-2215224
e-mail: academic.st@kud.ac.in
Pavate Nagar,Dharwad-580003
ಪಾವಟೆ ನಗರ, ಧಾರವಾಡ – 580003

NAAC Accredited
'A' Grade 2014

website: kud.ac.in

No. KU/Aca(S&T)/SVB-02/BOS /Chemistry (UG) /20-21/ 983 Date: 16 OCT 2020

NOTIFICATION

Sub: Regarding introduction of the syllabus of Chemistry UG under C.B.C.S. w.e.f. the academic year 2020-21 & onwards.

Ref: 1. UGC Letter DO No. 1-1/2016(SECY), dt. 10.08.2016.
2. Special BOS Res. No. 02, dt. 13.07.2020.
3. Special Faculty Res. No. 03, dt. 11.08.2020.
4. Special Academic Council Res. No. 35, dt. 21.08.2020.
5. Vice-Chancellor's order dated - 07-10-2020

Adverting to the above, it is hereby notified to the Principals of all constituent and affiliated degree colleges coming under the jurisdiction of Karnatak University, Dharwad that the Chemistry UG syllabus for I to VI Semester which is annexed herewith in Annexure-A is introduced under C.B.C.S. from the academic year 2020-21 & onwards.

Hence, the contents of this notification may please be brought to the notice of the students and all the concerned. The prescribed C.B.C.S. syllabus may also be obtained through K.U.website (www.kud.ac.in).

15/10/2020

(Dr. Hanumantappa K.T)
REGISTRAR

To,

1. The Chairman, BOS Chemistry (UG), Dept. of Chemistry, K.U.Dharwad.
2. The Chairman, Dept. of Chemistry, K.U.Dharwad.
3. The Principals of all the constituted and affiliated degree colleges under the jurisdiction of Karnatak University, Dharwad. (The same may be sent through e-mail)
4. The Registrar (Evaluation), K.U.Dharwad.

Copy fwcs to:

1. Dr. Ch.Ramesh, Dean, Faculty of Science & Tech., Dept. of Botany, K.U.Dharwad.
2. The Director, IT Section, Examination Section, K.U.Dharwad for information and to upload on K.U.Website (www.kud.ac.in).

Copy to:

1. PS to Vice-Chancellor, K.U.Dharwad.
2. S.A. to Registrar, K.U.Dharwad.
3. O.S., Exam UG / Confl / QP / GAD Section, K.U.Dharwad.
4. The System Analysist, Computer Unit Exam Section, K.U.Dharwad.

KARNATAK UNIVERSITY, DHARWAD

B.Sc. Programme

***

SYLLABUS FOR

CHEMISTRY (OPTIONAL)

AS DISCIPLINE SPECIFIC COURSE (DSC) and

SKILL ENHANCEMENT COURSE (SEC)

UNDER

CHOICE BASED CREDIT SYSTEM (CBCS)

*****

Effective from 2020-21

B.Sc. Programme structure under CBCS

Semester	*Core			Elective			Ability Enhancement Course						Total Credits
	DSC			**DSE			***SEC			AECC			
	Course	L+T+P	Credit	Course	L+T+P	Credit	Course	L+T+P	Credit	Course	L+T+P	Credit	
I	DSC-1A	4+0+4	4+2=6							English-1	2+1+0	2+1=3	26
	DSC-2A	4+0+4	4+2=6							MIL-1	2+1+0	2+1=3	
	DSC-3A	4+0+4	4+2=6							ENVIRONMENTAL SCIENCE	2+0+0	2+0=2	
II	DSC-1B	4+0+4	4+2=6							English-2	2+1+0	2+1=3	26
	DSC-2B	4+0+4	4+2=6							MIL-2	2+1+0	2+1=3	
	DSC-3B	4+0+4	4+2=6							CONSTITUTION OF INDIA	2+0+0	2+0=2	
III	DSC-1C	4+0+4	4+2=6							English-3	2+1+0	2+1=3	24
	DSC-2C	4+0+4	4+2=6							MIL-3	2+1+0	2+1=3	
	DSC-3C	4+0+4	4+2=6										
IV	DSC-1D	4+0+4	4+2=6							English-4	2+1=0	2+1=3	24
	DSC-2D	4+0+4	4+2=6							MIL-4	2+1=0	2+1=3	
	DSC-3D	4+0+4	4+2=6										
V				DSE-1E	4+0+4	4+2=6	SEC-1E	2+0+0	2				22
				DSE-2E	4+0+4	4+2=6	SEC-2E	2+0+0	2				
				DSE-3E	4+0+4	4+2=6							
VI				DSE-1F	4+0+4	4+2=6	SEC-1F	2+0+0	2				22
				DSE-2F	4+0+4	4+2=6	SEC-2F	2+0+0	2				
				DSE-3F	4+0+4	4+2=6							
TOTAL			72			36			08			28	144

L+T+P= Lecturing in Theory + Tutorial + Practical Hours per Week (no tutorial for practical subject).

* If the core course is Mathematics, there shall be two papers of 75 marks each. Then L+T+P = (2x3)+(2x1)+0, but credit shall be 6 only.

** Each DSE shall have at least two papers and student shall choose any one paper from each DSE.

*** SEC 1 & 2 shall be from all three DSC but student shall choose any two in each semester (SEC may be practical or theory for 2 credits only).

Note: 1. Each DSC/ DSE Shall have 60hrs syllabus / semester for 100 marks in theory (80 Sem. End exam +20 IA Exam) and 52 hrs practical/ sem for 50 marks(40 Sem. End exam +10 IA Exam).

2. English/ MIL Shall have 45 hrs syllabus / semester for 100 marks in theory (80 Sem. End exam +20 IA Exam).

3. Environmental Science/ Constitution of India / SEC shall have 30 hrs syllabus / semester for 50 marks in theory/ Practical (40 Sem. End exams +10 IA Exam).

Karnatak University, Dharwad

CBCS syllabus for Under Graduate Programme in Chemistry (opt.) as

DISCIPLINE SPECIFIC COURSE (DSC)

Effective from 2020-21

Semester	Theory/ Practical	Subject Code	Instruction hour per week	Total hours of Syllabus / Sem	Duration of Exam.	Internal Assessment Marks	Sem final Exam. Marks	Total Marks	Credits
I	Theory	DSC (CHT: A)	04 hrs	60	03 hrs	20	80	100	04
	Practical	DSC (CHPr: A)	04 hrs	52	03 hrs	10	40	50	02
II	Theory	DSC (CHT: B)	04 hrs	60	03 hrs	20	80	100	04
	Practical	DSC (CHPr: B)	04 hrs	52	03 hrs	10	40	50	02
III	Theory	DSC (CHT: C)	04 hrs	60	03 hrs	20	80	100	04
	Practical	DSC (CHPr: C)	04 hrs	52	03 hrs	10	40	50	02
IV	Theory	DSC (CHT: D)	04 hrs	60	03 hrs	20	80	100	04
	Practical	DSC (CHPr: D)	04 hrs	52	03 hrs	10	40	50	02
V	*Theory P-I / P- II	DSE (CHT: P-I E CHT: P-II E)	04 hrs / 04 hrs	60/ 60	03 hrs	20	80	100	04
	Practical	DSE (CHPr: E)	04 hrs	52	03 hrs	10	40	50	02
VI	*Theory P-I / P- II	DSE (CHT: P-I F CHT: P-II F)	04 hrs / 04 hrs	60/ 60	03 hrs	20	80	100	04
	Practical	DSE (CHPr: F)	04 hrs	52	03 hrs	10	40	50	02
Total						180	720	900	36

*Candidate shall choose either paper –I or P-II but not both in DSE theory.

SKILL ENHANCEMENT COURSE (SEC) for Chemistry opted as DSC

Semester	Theory	Subject Code	Instruction hour per week	Total hours of Syllabus / Sem	Duration of Exam.	Internal Assessment Marks	Sem final Exam. Marks	Total Marks	Credits
V	Theory	(SEC-CH- 1E)	02 hrs	30	1.5 hrs	10	40	50	02
V	Theory	(SEC-CH- 2E)	02 hrs	30	1.5 hrs	10	40	50	02
VI	Theory	(SEC-CH- 1F)	02 hrs	30	1.5 hrs	10	40	50	02
VI	Theory	(SEC-CH- 2F)	02 hrs	30	1.5 hrs	10	40	50	02
Total						40	160	200	08

Discipline Specific Course(DSC) under CBCS

B.Sc. Semester - I

CHEMISTRY: CHT: A

Credits: I. Theory	**: 04**	**Theory class 4 hrs / wk. Total theory: 60 Lectures**
		80 marks for Sem end Examination (3 hrs) & 20 marks IA
II. Practical	**: 02**	**Practical: 4 hrs./ wk. Total Practical: 52 hrs.**
		40 marks for Sem end Examination (3 hrs) & 10 marks IA
Total Credits	**: 06**	**Total Theory marks 100 and Practical marks 50**

Atomic Structure: 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. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1*s*, 2*s*, 2*p*, 3*s*, 3*p* and 3*d* orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1*s* and 2*s* atomic orbitals. 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. **(14 Lectures)**

Chemical Bonding and Molecular Structure: Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. 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. Concept of resonance and resonating structures of NO_3^-, CO_3^{2-}, and SO_4^{2-}.

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. **(16 Lectures)**

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. **(8 Lectures)**

Stereochemistry: Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (up to two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds. Threo and erythro; D and L; *cis* - *trans* nomenclature; CIP Rules: R/ S (for up to 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems). **(10 Lectures)**

Aliphatic Hydrocarbons

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

Alkanes: (Up to 5 Carbons). Preparation*:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions*:* Free radical Substitution: Halogenation.

Alkenes: (Up to 5 Carbons) Preparation*:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition(alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation.

Alkynes: (Up to 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$. **(12 Lectures)**

CHEMISTRY LAB: CHPr: A

1) Volumetric analysis – Meaning of terms such as standard solution, Normality, Molarity, Molality, Equivalent mass. Types of titrations, equations and indicator used in the titration. Calibration of glass wares (burette, pipette, volumetric flask) and weights (both grams and milligrams).Use of analytical balance.

2) Standardization of NaOH solution using standard oxalic acid solution and estimation of HCl in the given solution.

3) Standardization of HCl solution using standard sodium carbonate solution and estimation of total alkalinity or sodium carbonate and sodium bicarbonate in the given solution using double titration method.

4) Standardization of $KMnO_4$ solution using standard oxalic acid solution and estimation of Mohr's salt and water of crystallization in Mohr's salt.

5) Standardization of $K_2Cr_2O_7$ solution using standard Mohr's salt solution and estimation of ferrous and ferric ions in a given mixture.

6) Standardization of $Na_2S_2O_3$ solution using standard $K_2Cr_2O_7$ solution and estimation of iodine in the given solution.

7) Standardization of EDTA solution using standard $ZnSO_4$ solution and estimation of Zn^{2+} in the given solution.

8) Estimation of temporary, permanent and total hardness of water using standard EDTA solution.

9) Estimation of Phenol/ Aniline by bromination method.

10) Estimation of acetamide by hydrolysis method.

11) Estimation of Ethyl benzoate by hydrolysis method.

12) Estimation of aspirin in the tablet by hydrolysis method.

- Standard solution for all the experiments shall be prepared by students for both regular practicals and examinations.

Note: There shall be instructions / training for the students about laboratory etiquettes, handling of reagents, laboratory safety measures, use of apparatus / instruments pertaining to the semester before commencement of the regular practicals. The same shall be recorded in the Journal.

Examination

In a batch of ten students, at least five different experiments may be given in the practical examination. Selection of experiments may be done by the students based on the picking up of chits. Viva questions may be asked on any of the experiments prescribed in the practical syllabus.

Distribution of Marks:

Accuracy for Standardization/blank titration - 09 marks , Accuracy for main titration 15 marks, Reactions and calculations – 4 marks, Technique and Presentation-2 marks, Journal-5 marks, Viva-Voce-5 marks, Total=40 marks.

Deduction of Marks for accuracy:

Standardization / blank titration: ±0.2 CC-09 marks, ± 0.4 CC- 07 marks, ±0.6 CC- 06marks, ±0.8 CC- 04 marks, above ±0.8 CC- zero marks.

Main titration: ±0.2 CC-15 marks, ± 0.4 CC- 12 marks, ±0.6 CC- 09 marks, ±0.8 CC- 06 marks, ±0.9 CC- 03 marks, above ±0.9 – zero marks.

Discipline Specific Course (DSC) under CBCS

B.Sc. Semester - II

CHEMISTRY: CHT: B

Credits: I. Theory	**: 04**	**Theory class 4hrs / wk. Total theory: 60 Lectures**
		80 marks for Sem end Examination (3 hrs) & 20 marks IA
II. Practical	**: 02**	**Practical: 4 hrs./ wk. Total Practical: 52 hrs.**
		40 marks for Sem end Examination (3 hrs) & 10 marks IA
Total Credits	**: 06**	**Total Theory marks 100 and Practical marks 50**

Kinetic Theory of Gases: Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behavior, 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 (numerical problems). Andrews isotherms of CO_2. 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 and their comparisons. 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).

(8 Lectures)

Liquids: Surface tension and parachor and its applications. Determination of surface tension using stalagmometer (drop weight and drop number method). 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). Refractive index and its determination by Abbe's refractometer (numerical problems).

(7 Lectures)

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. **(7 Lectures)**

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(numerical problems). Methods for determination of order of a reaction by half life period and differential equation method. 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). **(8 Lectures)**

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

Aromatic hydrocarbons: *Preparation* (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. *Reactions*: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene). **(8 Lectures)**

Alkyl and Aryl Halides:

Alkyl Halides (Up to 5 Carbons): Types of Nucleophilic Substitution (S_N1, S_N2 and S_Ni) reactions. *Preparation:* from alkenes *and* alcohols. *Reactions:* hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs. substitution.

Aryl Halides *Preparation:* (Chloro, bromo and iodo-benzene case): 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. **(8 Lectures)**

Alcohols, Phenols and Ethers (Up to 5 Carbons)

Alcohols: *Preparation:* Preparation of 1^o, 2^o and 3^o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. *Reactions:* With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation *Diols:* (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) *Preparation:* Cumene hydroperoxide method, from diazonium salts. *Reactions:* Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer- Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

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

Reactions – Reaction with HCN, ROH, $NaHSO_3$, R-NH_2 derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

(14 Lectures)

CHEMISTRY LAB: CHPr: B

1. Explanation regarding crystallization, fractional crystallization, sublimation, reflux, distillation, fractional distillation, distillation under reduced pressure , steam distillation and determination of melting point of the crystallized solid & boiling point of the liquid. (Students should write in the journal regarding the above).
2. Experiment No 2 to 7 : **Systematic qualitative analysis** of organic compounds (without preparation of the derivative).**The following any twelve compounds may be given**.
   Phthalic acid, cinnamic acid, phenol, β- naphthol, aniline , p-toluidine, benzaldehyde, acetophenone, acetanilide , benzamide, thiourea, chlorobenzene, m-dinitro benzene, di-phenyl and ethyl acetate.
3. Experiment No 8 to 12: **Preparation of organic compounds.**
   i. Bromination – Phenol / aniline to 2,4,6-tribromo phenol/ aniline or acetanilide to p-bromo acetanilide (any one).
   ii. Nitration – Salicylic acid to 5-nitro salicylic acid / acetanilide to p-nitro acetanilide (any one).
   iii. Dehydration – Phthalic acid to phthalic anhydride.
   iv. Hydrolysis - Benzamide to benzoic acid.
   v. Oxidation – Benzaldehyde to benzoic acid.
   vi. Reduction – m-dinitrobenzene to m- nitro aniline.

Note: There shall be instructions / training for the students about laboratory etiquettes, handling of reagents, laboratory safety measures, use of apparatus / instruments pertaining to the semester before commencement of the regular practicals. The same shall be recorded in the Journal.

Examination

In a batch of ten students, each student should perform qualitative analysis of organic compound and preparation of organic compound. Not more than 2 students should get the same experiment. Selection of experiments may be done by the students based on the picking up of chits. Viva questions may be asked on any of the experiments prescribed in the practical syllabus.

Distribution of Marks:

Journal – 05 marks , Viva-Voce-5 marks,(Total=40 marks.)

1. For Preparation Experiments (10 Marks):

Reaction and calculation of theoretical yield – 2 mark, technique and presentation-2 marks , observed yield -04 marks, M.P- 02 marks. Total – 10 marks.

Deduction of Marks:

Error yield- less than 10%- 04 marks, 11-15% 03 marks, 16-20% 02 marks, 21-25% 01 marks, more than 25% Zero marks

2. For qualitative analysis of organic compound(20 Marks)

Nature of the compound – 4 marks. element test – 4 marks, functional group and confirmative test – 05marks , melting point/ boiling point – 3 marks, name and structure-04 marks, Total - 20marks.

Discipline Specific Course (DSC) under CBCS

B.Sc. Semester - III

CHEMISTRY: CHT: C

Credits: I. Theory	**: 04**	**Theory class 4 hrs / wk. Total theory: 60 Lectures**
		80 marks for Sem end Examination (3 hrs) & 20 marks IA
II. Practical	**: 02**	**Practical: 4 hrs./ wk. Total Practical: 52 hrs.**
		40 marks for Sem end Examination (3 hrs) & 10 marks IA
Total Credits	**: 06**	**Total Theory marks 100 and Practical marks 50**

Chemical Energetics: First Law of Thermodynamics. Enthalpy, concept of standard state, standard enthalpy, Types of enthalpies: formation, combustion, neutralization, integral and differential enthalpies of solution and dilution, lattice enthalpy(numerical problems). Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. **(08 Lectures)**

Chemical Equilibrium: Limitations of first law of thermodynamics, concept of entropy, Second law of thermodynamics, Free energy, free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG°, Le Chatelier's principle. Relationships between K_p, K_C and K_x for reactions involving ideal gases(numerical problems). Third Law of thermodynamics and calculation of absolute entropies of substances. **(08 Lectures)**

Ionic Equilibria: Strong, moderate and weak electrolytes with examples, 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. 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(numerical problems). **(10 Lectures)**

Distribution law: Nernst distribution law and its derivation. Limitations of law. Modification of distribution law for change in molecular state(association and dissociation). Application in solvent extraction- simple and multiple extractions. Derivation for multiple extraction(numerical problems). **(4 Lectures)**

Carboxylic acids and their derivatives: Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Carboxylic acids (aliphatic and aromatic): *Preparation:* Acidic and Alkaline hydrolysis of esters. *Reactions:* Hell – Vohlard - Zelinsky Reaction.

Carboxylic acid derivatives (aliphatic) (Up to 5 carbons) : *Preparation:* Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion. *Reactions:* Comparative study of acylation of acyl derivatives. Reformatsky Reaction, Perkin condensation. **(6 Lectures)**

Amines and Diazonium Salts: Amines (Aliphatic and Aromatic): (Up to 5 carbons)

Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.

Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

Diazonium salts: *Preparation:* from aromatic amines. *Reactions:* conversion to benzene, phenol, dyes. **(6 Lectures)**

Heterocyclic Compounds: Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structural elucidation of Indole, Fischer indole synthesis, Structural elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis.

Alkaloids: Natural occurrence, General structural features, Hoffmann's exhaustive methylation, Structure elucidation and synthesis of Hygrine and Nicotine.

Terpenes: Occurrence, classification, isoprene rule; Elucidation of structure and synthesis of Citral, Neral and α-terpineol. **(18 Lectures)**

CHEMISTRY LAB: CHPr: C

1. Explanation regarding errors, types of errors, accuracy, precision, significant figures, standard deviation, and Use of log table (students should write in the journal regarding the above).
2. Study of effect of acid strength on hydrolysis of methyl acetate using HCl and H_2SO_4.
3. Determination of velocity constant and effect of concentration on velocity constant of second order reaction $KI + K_2S_2O_8$ (a = b).
4. Study of adsorption of acetic acid on animal charcoal.
5. Determination of surface tension and parachor of benzene series or alcohol series.

6. Determination of surface tension and parachor of toluene, xylene and n-hexane and calculate the atomic parachor of Carbon and Hydrogen
7. Determination of viscosity of toluene and carbon tetrachloride by Ostwald's Viscometer method.
8. Determination of viscosity of binary liquid mixtures of Toluene & carbon tetrachloride and to calculate the percentage composition of the unknown mixture.
9. Study of distribution of acetic acid/ benzoic acid between water and toluene.
10. Determination of enthalpy of ionization of acetic acid by calorimetric method.
11. Determination of heat of solution of KNO_3 by calorimetric method.
12. Determination of degree of dissociation of KCl by Landsberger's method.

Note: There shall be instructions / training for the students about laboratory etiquettes, handling of reagents, laboratory safety measures, use of apparatus / instruments pertaining to the semester before commencement of the regular practicals. The same shall be recorded in the Journal.

Examination

In a batch of ten students, not more than two students should get the same experiment in the practical examination. Selection of experiments may be done by the students based on the picking up of chits. Viva questions may be asked on any of the experiments prescribed in the practical syllabus.

Distribution of Marks:

Accuracy-18 marks, Technique and Presentation-3marks Calculation and graph- (5+4) 9 marks, Journal-5 marks, Viva-Voce-5 marks, Total=40 marks.

Deduction of Marks for accuracy:

Error up to 5% - 18 marks, 6 - 10% 15 marks, 11-15%- 12 marks, 16-20% 09 marks, above 20% zero (0) marks

Discipline Specific Course (DSC) under CBCS

B.Sc. Semester - IV

CHEMISTRY: CHT: D

Credits: I. Theory	**: 04**	**Theory class 4hrs / wk. Total theory: 60 Lectures**
		80 marks for Sem end Examination(3 hrs) & 20 marks IA
II. Practical	**: 02**	**Practical: 4 hrs./ wk. Total Practical: 52 hrs.**
		40 marks for Sem end Examination(3 hrs) & 10 marks IA
Total Credits	**: 06**	**Total Theory marks 100 and Practical marks 50**

Chemistry of *s* and *p* Block Elements:

Diagonal relationship and anomalous behaviour of first member in s block elements. Complex formation tendency of *s* and *p* block elements. Structure, bonding, preparation, and uses of boron nitrides, borohydrides (diborane), carboranes, silicates, oxides and oxoacids of nitrogen, peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens. Bonding in XeF_2, XeF_4 and XeO_3. **(10 Lectures)**

Chemistry of *d* and *f* Block Elements:

Transition Elements: General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states. Chemistry of Ti, V, Cr, Mn, Fe and Co in various oxidation states (excluding their metallurgy)

Lanthanides and Actinides: Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).Preparation of Trans-uranic elements. **(10 Lectures)**

Coordination Chemistry-I: Werner's theory**,** IUPAC system of nomenclature, Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Drawbacks of VBT. **(5Lectures)**

Nuclear Chemistry: Nuclear particles (positron, neutrino, mesons, pions and quarks), nuclear instability, Nuclear reactions [(α, n), (n, α), (α, p), (p, α), (p, n), & (n, p)], nuclear fission, nuclear reactor and types of nuclear reactors in India, applications of radioisotopes in tracer technique, and carbon dating(numerical , problems). **(05Hours)**

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.

Lever rule. Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. **(6 Lectures)**

Phase Equilibrium: Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only).

(8 Lectures)

Conductance: Ionic conductance, ohms law**,** conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions. Conductivity cell, measurement of conductance of ionic solution and its applications in : a) determination of degree of ionization of weak electrolyte b) solubility and solubility products of sparingly soluble salts c) ionic product of water d) hydrolysis constant of a salt and e) conductometric titrations of acid-base(numerical problems).

Ionic mobility, transference number and its experimental determination using Hittorf and Moving boundary methods (numerical problems). **(6 Lectures)**

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, standard electrode, type of electrodes, reference electrodes, sign convention of cell. 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, quinhydrone electrode and glass electrode . Potentiometric titrations-qualitative treatment (acid-base and oxidation-reduction only).

Battery technology: Primary and secondary cells, lead storage battery and its applications, Ni-Cd cells, Lithium battery, fuel cells and their applications. **(10 Lectures)**

CHEMISTRY LAB: CHPr: D

1. Explanation regarding solubility, solubility product, common ion effect and applications of these in physico-chemical principles of separation of cations into groups in qualitative analysis of in-organic salts (students should write in the journal regarding the above).

2 to 10: Semi-micro qualitative analysis of mixtures of two simple inorganic salts containing two anions and two cations.

ANIONS: CO_3^{2-}, S^{2-}, Cl^-, Br^-, I^-, NO_3^-, SO_4^{2-}, $C_2O_4^{2-}$, BO_3^{3-} and PO_4^{3-}

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^+.

Phosphate separation technique is to be demonstrated but not to be given at the time of examination.

11. Determination of dissolved oxygen present in water by Winkler's method.

12. Determination of C.O.D in polluted water.

Note: There shall be instructions / training for the students about laboratory etiquettes, handling of reagents, laboratory safety measures, use of apparatus / instruments pertaining to the semester before commencement of the regular practicals. The same shall be recorded in the Journal.

Examination

In a batch of ten students, not more than two students should get the same mixture in the practical examination. Viva questions may be asked on any of the experiments prescribed in the practical syllabus.

Distribution of Marks:

Preliminary tests and presentation (6+2) - 8 marks , Negative radicals (group test + C.T) (2+3)×2=10 marks, positive radicals (group test + C.T) (2+4)×2=12 marks, Journal-5 marks, Viva-Voce-5 marks, Total=40 marks.

Discipline Specific Elective (DSE) under CBCS

B.Sc. Semester - V

CHEMISTRY: Paper-I (CHT:P-I E)

(Candidate shall choose either Paper-I or paper-II)

Credits: I. Theory	**: 04**	**Theory class 4 hrs / wk. Total theory: 60 Lectures**
		80 marks for Sem end Examination (3 hrs) & 20 marks IA
II. Practical	**: 02**	**Practical: 4 hrs./ wk. Total Practical: 52 hrs.**
		40 marks for Sem end Examination (3 hrs) & 10 marks IA
Total Credits	**: 06**	**Total Theory marks 100 and Practical marks 50**

I. Coordination Chemistry-II and Organometallic Compounds:

Crystal Field Theory: Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for *Oh* and *Td* complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.

Organometallic Compounds: Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds), heptacity. Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Structure and bonding of mononuclear and polynuclear carbonyls of 3d metals. π-acceptor behaviour of carbon monoxide. **(15 Lectures)**

II: Analytical Chemistry

Flame Atomic Absorption and Emission Spectrometry*:* Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

Thermal methods of analysis: Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.

Separation techniques: Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution. Chromatography: Classification, principle and efficiency of the technique. Mechanism of

separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: GLC, and TLC. **(15 Lectures)**

III. Biochemistry:

Carbohydrates: Classification of carbohydrates, reducing and non-reducing sugars, their open chain structure. Epimers, mutarotation and anomers. Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

Amino Acids, Peptides and Proteins: Classification *of Amino Acids,* Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups.

Enzymes and correlation with drug action: Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and their role in biological reactions, Specificity of enzyme action(Including stereospecificity), Drug action-receptor theory. Structure–activity relationships of drug molecules, binding role of –OH group,-NH_2 group, double bond and aromatic ring,

Nucleic Acids: Components of Nucleic acids: Adenine, guanine, thymine, Uracil and Cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides **(nomenclature**), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA(**types of RNA**), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

Lipids: Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol). **(15 Lectures)**

IV. Quantum Chemistry:

Black body radiation, Spectral distribution of black body radiation, Plank's theory, derivation for Planck's radiation law, photoelectric effect, Compton effect, wave nature of electron, derivation of Schrödinger's wave equation, wave function and its interpretation, Eigen function and Eigen values, normalization and orthogonality.

Equation of motion for a particle, Newtonian, Lagrangian and Hamiltonian equations of motion, elementary wave motion. Operators, eigen values and expectation values, commuting operators, linear operator and hermitian operators. Solutions of Schrödinger equations of a free particle, particle in a box problem: in one and three dimensions, degeneracy, reflection and penetration of a particle in a one dimensional box of semi-infinite barrier, a particle in a box of finite walls.

Rigid rotator, derivation of selection rules for transitions in rotating molecule, linear harmonic oscillator, Hermite polynomials. Equation for the hydrogen atom in spherical polar coordinates and an indication of the method of its solution, the quantum numbers and their significance. **(15 Lectures)**

Discipline Specific Elective (DSE) under CBCS

B.Sc. Semester - V

CHEMISTRY: Paper-II (CHT:P-II E)

(Candidate shall choose either Paper-I or paper-II)

Credits: I. Theory	**: 04**	**Theory class 4hrs / wk. Total theory: 60 Lectures**
		80 marks for Sem end Examination(3 hrs) & 20 marks IA
II. Practical	**: 02**	**Practical: 4 hrs./ wk. Total Practical: 52 hrs.**
		40 marks for Sem end Examination(3 hrs) & 10 marks IA
Total Credits	**: 06**	**Total Theory marks 100 and Practical marks 50**

I. Coordination Chemistry-II and Organometallic Compounds:

Crystal Field Theory: Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for O_h and T_d complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.

Organometallic Compounds: Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds), heptacity. Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Structure and bonding of mononuclear and polynuclear carbonyls of 3d metals. π-acceptor behaviour of carbon monoxide. **(15 Lectures)**

II. Industrial chemistry

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

Fertilizers: Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

Alloys: Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels. **(15 Lectures)**

III. Introduction to Green Chemistry

Meaning of Green Chemistry. Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry Twelve principles of Green Chemistry with their explanations and examples

Examples of Green Synthesis/ Reactions and some real world cases

1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)
2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction
3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)
4. Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.
5. Designing of Environmentally safe marine antifoulant.
6. Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments.
7. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.
8. Healthier fats and oil by Green Chemistry: Enzymatic interesterification for production of no Trans-Fats and Oils **(15 Lectures)**

IV. Quantum Chemistry:

Black body radiation, Spectral distribution of black body radiation, Plank's theory, derivation for Planck's radiation law, photoelectric effect, Compton effect, wave nature of electron, derivation of Schrödinger's wave equation, wave function and its interpretation, Eigen function and Eigen values, normalization and orthogonality.

Equation of motion for a particle, Newtonian, Lagrangian and Hamiltonian equations of motion, elementary wave motion. Operators, eigen values and expectation values,

commuting operators, linear operator and hermitian operators. Solutions of Schrödinger equations of a free particle, particle in a box problem: in one and three dimensions, degeneracy, reflection and penetration of a particle in a one dimensional box of semi-infinite barrier, a particle in a box of finite walls.

Rigid rotator, derivation of selection rules for transitions in rotating molecule, linear harmonic oscillator, Hermite polynomials. Equation for the hydrogen atom in spherical polar coordinates and an indication of the method of its solution, the quantum numbers and their significance. **(15 Lectures)**

CHEMISTRY LAB: CHPr: E

(Common for both Paper I and II)

SET –I: INORGANIC EXPERIMENTS

A. Gravimetric Analysis (20 marks)

1. Determination of barium as $BaSO_4$.
2. Determination of Aluminium as Al_2O_3.
3. Determination of iron as Fe_2O_3.

B. Complex Preparation(10 marks)

4. Preparation of trans-potassium diaqua di oxalato chromate (III).
5. Preparation of tris(thiourea) copper (I) sulphate monohydrate.
6. Preparation of sodium tris oxalate ferrate (III).

SET –II: PHYSICAL EXPERIMENTS

1. Determination of concentration of HCl and CH_3COOH or mixture of HCl + CH_3COOH by conductometric titrations using standard NaOH.
2. Determination of equivalent conductance of strong electrolyte (NaCl) and equivalent conductance at infinite dilution (λ_∞).
3. Determination of concentration of strong acid by potentiometric titration against standard solution of 0.1 N NaOH.
4. Determination of K_a of a weak acid potentiometrically.
5. Verification of Beer- Lambert's law by colorimetric method. Calculation of molar extinction coefficient and determination of unknown concentration of tetraammine copper (II) complex / ferric thiocyanate complex.
6. Determination of critical solution temperature of two partially miscible liquids (water and phenol).

Note: There shall be instructions / training for the students about laboratory etiquettes, handling of reagents, laboratory safety measures, use of apparatus / instruments pertaining to

the semester before commencement of the regular practicals. The same shall be recorded in the Journal.

Examinations

In a batch of 10 students in the practical examination, 05 students shall be given Set – I experiments: **Inorganic** (one each from A and B) and the other 05 students be Set–II experiments (**PHYSICAL EXPERIMENTS**). Selection of experiments may be done by the students based on the picking up of chits.

Distribution of Marks:

Journal-5 marks and Viva-Voce-5 marks

SET-I: INORGANIC EXPERIMENTS

Note: At least two different experiments from set I (one each from A and B) shall be given in a batch of 05 students. Viva questions may be asked on any of the experiments prescribed in the practical syllabus.

A. Gravimetric Determination (20 Marks)

Technique-02 marks, Accuracy-16 marks, calculation - 02marks, Total - 20 marks

Deduction of Marks for accuracy:

±6mg -16 marks, ± 8mg-14 marks, ±10 mg -12 marks, ±12mg-10 marks, ±14mg-08 marks, ±16mg-06 marks, above ±16 mg -zero marks.

B. Complex Preparation(10 marks)

Technique-02 marks, Yield of the complex- 08marks, Total -10 marks

Deduction of Marks for accuracy:

Preparation Error yield- Less than 10%- 08 marks, 11-15% -06 marks, 16-20% -04 marks, 21-25% -03 marks, more than25% -zero marks

SET –II: PHYSICAL EXPERIMENTS

NOTE: In a batch of 05 students, not more than two students should get the same experiment in the practical examination. Selection of experiments may be done by the students based on picking up of chits. Viva questions may be asked on any of the experiments prescribed in the practical syllabus.

Distribution of Marks:

Technique and Presentation-3 Calculation and graph- (5+4) 9 marks, Accuracy-18 marks, Journal-5 marks, Viva-Voce-5 marks, Total=40 marks.

Deduction of Marks for accuracy:

Error up to 5% - 18 marks, 6 - 10% 15 marks, 11-15% 12 marks, 16-20% 6 marks, above 20% zero (0) marks

Discipline Specific Elective (DSE) under CBCS

B.Sc. Semester - VI

CHEMISTRY: Paper-I (CHT: P-I F)

(Candidate shall choose either Paper-I or II)

Credits: I. Theory	**: 04**	**Theory class 4hrs / wk. Total theory: 60 Lectures**
		80 marks for Sem. end Examination (3 hrs) & 20 marks IA
II. Practical	**: 02**	**Practical: 4 hrs. / wk. Total Practical: 52 hrs.**
		40 marks for Sem. end Examination (3 hrs) & 10 marks IA
Total Credits	**: 06**	**Total Theory marks 100 and Practical marks 50**

I. Metallurgy, Inorganic Polymers and Bio-Inorganic chemistry

Metallurgy: Ellingham diagrams for reduction of metal oxides using carbon as reducing agent. Hydrometallurgy(Ag and Au), 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.

Inorganic Polymers: Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.

Bio-inorganic chemistry: Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones). **(15 Lectures)**

II. Application of Spectroscopy to Simple Organic Molecules

a) Ultraviolet Spectroscopy:

Electromagnetic radiations, electronic transitions, λ_{max} & ε_{max}, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λ_{max} of conjugated dienes- alicyclic homo nuclear and hetero nuclear. cis – trans isomerism, α, β – unsaturated compounds, aldehydes, ketones, carboxylic acids and esters.

b) Infrared Spectroscopy:

Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).

c) Nuclear Magnetic resonance(NMR):

Basic principles of PMR, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constant, areas of signals. Interpretation of PMR structure of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, ethyl acetate, toluene, acetophenone and acetanilide. **(15 Lectures)**

III. Molecular Spectroscopy:

Electromagnetic spectrum, Interaction of electromagnetic radiation with matter.

(a). Rotational spectroscopy:

Rotation of molecules, diatomic: rigid rotator, selection rule: derivation for expression of energy and bond length (HCl), problems on bond length, polyatomic molecules: linear, symmetric top, asymmetric top molecules (qualitative approach).

(b). Vibrational spectroscopy:

Vibrating diatomic molecules - energy of diatomic molecules, Hooks law and force constant, Vibrational spectra: harmonically vibrating diatomic molecules (HCl) and anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies, and problems on force constants. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectra: Classical theory, Rotational Raman spectroscopy (Linear and symmetric top molecules for S and R branch), Vibrational Raman spectroscopy; vibration - rotational Raman spectra(Rotational fine structures), complementary of Raman and IR.

(c). Electronic spectroscopy:

Diatomic molecules: Born- Oppenheimer approximation, Vibrational course structure of electronic transition and intensity, Franck – Condon principle, pre-dissociation, 'g' and 'u' transitions and their applications in organic molecules. **(15 Lectures)**

IV. Photochemistry and Chemical Kinetics-II

Photochemistry: Characteristics of electromagnetic radiation, Beer –Lambert's law and its limitations, physical significance of absorption coefficients. Laws of photochemistry, quantum yield and its determination using thermopile and actinometer, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitized reactions, quenching. Role of photochemical reactions in biochemical processes, photo stationary states, chemiluminescence, Fluorescence and phosphorescence. (numerical problems). **(10 Lectures)**

Chemical Kinetics-II : Reversible, Parallel, Consecutive and Chain reactions. Derivations of rate constant for first order parallel, reversible and consecutive reactions. Reaction kinetics of thermal and photochemical Hydrogen – Bromine Reactions. **(05 Lectures)**

Discipline Specific Elective (DSE) under CBCS

B.Sc. Semester - VI

CHEMISTRY: Paper-II (CHT:P-II F)

(Candidate shall choose either Paper-I or paper-II)

Credits: I. Theory	**: 04**	**Theory class 4 hrs / wk. Total theory: 60 Lectures**
		80 marks for Sem end Examination (3 hrs) & 20 marks IA
II. Practical	**: 02**	**Practical: 4 hrs./ wk. Total Practical: 52 hrs.**
		40 marks for Sem end Examination (3 hrs) & 10 marks IA
Total Credits	**: 06**	**Total Theory marks 100 and Practical marks 50**

I. Environment Chemistry

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution. Methods of estimation of CO, NO_X, SO_X and control procedures.

Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens.

Water Pollution: Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal.

Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water. **(15 Lectures)**

II. Application of Spectroscopy to Simple Organic Molecules

a) Ultraviolet Spectroscopy:

Electromagnetic radiations, electronic transitions, λ_{max} & ε_{max}, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λ_{max} of conjugated dienes-alicyclic homo nuclear and hetero nuclear. cis – trans isomerism, α, β – unsaturated compounds, aldehydes, ketones, carboxylic acids and esters.

b)Infrared Spectroscopy:

Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).

c) Nuclear Magnetic Resonance (NMR):

Basic principles of PMR, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constant, areas of signals. Interpretation of PMR structure of simple organic molecules such as ethylbromide, ethanol, acetaldehyde, ethyl acetate, toluene, acetophenone and acetanilide. (15 **Lectures)**

III. Molecular Spectroscopy:

Interaction of electromagnetic radiation with matter, electromagnetic spectrum.

(a). Rotational Spectroscopy:

Rotation of molecules, diatomic: rigid rotator, selection rule : derivation for expression of energy and bond length (HCl), problems on bond length, polyatomic molecules: linear, symmetric top, asymmetric top molecules(qualitative approach).

(b). Vibrational Spectroscopy:

Vibrating diatomic molecules - energy of diatomic molecules, force constant, vibrational spectra: harmonically vibrating diatomic molecules (HCl) and anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies, and problems on force constants. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectra: Classical theory, Rotational Raman spectroscopy (Linear and symmetric top molecules for S and R branch), Vibrational Raman spectroscopy; vibration - rotational Raman spectra(Rotational fine structures), complementary of Raman and IR.

(c). Electronic Spectroscopy:

Diatomic molecules: Born- Oppenheimer approximation, vibrational course structure of electronic transition and intensity, Franck – Condon principle, pre-dissociation, 'g' and 'u' transitions and their applications in organic molecules. **(15 Lectures)**

IV. Polymer Chemistry and Micelle:

Polymer Chemistry: Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

Crystallization and Crystallinity: Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point. Nature and structure of polymers-Structure Property relationships.

Determination of molecular weight of polymers (M_n, M_w, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

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, polyamides. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

(12 Lectures)

Micelle: Emulsions, micro emulsions or micellar emulsions, and its Stability, Properties of Micro emulsions**:** electro kinetic effects. Colloidal electrolytes or association colloids, types of Colloidal electrolytes. **Micelles:** surface-active agents or surfactants. (**03 Hours**)

CHEMISTRY LAB: CHPr-F

(Common for both Paper I and II)

SET – I: PHYSICAL EXPERIMENTS

1. Determination of dissociation constant of acetic acid conductometrically.
2. Determination of solubility of sparingly soluble salt ($BaSO_4$/ $PbSO_4$) conductometrically.
3. Determination of redox potentials of Fe^{3+}/ Fe^{2+} using of $FeSO_4.7H_2O$ solution (0.1N) by potentiometric titration against the standard solution of $K_2Cr_2O_7$ (0.1N)
4. Determination of solubility and solubility product of sparingly soluble salts (AgCl) potentiometrically.
5. Preparation of standard acidic buffer solutions using 0.1M acetic acid & 0.1M sodium acetate using Henderson-Hasselbatch and determination of mole ratio of buffer solutions of unknown pH.
6. Determination of percentage composition of unknown mixture of A and B liquids using Abbe's refractometer (formula and graphical method).

SET-II: INORGANIC / ORGANIC

A. Ore / Alloy Analysis (20 marks)

1. Extraction of Iron (III) from haematite ore or solid Fe_2O_3 and determination of percentage of iron in the solution using standard $K_2Cr_2O_7$ solution (internal indicator method).
2. Extraction of Cu and Zn from brass and determination of percentage of copper in the solution using standard $Na_2S_2O_3$ solution.
3. Extraction of calcium from limestone and determination of percentage of calcium in the solution by oxalate method.

B. Organic analysis (10 marks)

4. Separation of amino acids by paper chromatography, measuring R_f value and determination of glycine present in the solution volumetrically.
5. Saponification value of oil or fat.
6. Determination of Iodine number of an oil/ fat.

Note: There shall be instructions / training for the students about laboratory etiquettes, handling of reagents, laboratory safety measures, use of apparatus / instruments pertaining to the semester before commencement of the regular practicals. The same shall be recorded in the Journal.

Examinations

A batch of 10 students in the practical examination, 05 students may be given Set – I experiments (**PHYSICAL EXPERIMENTS**) and the other 05 students may be given Set – II experiments **(SET-II: INORGANIC / ORGANIC)**. Selection of experiments may be done by the students based on the picking up of chits.

Distribution of Marks:

Journal-5 marks and Viva-Voce-5 marks

SET – I : PHYSICAL EXPERIMENTS

NOTE: In a batch of 05 students, not more than two students should get the same experiment in the practical examination. Selection of experiments may be done by the students based on the picking up of chits. Viva questions may be asked on any of the experiments prescribed in the practical syllabus.

Distribution of Marks:

Technique and Presentation-3 Calculation and graph- (5+4) 9 marks, Accuracy-18 marks, Journal-5 marks, Viva-Voce-5 marks, Total=40 marks.

Deduction of Marks for accuracy:

Error up to 5% - 18 marks, 6 - 10% 15 marks, 11-15% 12 marks, 16-20% 6 marks, above 20% zero (0) marks

SET-II: INORGANIC / ORGANIC

Note: At least two different experiments from set II (one each from A and B) shall be given in a batch of 05 students. Selection of experiments may be done by the students based on the picking up of chits. Viva questions may be asked on any of the experiments prescribed in the practical syllabus.

A. Ore / Alloy Analysis(20 marks)

Technique-02 marks, Accuracy- 14 marks, calculation -4 marks, Total 20 marks.

Deduction of Marks for accuracy:

Determination ±0.2 CC -14marks, ± 0.4 CC- 12marks, ±0.6 CC- 10 marks, ±0.8 CC- 06 marks, above ±0.9 - zero marks.

B. Organic analysis (10 marks)

Technique-02 marks Accuracy – 08 marks, Total 10 marks.

Deduction of Marks for accuracy:

Determination ±0.2 CC -08marks, ± 0.4 CC- 06marks, ±0.6 CC- 04 marks, ±0.8 CC- 03 marks, above ±0.9 - zero marks.

GENERAL PATTERN OF THEORY QUESTION PAPER FOR ALL THE SEMESTERS

1. **Question number 1-12 carries 2 marks to answer any 10 questions : 20 marks**
2. **Question number 13-21 carries 5 marks to answer any 6 questions : 30 marks**
3. **Question number 22-26 carries 10 marks to answer any 3 questions : 30 marks**
   (10 marks questions may be 6+4 or 7+3 or 10) Total: 80 marks

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REFERENCE BOOKS

Inorganic Chemistry

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. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
6. Wulfsberg, G. *Inorganic Chemistry,* Viva Books Pvt. Ltd.
7. Rodgers, G.E. *Inorganic & Solid State Chemistry,* Cengage Learning India Ltd.,2008.
8. Mark Weller and Fraser Armstrong, 5th Edition, Oxford University Press (2011-2012)Adam, D.M. *Inorganic Solids: An introduction to concepts in solid-state structural chemistry*. John Wiley & Sons, 1974.
9. Poole, C.P. & Owens, F.J. *Introduction to Nanotechnology* John Wiley & Sons, 2003. *Structure and Reactivity,* Pearson Publication.
10. G.L. Miessler & Donald A. Tarr: *Inorganic Chemistry,* Pearson Publication.
11. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
12. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York(1985).

Organic Chemistry

1. Organic Chemistry-P. Y. Bruice, 7th Edition, Pearson Education Pvt. Ltd., New Delhi (2013).
2. Heterocyclic Chemistry- R. K. Bansal, 3rd Edition, New- Age International, New Delhi,2004
3. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
4. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry,* Orient Longman, NewDelhi (1988).
5. Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education,2000.
6. Stereochemistry-Conformation and Mechanism-P. S. Kalsi, Wiley-Eastern Ltd, New Delhi.
7. (1992).Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
8. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry,* S. Chand, 2010.
9. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry,* John Wiley & Sons (2014).
10. Organic Chemistry Volume-I, II- I. L. Finar, 6th Edition, ELBS London (2004).
11. Organic Chemistry-F.A. Carey, 4th Edition, McGraw Hill (2000).
12. Advanced Organic Chemistry - J. March, John Wiley & Sons, 1992
13. Modern Organic Chemistry - R.O.C. Norman and D.J. Waddington, ELBS, 1983
14. Understanding Organic reaction mechanisms - A. Jacobs, Cambridge Univ. Press, 1998
15. Organic Chemistry - L.Ferguson, Von Nostrand, 1985
16. Organic Chemistry - M. K. Jain, Nagin & Co., 1987

Physical Chemistry

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. P.W. Atkins: Physical Chemistry.

5. W.J. Moore: Physical Chemistry
6. Text Book of Physical Chemistry - P.L. Soni, S. Chand & Co.,1993
7. Text Book of physical chemistry - S. Glasstone, Mackmillan India Ltd., 1982
8. Principles of Physical Chemistry - B. R. Puri, L.R. Sharma and M.S.Patania, S.L.N. Chand & Co. 1987
9. Physical Chemistry - Alberty R. A. and Silbey, R.J.John Wiley and sons, 1992
10. Physical Chemistry - G.M.Barrow, Mc Graw Hill, 1986
11. Physical Chemistry(3rd Edition) - Gilbert W. Castilian, Narosa Publishing House,1985
12. Chemical Kinetics by K. J. Laidler, Tata McGraw Hill Publishing Co., New Delhi.
13. Kinetics and Reaction Mechanisms by Frost and Pearson, Wiley, New York.

Analytical Chemistry

1. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley & Sons, 1989.
2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
3. Christian, G.D; *Analytical Chemistry*, VI Ed. John Wiley & Sons, New York, 2004.
4. Harris, D. C. *Exploring Chemical Analysis*, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
7. Ditts, R.V. *Analytical Chemistry; Methods of Separation*, van Nostrand, 1974.

Biochemistry

1. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry 7th Ed.,* W. H. Freeman.
2. Berg, J.M., Tymoczko, J. L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.
3. Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.

Polymer Chemistry

1. Seymour, R.B. & Carraher, C.E. *Polymer Chemistry: An Introduction,* Marcel Dekker, Inc. New York, 1981.
2. Odian, G. *Principles of Polymerization*, 4th Ed. Wiley, 2004.
3. Ghosh, P. *Polymer Science & Technology*, Tata McGraw-Hill Education, 1991.
4. Lenz, R.W. *Organic Chemistry of Synthetic High Polymers*. Interscience publishers, New York, 1967.
5. Text Book of Polymer Chemistry, Fred W. Billmeyer, Jr., Wiley Publisher, 1984.
6. Polymer Science, V. R. Gowariker, N. V. Viswanathan and Jayadev Sreedhar, New Age International Publisher, 2001.

Green Chemistry

1. Ahluwalia, V.K. & Kidwai, M.R. *New Trends in Green Chemistry*, Anamalaya Publishers (2005).
2. Anastas, P.T. & Warner, J.K.: *Green Chemistry - Theory and Practical*, Oxford University Press (1998).
3. Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
4. Cann, M.C. & Connely, M.E. *Real-World cases in Green Chemistry*, American Chemical Society, Washington (2000).
5. Ryan, M.A. & Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).

6. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2 Edition, 2010.

Industrial and environmental Chemistry

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Harwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. A. Kent: *Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.*
4. *S. S. Dara: A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
7. S.E. Manahan, *Environmental Chemistry*, CRC Press (2005).
8. G.T. Miller, *Environmental Science* 11th edition. Brooks/ Cole (2006).
9. Mishra, *Environmental Studies*. Selective and Scientific Books, New Delhi (2005).
10. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.
11. P. C. Jain & M. Jain: *Engineering Chemistry,* Dhanpat Rai & Sons, Delhi.
12. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry,* Vikas Publications, New Delhi
13. K. Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut

Quantum Chemistry

1. Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill (2001).
2. House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA (2004).
3. Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press (2005).
4. Quantum Chemistry by R. K. Prasad, New Age International Publications, New Delhi,1997.
5. Quantum Chemistry by Eyring, Walter and Kimball, John-Wiley, New York.

Spectroscopy

1. John R. Dyer: *Applications of Absorption Spectroscopy of Organic Compounds*, Prentice Hall.
2. R.M. Silverstein, G.C. Bassler & T.C. Morrill*: Spectroscopic Identification of Organic Compounds*, John Wiley & Sons.
3. Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy IV* Ed. Tata McGraw-Hill: New Delhi (2006).
4. Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.
5. Kakkar, R. *Atomic & Molecular Spectroscopy*: *Concepts & Applications*, Cambridge University Press (2015).
6. Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, and George S. Kriz, Cenage Learning, USA, (2015).

Practical Chemistry

1. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
2. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
3. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
4. 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.
5. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
6. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
7. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* Universities Press, Hyderabad.

8. Experiments in Physical Chemistry by Shoemaker and Garland, McGraw Hill, New York.
9. Experiments in Physical Chemistry by Daniels, Alberty and Willams, McGraw Hill, New York.
10. Experimental Physical Chemistry by W. G. Palmer, Cabridge University Press, London.
11. Experimental Physical Chemistry by V. D. Athawale and Parul Mathur, New Age International, New Delhi.

SKILL ENHANCEMENT COURSES (SEC) in Chemistry

B.Sc. Semester - V

CHEMISTRY : SEC- I (SEC-CH- 1E)

Total Syllabus: 30 hrs / Sem.: 2 hrs / Week

Examination: Maximum Marks- 50 (40 Semester End exam + 10 IA Exam)

Duration of Exam: 1.5 hrs

ANALYTICAL CHEMISTRY

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.

a. Determination of pH of soil samples.
b. 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.

a. Determination of pH, acidity and alkalinity of a water sample.
b. 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.

a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
b. Analysis of preservatives and colouring matter.

Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

a. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}).
b. 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 function

a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.
b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration
c. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
b. d. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft drinks. **30 Lectures**

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 6th Ed., 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.
11. Robinson, J.W. Undergraduate Instrumental Analysis 5th Ed., Marcel Dekker, Inc., New York (1995).

SKILL ENHANCEMENT COURSES (SEC) in Chemistry

B.Sc. Semester - V

CHEMISTRY : SEC- II (SEC-CH- 2E)

Total Syllabus: 30 hrs / Sem.: 2 hrs / Week

Examination: Maximum Marks- 50 (40 Semester End exam + 10 IA Exam)

Duration of Exam: 1.5 hrs

PHARMACEUTICAL CHEMISTRY

Drugs & Pharmaceuticals: Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative 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 related drugs (AZT- Zidovudine).

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.

Practical in one hour, nevertheless no practical examination.

a. Preparation of Aspirin and its analysis.

b. Preparation of magnesium bisilicate (Antacid). **30 Lectures**

Reference Books:

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

SKILL ENHANCEMENT COURSES (SEC) in Chemistry

B.Sc. Semester - VI

CHEMISTRY: SEC- III (SEC-CH- 1F)

Total Syllabus: 30 hrs / Sem.: 2 hrs / Week

Examination: Maximum Marks- 50 (40 Semester End exam + 10 IA Exam)

Duration of Exam: 1.5 hrs

PESTICIDE CHEMISTRY

General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship, synthesis and technical manufacture and uses of representative pesticides in the following classes:

Organochlorines (DDT, Gammexene,);

Organophosphates (Malathion, Parathion);

Carbamates (Carbofuran and carbaryl);

Quinones (Chloranil), Anilides (Alachlor and Butachlor).

Practical in one hour, nevertheless no practical examination.

1 To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.

2 Preparation of simple organophosphates, phosphonates and thiophosphates.

30 Lectures

Reference Book:

1. Cremlyn, R. *Pesticides. Preparation and Modes of Action*, John Wiley & Sons, NewYork, 1978.

SKILL ENHANCEMENT COURSES (SEC) in Chemistry

B.Sc. Semester - VI

CHEMISTRY: SEC- IV (SEC-CH- 2F)

Total Syllabus: 30 hrs / Sem.: 2 hrs / Week

Examination: Maximum Marks- 50 (40 Semester End exam + 10 IA Exam)

Duration of Exam: 1.5 hrs

FUEL CHEMISTRY

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.

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.

30 Lectures

Reference Books:

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).

GENERAL PATTERN OF THEORY QUESTION PAPER FOR ALL SEC PAPERS

1. **Question number 1-6 carries 2 marks to answer any 5 questions : 10 marks**
2. **Question number 7-14 carries 4 marks to answer any 5 questions : 20 marks**
3. **Question number 15-17 carries 5 marks to answer any 2 questions : 10 marks**

Total: 40 marks

Name and signature of Committee members of BOS in B.Sc. Chemistry, prepared the syllabi pertaining to B.Sc. Chemistry (General) under CBCS for Karnatak University, Dharwad, effective from 2020-21.

1	Prof. M.Y.Kariduraganavar , Chairman , UG BOS in Chemistry and Chairman P. G. Department of Chemistry K.U. Dharwad	Chairman
2	Smt. K.K Kerwadikar Principal Govt. First Grade College Karwar.	Member
3	Dr. S.N. Setty Principal KCS, Dr. A. V. Baliga Arts/ Science College Kumta	Member
4	Dr. Smt. Shobha Sharma Principal B. N. Degree College Dandeli	Member
5	Dr. S. M. Tuwar Associate Professor Dept. of Chemistry Dharwad	Member(Co-opted)
6	Prof. K.V. Pai Department of Industrial Chemistry Kuvempu University Shivamogga	Member(External)