List of New Course(s) Introduced

Department : *Chemistry*

Programme Name : *B.Sc.*

Academic Year : 2021-22

List of New Course(s) Introduced

Sr. No.	Course Code	Name of the Course
01.	CYUATT1	Inorganic Chemistry-I
02.	CYUALT1	Inorganic Chemistry Practical-I
03.	CYUATT2	Organic Chemistry-I
04.	CYUALT2	Organic Chemistry Practical-I
05.	CYUATA1	Select one from the Pool of AEC Courses offered
06.	CYUATL1	Select one from the Pool of SEC Courses offered
07.	CYUATG1 1A	Physics-I, 1B Mathematics-I, 1C Zoology-I 1D Botany-1, 1EAnthropology-1, 1F Biotechnology-1,1G Forensic Science-1
08.	CYUALG1	Generic Elective- Practical-I
09.	CYUATC1	Select one from the Pool of Value added Courses offered
10.	CYUBTT1	Physical Chemistry-I
11.	CYUBLT1	Physical Chemistry Practical-I
12.	CYUBTT2	Organic Chemistry-II
13.	CYUBLT2	Organic Chemistry Practical-II
14.	CYUBTA1	Select one from the Pool of AEC Courses offered
15.	CYUBTL1	Select one from the Pool of SEC Courses offered
16.	CYUBTG1	2A Physics-I, 2B Mathematics-I, 2C Zoology-I, 2D Botany-1, 2EAnthropology-1, 2F Biotechnology-1,2G Forensic Science-1

17.	CYUBLG1	Generic Elective- Practical-II
18.	CYUBTC1	Select one from the Pool of Value added Courses offered

Minutes of Meetings (MoM) of Board of Studies (BoS)

Academic Year : 2021-22

School : *School of Studies of Physical Science*

Department : *Chemistry*

Date and Time : *Oct. 28, 2021 – 12:00 noon*

Venue : *Meeting room*

The scheduled meeting of member of Board of Studies (BoS) of Department of Chemistry, School of Studies of Physical Science, Guru Ghasidas Vishwavidyalaya, Bilaspur was held to design and discuss the structure and scheme of examination of Integrated UG/PG, M. Sc. Chemistry syllabi.

The following members were present in the meeting:

1. Dr Santosh Singh Thakur – Chairman
2. Prof. C. R. Sinha – External Expert
3. Prof. G. K. Patra – Member
4. Dr. A. K. Singh– Member
5. Dr. V. K. Rai – Member

Following points were discussed during the meeting

1. In this meeting; the contents of each paper of learning outcome based curriculum framework (LOCF) at undergraduate (UG) level and choice based credit system (CBCS) at postgraduate level (P.G.) were thoroughly discussed and suggestions made by members (both internal and external) were considered and incorporated.
2. The syllabus of Chemistry was thoroughly modified and restructured as per university as well as UGC guidelines.
3. The schemes and syllabus of UG and PG course in Chemistry are attached (Annexure –I and Annexure –II) which would be submitted to the university authority for approval.

The following new courses were introduced in the B. Sc. and M. Sc.:

- B. Sc. LOCF scheme

CYUATT1	Inorganic Chemistry-I
CYUALT1	Inorganic Chemistry Practical-I
CYUATT2	Organic Chemistry-I
CYUALT2	Organic Chemistry Practical-I
CYUATA1	Select one from the Pool of AEC Courses offered
CYUATL1	Select one from the Pool of SEC Courses offered

CYUATG1 1A Physics-I, 1B Mathematics-I, 1C Zoology-I 1D Botany-1, 1EAnthropology-1, 1F Biotechnology-1,1G Forensic Science-1
CYUALG1 Generic Elective- Practical-I
CYUATC1 Select one from the Pool of Value added Courses offered
CYUBTT1 Physical Chemistry-I
CYUBLT1 Physical Chemistry Practical-I
CYUBTT2 Organic Chemistry-II
CYUBLT2 Organic Chemistry Practical-II
CYUBTA1 Select one from the Pool of AEC Courses offered
CYUBTL1 Select one from the Pool of SEC Courses offered
CYUBTG1 2A Physics-I, 2B Mathematics-I, 2C Zoology-I, 2D Botany-1, 2EAnthropology-1, 2F Biotechnology-1,2G Forensic Science-1
CYUBLG1 Generic Elective- Practical-II
CYUBTC1 Select one from the Pool of Value added Courses offered

- M. Sc. CBCS scheme

CYPATT1 Analytical Chemistry I
CYPALT1 Analytical Chemistry Practical I
CYPATT2 Inorganic Chemistry I
CYPALT2 Inorganic Chemistry Practical I
CYPATT3 Organic Chemistry I
CYPALT3 Organic Chemistry Practical I
CYPATT4 Physical Chemistry I
CYPALT4 Physical Chemistry Practical I
CYPATO1 Polymer Chemistry
CYPALO1 Polymer Chemistry- Practical I
CYPATC1 Refer the List of Value-Added Course
CYPALC1 Refer the List of Value-Added Course
CYPBTT1 Analytical Chemistry II
CYPBLT1 Analytical Chemistry Practical-II
CYPBTT2 Inorganic Chemistry II
CYPBLT2 Inorganic Chemistry Practical-II
CYPBTT3 Organic Chemistry II
CYPBLT3 Organic Chemistry Practical-II
CYPBTT4 Physical Chemistry II
CYPBLT4 Physical Chemistry Practical-II
CYPBTT5 Molecular Spectroscopy
CYPBTD1 Instrumental Analytical Techniques
CYPBTD2 Bio-inorganic Chemistry
CYPBTD3 Chemistry of Heterocycles
CYPBTD4 Solid State Chemistry
CYPATC1 Refer the List of Value-Added Course
CYPALC1 Refer the List of Value-Added Course

अध्यक्ष/Head
रसायन शास्त्र विभाग
Deptt. of Chemistry
गुरु घासीदास विश्वविद्यालय,
Guru Ghasidas Vishwavidyalaya,
बिलासपुर 495009 (छ.ग.)
Bilaspur 495009 (C.G.)

Signature & Seal of HoD

Scheme and Syllabus

Semester wise Theory Papers and Practical

B.Sc. Hon's (Chemistry): LOCF 2021-2022

Department of Chemistry, School of Physical Sciences

Course Opted	Course Code	Name of the course	Credit	Hour/ week	Internal Assess	End Sem Exam
		Semester I				
CC-I Theory	CYUATT1	Inorganic Chemistry-I	3	3	30	70
CC-I Practical	CYUALT1	Inorganic Chemistry Practical-I	2	4	30	70
CC-II Theory	CYUATT2	Organic Chemistry-I	3	3	30	70
CC-II Practical	CYUALT2	Organic Chemistry Practical-I	2	4	30	70
AEC-I Theory	CYUATA1	Select one from the Pool of AEC Courses offered	2	2	30	70
SEC-I Theory	CYUATL1	Select one from the Pool of SEC Courses offered	2	2	30	70
GEC-I Theory	CYUATG1	1A Physics-I, 1B Mathematics-I, 1C Zoology-I 1D Botany-1, 1EAnthropology-1, 1F Biotechnology-1, 1G Forensic Science-1	3	3	30	70
GEC-I Practical	CYUALG1	Generic Elective- Practical-I	2	4	30	70
Additional Credit Course I	CYUATC1	Select one from the Pool of Value added Courses offered				
		TOTAL	**19**	**25**	**240**	**560**
		Semester II				
CC-III Theory	CYUBTT1	Physical Chemistry-I	3	3	30	70
CC-III Practical	CYUBLT1	Physical Chemistry Practical-I	2	4	30	70
CC-IV Theory	CYUBTT2	Organic Chemistry-II	3	3	30	70
CC-IV Practical	CYUBLT2	Organic Chemistry Practical-II	2	4	30	70
AEC-II Theory	CYUBTA1	Select one from the Pool of AEC Courses offered	2	2	30	70
SEC-II Theory	CYUBTL1	Select one from the Pool of SEC Courses offered	2	2	30	70
GEC-II Theory	CYUBTG1	2A Physics-I, 2B Mathematics-I, 2C Zoology-I 2D Botany-1, 2EAnthropology-1, 2F Biotechnology-1, 2G Forensic Science-1	3	3	30	70
GEC-II Practical	CYUBLG1	Generic Elective- Practical-II	2	4	30	70
Additional Credit Course II	CYUBTC1	Select one from the Pool of Value added Courses offered				
		Total	**19**	**25**	**240**	**560**
		Semester III				
CC-V Theory	CYUCTT1	Physical Chemistry-II	3	3	30	70
CC-V Practical	CYUCLT1	Physical Chemistry Practical-II	2	4	30	70
CC-VI Theory	CYUCTT2	Organic Chemistry-III	3	3	30	70
CC-VI Practical	CYUCLT2	Organic Chemistry Practical-III	2	4	30	70
CC-VII Theory	CYUCTT3	Molecular Spectroscopy & Photochemistry	3	3	30	70
CC-VII Practical	CYUCLT3	Spectroscopy Practical	2	4	30	70
AEC-III Theory	CYUCTA1	Select one from the Pool of AEC Courses offered	2	2	30	70
GEC-III Theory	CYUCTG1	3A Physics-I, 3B Mathematics-I, 3C Zoology-I 3D Botany-1, 3EAnthropology-1, 3F Biotechnology-1, 3G Forensic Science-1	3	3	30	70
GEC-III Practical	CYUCLG1	Generic Elective- Practical-III	2	4	30	70
Additional Credit Course III	CYUCTC1	Select one from the Pool of Value added Courses offered				
		Total	**22**	**30**	**270**	**630**
		Semester IV				
CC-VIII Theory	CYUDTT1	Physical Chemistry-III	3	3	30	70
CC-VIII Practical	CYUDLT1	Physical Chemistry practical-III	2	4	30	70
CC-IX Theory	CYUDTT2	Inorganic Chemistry-II	3	3	30	70
CC-IX Practical	CYUDLT2	Inorganic Chemistry practical-II	2	4	30	70
CC-X Theory	CYUDTT3	Introduction to Quantum Chemistry	3	3	30	70
CC-X Practical	CYUDLT3	QuantumChemistry Practical	2	4	30	70

CORE COURSES

Semester	Course	Name of the course	Credits
I	CC 1	Inorganic Chemistry-I	Theory 3
			Practical: 2

Learning objective:

After completing this course, the students will be able to:

- Develop an understanding on atomic theory, concept of wavefunction.
- Elements in periodic table; physical and chemical characteristics,periodicity.
- To predict the atomic structure, chemical bonding, and molecular geometry based on acceptedmodels.
- To understand atomic theory of matter, composition ofatom.
- Identity of given element, relative size, charges of proton, neutron and electrons, and their assembly to form differentatoms.
- Physical and chemical characteristics of elements in various groups and periods according to ionic size, charge, etc. and position in periodictable.
- Characterize bonding between atoms, molecules, interaction and energetics (ii) hybridization and shapes of atomic, molecular orbitals, bond parameters, bond- distances and energies.
- Valence bond theory incorporating concepts of hybridization predicting geometry of molecules.
- Importance of hydrogen bonding, metallicbonding.

Inorganic Chemistry-I (Theory)

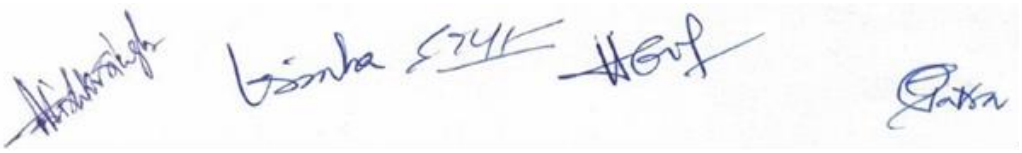
Unit I: Atomic Structure **10 Lectures**

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de' Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and $\psi 2$. Quantum numbers and their significance.Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

Unit II: Periodicity of Elements **10 Lectures**

s, *p*, *d*, *f* block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to *s* and*p*-block.

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective



nuclear charge in periodic table.

(b) Atomic radii (van'derWaals)

(c) Ionic and crystalradii.

(d) Covalent radii (octahedral andtetrahedral)

(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionizationenthalpy.

(f) Electron gain enthalpy, trends of electron gainenthalpy.

(g) Electronegativity, Pauling, Mullikan, Allred Rachow scales, electronegativity and bond order, partial charge, hybridization, group electronegativity. Sanderson electron densityratio.

Unit III: Chemical Bonding **14 Lectures**

(i) *Ionic bond:* General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation, expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvationenergy.

(ii) *Covalent bond:* Lewis structure, Valence Shell Electron Pair Repulsion Theory (VSEPR), Shapes of simple molecules and ions containing lone-and bond-pairs of electrons multiple bonding, sigma and pi-bond approach, Valence Bond theory, (Heitler-London approach). Hybridization containing s, p and s, p, d atomic orbitals, shapes of hybrid orbitals, Bents rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of simple homonuclear and heteronuclear diatomic molecules, MO diagrams of simple tri and tetra-atomic molecules, e.g., N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, HCHO, (idea of s-p mixing and orbital interaction to be given). Covalent character in ionic compounds, polarizing power and polarizability. Fajan rules, polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Ionic character from dipole moment andelectronegativities.

UNIT IV: Metallic bonding and Weak chemical forces **6 Lectures**

(iii) *Metallic Bond:* Qualitative idea of free electron model, Semiconductors,Insulators.

(iv) *Weak Chemical Forces:* vander Waals, ion-dipole, dipole-dipole, induced dipole dipole-induced dipole interactions, Lenard-Jones 6-12 formula, hydrogen bond, effects of hydrogen bonding on melting and boiling points, solubility,dissolution.

Recommended Books/References:

1. Lee, J. D. *Concise Inorganic Chemistry,* Wiley, 5thEd^{n}.
2. Douglas, B.E., McDaniel, D.H., Alexander J.J., *Concepts & Models of Inorganic Chemistry, (Third Edition)* John Wiley &Sons,1999.
3. Atkins, P. W. and DePaula, J. *Physical Chemistry*, Tenth Edition, Oxford University Press, 2014.
4. Rodger, G. E. *Inorganic and Solid State Chemistry*, Cengage Learning,2002.

Inorganic Chemistry-I (Practical)

(A) TitrimetricAnalysis

(i) Calibration and use of apparatus.

(ii) Preparation of solutions of different Molarity/Normality oftitrants.

(iii) Use of primary and secondary standardsolutions.

(B) Acid-BaseTitrations

(i) Estimation of carbonate and hydroxide present together inmixture.

(ii) Estimation of carbonate and bicarbonate present together in amixture.

(iii) Estimation of free alkali present in differentsoaps/detergents

(C) Oxidation-ReductionTitrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$solution.

(ii) Estimation of oxalic acid and sodium oxalate in a givenmixture.

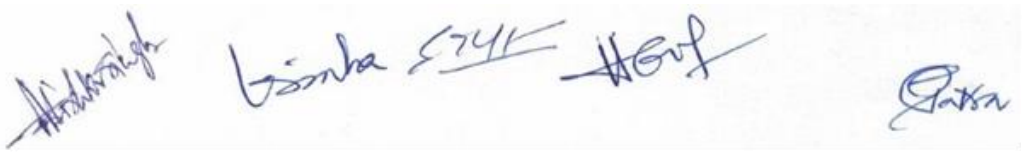
(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and externalindicator.

Note: Experiments may be added/deleted subject to availability of time and facilities

Recommended Books/References:

1. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis* Sixth Edition, Pearson,2009.

2. Svehala G. and Sivasankar I. B, Vogel's Qualitative Inorganic Analysis, Pearson, India, 2012.



Semester	Course	Name of the course	Credits
I	CC 2	Organic Chemistry-I	Theory:3
			Practical: 2

Learning objectives:

On completion of this course, the students will be able to understand:

- Basic of organic molecules, structure, bonding, reactivity and reactionmechanisms.
- Stereochemistry of organic molecules – conformation and configuration, asymmetricmolecules andnomenclature.
- Aromatic compounds and aromaticity, mechanism of aromaticreactions.
- Understanding hybridization and geometry of atoms, 3-D structure of organic molecules, identifying chiral centers.
- Electrophile, nucleophiles, free radicals, electronegativity, resonance, and intermediates along the reaction pathways.
- Mechanism of organic reactions (effect of nucleophile/leaving group, solvent), substitution *vs*.elimination.

OrganicChemistry-I (Theory)

UNIT I: Basics of Organic Chemistry **10 Lectures**

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric,resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples.Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; types, shape and relative stabilities of reaction intermediates (Carbocations, Carbanions, Free radicals and Carbenes).Organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

UNIT II: Stereochemistry **6 Lectures**

Concept of asymmetry, Fischer Projection, Newmann and Sawhorse projection formulae and their interconversions; Geometrical isomerism: cis–trans andsyn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, racemic mixtures, Relative and absolute configuration: D/L and R/S designations.

UNIT III: Chemistry of Aliphatic Hydrocarbons **18 Lectures**

A. Carbon-Carbon sigmabonds

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz- Fittig Reactions, Free radical substitutions: Halogenation - relative reactivity and selectivity.

B. Carbon-Carbonpi-bonds

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions.Saytzeff and Hofmann eliminations. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration- oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2- and 1,4- addition reactions in

conjugated dienes and, Diels- Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilicadditions.

C. Cycloalkanes and ConformationalAnalysis

Cycloalkanes and stability, Baeyer strain theory, Conformation analysis, Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms.

UNIT IV: Aromatic Hydrocarbons **6 Lectures**

Aromaticity: Huckel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of substituent groups.

Recommended Books/References:

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, 6th Edn., Dorling Kindersley (India) Pvt. Ltd. (PearsonEducation).
2. Pine S. H. Organic Chemistry, Fifth Edition, McGraw Hill,(2007)
3. F. A. Carey, Organic Chemistry, Seventh Edition, Tata McGraw Hill(2008).
4. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., (2012), Oxford UniversityPress.
5. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure and mechanism, Kluwer Academic Publisher,(2000).

Organic Chemistry-I (Practical)

1. Checking the calibration of thethermometer.
2. Purification of organic compounds by crystallization using the followingsolvents:
   a.Water b. Alcohol c. Alcohol-Water
3. Determination of the melting points of given organic compounds and unknown organic compounds (using Kjeldahl method and electrically heated melting pointapparatus).
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds.
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillarymethod)
6. Chromatography
   a. Separation of a mixture of two amino acids by ascending and horizontal paper Separation of a mixture of two sugars by ascending paperchromatography
   b. Separation of a mixture of *o*-and *p*-nitrophenol or o-and p-aminophenol by thin layer chromatography(TLC).
   c. chromatography

Recommended Books/Reference:

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.*, Pearson(2012)

Note: Experiments may be added/deleted subject to availability of time and facilities

Semester	Course	Name of the course	Credits
II	CC 3	Physical Chemistry-I	Theory:3
			Practical: 2

Learning objective:

On completion of this course, the students will be able to understand:

- Familiarization with various states ofmatter.
- Physical properties of each state of matter and laws related to describe thestates.
- Calculation of latticeparameters.
- Electrolytes and electrolytic dissociation, salt hydrolysis and acid-baseequilibria.
- Understanding Kinetic model of gas and itsproperties.
- Maxwell distribution, mean-free path, kineticenergies.
- Behavior of real gases, its deviation from ideal behavior, equation of state, isotherm, and law of correspondingstates.
- Liquid state and its physical properties related to temperature and pressurevariation.
- Properties of liquid as solvent for various household and commercialuse.
- Solids, lattice parameters – its calculation, application of symmetry, solid characteristics of simplesalts.
- Ionic equilibria – electrolyte, ionization,dissociation.
- Salt hydrolysis (acid-base hydrolysis) and its application inchemistry.

Physical Chemistry-I (Theory)

UNIT I: Gaseous state **12 Lectures**

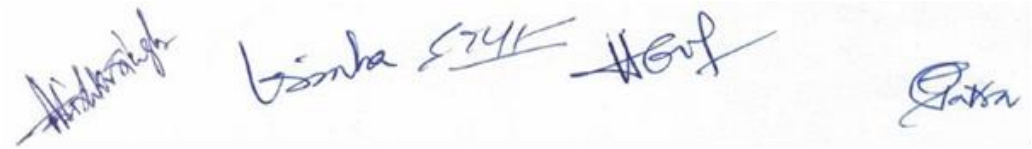
Behavior of real gases: Deviations from ideal gas behavior, compressibility factor, and its variation with pressure for different gases. Causes of deviation from ideal behavior.van der Waals equation of state, its derivation and application in explaining real gas behaviour; van der Waals equation expressed in virial form, Boyle temperature. Isotherms of real gases and theircomparison with van der Waals isotherms, continuity of states, critical state, critical and van der Waals constants, law of corresponding states.Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

UNIT II: Liquid state **5 Lectures**

Structure and physical properties of liquids; vapour pressure, surface tension, viscosity, and their dependence on temperature, Effect of addition of various solutes on surface tension, cleansing action of detergents. Structure of water.

UNIT III: Ionic equilibria **13 Lectures**

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; dissociation constants of mono-, di- and tri-proticacids.

Salt hydrolysis, hydrolysis constants, degree of hydrolysis and pH for different salts.Buffer solutions; Henderson equation, buffer capacity, buffer range, buffer action, applications of buffers in analytical chemistry, Solubility and solubilityproduct.

Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle.

Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of indicators; selection of indicators and their limitations.Multistage equilibria in polyelectrolytes.

UNIT IV: Solid state **10 Lectures**

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitativeidea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Various types of defects in crystals, Glasses and liquid crystals.

Recommended Text books/references:

1. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 8th Ed., Oxford University Press (2006).
2. Ball, D. W. *Physical Chemistry* Thomson Press, India(2007).
3. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa(2004).
4. Mortimer, R. G. *Physical Chemistry* 3rd Ed. Elsevier: NOIDA, UP (2009). 5 G. M. Barrow, Tata McGraw Hill (Fifth Edition)(2007)

Physical Chemistry-I (Practical)

1. **Surface tensionmeasurements.**
   a. Determine the surface tension by (i) drop number (ii) drop weightmethod.
   b. Study the variation of surface tension of detergent solutions withconcentration.
2. **Viscosity measurements using Ostwald'sviscometer.**
   a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at roomtemperature.
   b. Viscosity of sucrose solution with the concentration ofsolute.
3. **pH metry**
   a. Effect on pH of addition of HCl/NaOH to solutions of aceticacid,sodium acetate and their mixtures.
   b. Preparation of buffer solutions of differentpH
      i. Sodium acetate-aceticacid
      ii. Ammonium chloride-ammoniumhydroxide
   c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strongbase.
   d. Determination of dissociation constant of a weakacid.

Semester	Course	Name of the course	Credits
II	CC 4	Organic Chemistry-II	Theory:3
			Practical: 2

Learning objective:

After completion of the course, the learner shall be able to understand:

- Familiarization about classes of organic compounds and their methods ofpreparation.
- Basic uses of reactionmechanisms.
- Name reactions, uses of various reagents and the mechanism of theiraction.
- Preparation and uses of various classes of organiccompounds.
- Organometallic compounds and theiruses.
- Organic chemistry reactions and reactionmechanisms.
- Use of reagents in various organic transformationreactions.

OrganicChemistry-II (Theory)

UNIT I: Chemistry of Halogenated Hydrocarbons **8 Lectures**

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – S_N1, S_N2 and S_N^i mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism.

Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Organometallic compounds of Mg and Li and their use in synthesis.

UNIT II: Alcohols, Phenols, Ethers and Epoxides **6Lectures**

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement.

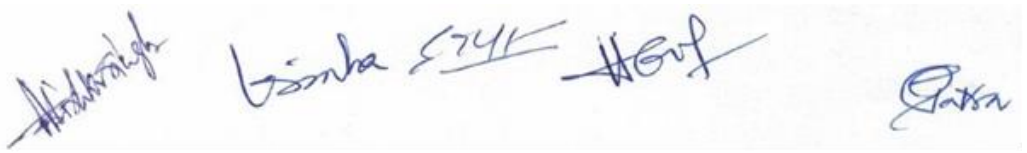
Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism.

Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$

UNIT III: Carbonyl Compounds **10 Lectures**

Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, PDC and PGC);

Addition reactions of unsaturated carbonyl compounds: Michael addition.



Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

UNIT IV: Carboxylic Acids and their Derivatives **10 Lectures**

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids; Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmannbromamide degradation and Curtiusrearrangement.

UNIT V: Sulphur containing compounds **6 Lectures**

Preparation and reactions of thiols, thioethers and sulphonic acids.

Recommended Books/references:

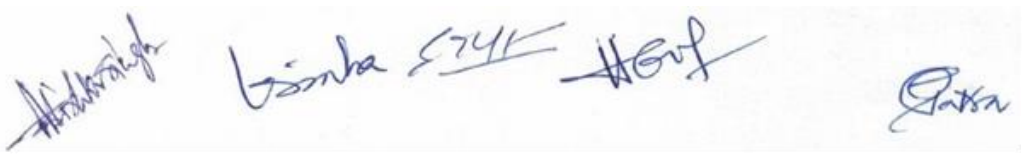
1 Solomons, T.W G., Fryhle, B. Craig. *Organic Chemistry*, John Wiley & Sons, Inc(2009).

2 McMurry, J.E. *Fundamentals of Organic Chemistry*, Seventh edition Cengage Learning, 2013. 3 P Sykes, *A Guide Book to Mechanism in Organic Chemistry*, 6th Edition (1997), Orient Longman, NewDelhi.

4 Morrison R. T. and Boyd R. N. Organic Chemistry, Sixth Edition Prentice Hall India,2003.

OrganicChemistry-II (Practical)

1. Identification of elements (N, S, and halogen) and Functional group tests for alcohols, phenols, carbonyl, carboxylic acid and amine group of compounds.
2. Organic preparations:
   - i. Acetylation of one of the following compounds: amines (aniline, *o*-, *m*-, *p*-toluidines and *o*-, *m*-, *p*-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method: (Using conventional method.and Using green chemistryapproach)
   - ii. Benzolyation of one of the amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-, *m*-, *p*-anisidine) and one of the phenols (*β*-naphthol, resorcinol, *p*-cresol) by Schotten-Baumannreaction.
   - iii. Oxidation of ethanol/ isopropanol (Iodoformreaction).
   - iv. Bromination (anyone)
     - a. Acetanilide by conventionalmethods
     - b. Acetanilide using green approach (Bromate-bromidemethod)
   - v. Nitration: (anyone)
     - a. Acetanilide/nitrobenzene by conventionalmethod
     - b. Salicylic acid by green approach (using ceric ammoniumnitrate).
   - vi. Selective reduction of *meta*dinitrobenzene to*m*-nitroaniline.
   - vii. Reduction of *p*-nitrobenzaldehyde by sodiumborohydride.
   - viii. Hydrolysis of amides andesters.
   - ix. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
   - x. *S*-Benzylisothiouronium salt of one each of water soluble/ insoluble acids (benzoic acid,



oxalic acid, phenyl acetic acid and phthalicacid).

xi. Aldol condensation with either conventional or greenmethod.

xii. Benzil-Benzilic acidrearrangement.

Collected solid samples may be used for recrystallization, melting point and TLC.

Note: Experiments may be added/deleted subject to availability of time and facilities

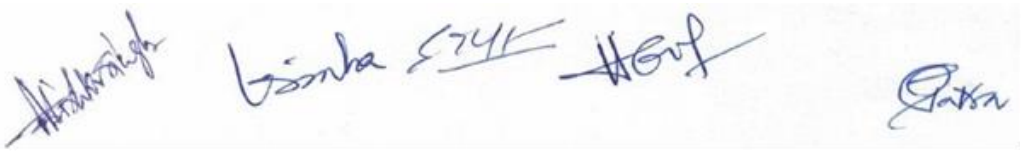
Recommended Books/References:

1 Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education(2009)

2 Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.* Pearson(2012)

3 Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,* University Press(2000)

4 Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press(2000).



GENERIC ELECTIVE COURSES

Generic Elective Course (GE) (any four) for other Departments/Disciplines:

Semester	Course	Name of the course	Credits
I	GE-I	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	Theory: 3
			Practical: 2

Theory: 45Hours

Section – A: Inorganic Chemistry – 1

Unit – 1: Atomic Structure

Review of: Bohr's theory and its limitations, dual behaviour of matterand 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 hydogenicwavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d 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 1s and 2s 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.

(9Hours)

Unit – 2: Chemical Bonding

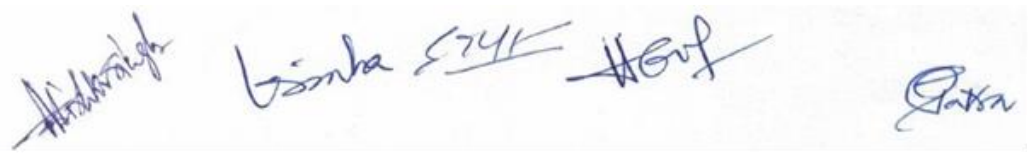
Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionicbonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds.Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and 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 basisof VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonalbipyramidal and octahedral arrangements, such as $BeCl_2$, BF_3, SiF_4, PCl_5, SF_6, NH_3, H_2O, OF_2, ClF_3, SF_4, XeF_4, XeF_6, H_3O^+, I_3^-, I_3^+, ICl_2^-, XeF_5^+.

Concept of resonance and resonating structures in various inorganic and organic compounds.

(7Hours)

Unit – 3: Molecular Orbital Theory



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.

(7Hours)

Section – B: Organic Chemistry – 1

Unit – 1: 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.

(6Hours)

Unit – 2: Stereochemistry

Conformations with respect to ethane, butane and cyclohexane.Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations.Concept of chirality (upto 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 upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

(7Hours)

Unit – 3: Aliphatic Hydrocarbons

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

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

Alkenes: (Upto 5 Carbons)*Preparation:*Elimination reactions: Dehydration of alkenes anddehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:*cis-addition (alk. KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons)*Preparation:*Acetylene from $CaC_2$and conversion into higheralkynes; 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. $KMnO_4$.

(9Hours)

Reference Books:

- J. D. Lee: *A new Concise Inorganic Chemistry*, E L. B. S.
- F. A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley.
- Douglas, McDaniel and Alexader: *Concepts and Models in Inorganic Chemistry*, John

Wiley.
- James E. Huheey, *Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principlesof Structure and Reactivity*, Pearson Publication.
- T. W. Graham Solomon: *Organic Chemistry, John Wiley and Sons.*
- Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
- E. L. Eliel: *Stereochemistry of Carbon Compounds*, Tata McGraw Hill.
- I. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
- ArunBahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand

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GE PRACTICAL – I (Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons)

(30Hours)

Section – A: Inorganic Chemistry - Volumetric Analysis

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 $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Section – B: Organic Chemistry

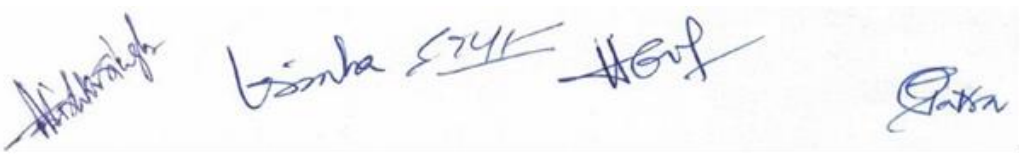
1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)

(a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography

(b) Identify and separate the sugars present in the given mixture by paper chromatography.

Reference Books:

- Textbook of Practical Organic Chemistry, A.I. Vogel , Prentice Hall, 5th edition.
- Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.
- Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
- Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
- A. K. Nad, B. Mahapatra and A. Ghosal, An Advanced Course in Practical Chemistry, New Central Book Agency Priv. Ltd, 2011



Semester	Course	Name of the course	Credits
II	GE-II	Kinetic Theory of Gases, Chemical Energetics, Equilibria& Functional Group Organic Chemistry	Theory: 3 Practical: 2

Theory: 45Hours

Section – A: Physical Chemistry – 1

Unit – 1: Kinetic Theory of Gases

Postulates of Kinetic Theory of Gases and 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 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 (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).

(8 Hours)

Unit – 2: Chemical Energetics

Chemical Energetics: Introduction of different terms and processes in thermodynamics: [systems (isolated, closed, open) and surrounding, macroscopic properties, state and path functions and their differentials.

First Law: concept of heat, q, work, w, internal energy, U, sign convention for heat and work, nature of work, path dependence of work and heat; statement of first law; enthalpy, H, heat changes at constant volume and constant pressure; heat capacities (C_v, C_p) and relation between them for ideal gases. Reversible and irreversible processes, maximum work, thermodynamic quantities (w, q, ΔU, ΔH) and its calculation for isothermal and adiabatic reversible expansion of ideal gases. Ideal gas law for adiabatic reversible expansion, comparison of adiabatic and isothermal reversible expansion. Joule-Thomson effect, JouleThomson coefficient in ideal and real (van der Waal) gases, inversion temperature.

Thermo-chemistry: Standard state, standard enthalpy of formation, Hess's Laws of constant heat summation and its application. Change in internal energy (ΔU) and enthalpy (ΔH) of chemical reactions, relation between ΔU and ΔH, variation of heat of reaction with temperature (Kirchhoff's equation). Enthalpy of neutralization. Bond Energy – Bond dissociation energy and its calculation from thermo-chemical data.– Kirchhoff's equation.

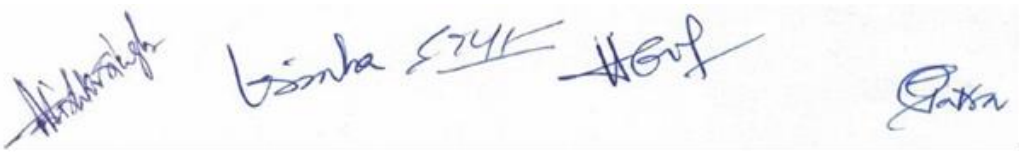
Second law of thermodynamics, concept of entropy, free energy work functions, Gibbs Helmholtz equation and its applications

Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

(9 Hours)

Unit – 3: Chemical and Ionic Equilibrium

Free energy change in a chemical reaction.Thermodynamic derivation of the law of chemical



equilibrium.Distinction between G and G^0, Le Chatelier's principle. Relationships between K_p, K_c and K_x for reactions involving ideal gases.

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.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.

(6 Hours)

Section – B: Organic Chemistry – 2

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

Unit – 1: Aromatic Hydrocarbons & Alkyl and Aryl Halides

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 andacylation) (upto 4 carbons on benzene).Side chain oxidation of alkyl benzenes (upto 4carbons on benzene); aromatic hydrocarbon side chain reactions.

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

Aryl Halides*: *Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer &Gattermann reactions. *Reactions (Chlorobenzene):* Aromatic nucleophilicsubstitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 or $NaNH_2/NH_3$ reagent system. Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

(7 Lectures)

Unit – 2: Alcohols, Phenols, Ethers, Aldehydes and Ketones (Upto 5 Carbons)

Alcohols*: *Preparation: Preparation of 1°, 2° and 3° 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:* Cumenehydroperoxide 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 andbenzaldehyde); *Preparation:* from acid chlorides and from nitriles. *Reactions* -Reaction withHCN, ROH, $NaHSO_3$, NH-G derivatives. Iodoform test.Aldol Condensation, Cannizzaro'sreaction, Wittig reaction, Benzoin condensation.Clemensen reduction and Wolff Kishnerreduction.Meerwein-PondorffVerley reduction.

(9 Hours)

Unit – 3: Carboxylic acids and their derivatives& Amines salt

Carboxylic acids (aliphatic and aromatic): *Preparation:* Acidic and Alkaline hydrolysis of esters. *Reactions:* Hell – Vohlard - Zelinsky Reaction. *Preparation:* Acid chlorides, Anhydrides, Esters and Amides from acids and theirinterconversion. *Reactions:* Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction,Perkin condensation.

Amines and Diazonium Salts: Amines (Aliphatic and Aromatic): (Upto 5 carbons), *Preparation*: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamidereaction. *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.

(6Hours)

Reference Books:

- T. W. Graham Solomons: *Organic Chemistry, John Wiley and Sons*.
- Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
- R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
- ArunBahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand.
- G. M. Barrow: *Physical Chemistry* Tata McGraw-Hill (2007).
- G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
- J. C. Kotz, P. M. Treichel& J. R. Townsend: *General Chemistry*CengageLening India Pvt. Ltd., New Delhi (2009).
- Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 2*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
- R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

GE PRACTICAL – II(Kinetic Theory of Gases, Chemical Energetics, Equilibria& Functional Group Organic Chemistry)

(30Hours)

Section – A: Physical Chemistry

Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of *H*.

Ionic Equilibria

pH measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.

b) Preparation of buffer solutions:

(i) Sodium acetate-acetic acid

(ii) Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section – B: Organic Chemistry

I Systematic Qualitative Organic Analysis of Organic Compounds possessingmonofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

II

1. Criteria of Purity: Determination of melting and boiling points.
2. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
3. Preparations: Mechanism of various reactions involved to be discussed.
   Recrystallisation, determination of melting point and calculation of quantitative yields to be done.

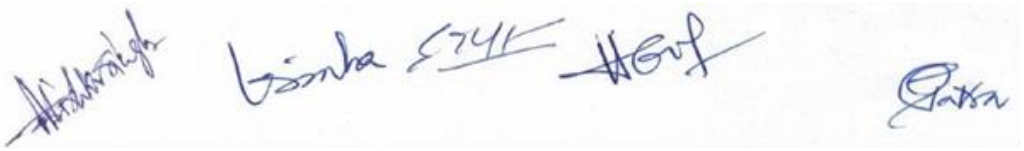
(a) Bromination of Phenol/Aniline

(b) Benzoylation of amines/phenols

(c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

Reference Books

- A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
- F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
- Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* UniversitiesPress
- B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.
- A. K. Nad, B. Mahapatra and A. Ghosal, An Advanced Course in Practical Chemistry, New Central Book Agency Priv. Ltd, 2011



Ability EnhancementCourses

Semester	Course	Name of the course	Credits
I,II	AEC 1	English for communication	Theory:2

Learning Objective:

On completion of this course, the students will be able to understand about:

- The features of communication
- The various writing skills
- The scientific and technical writings

Unit I: Communication **3 Lectures**

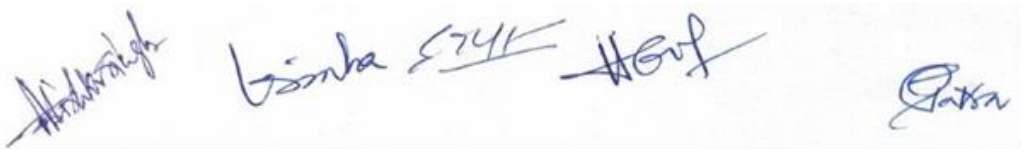
Language and communication, differences between speech and writing, distinct features of speech, distinct features of writing.

Unit II: Writing Skills **5 lectures**

Selection of topic, thesis statement, developing the thesis; introductory, developmental, transitional and concluding paragraphs, linguistic unity, coherence and cohesion, descriptive, narrative, expository and argumentative writing.

Unit III: Technical Writing **4 lectures**

Scientific and technical subjects; formal and informal writings; formal writings/reports, handbooks, manuals, letters, memorandum, notices, agenda, minutes; common errors to be avoided.



Semester	Course	Name of the course	Credits
I,II	AEC 2	Intellectual Property Rights	Theory:2

Learning Objective:

On completion of this course, the students will be able to:

- Understand the concept of IPR
- Differentiate between various agreements ofIPR
- Compare copyrights, patents and GeographicalIndicators
- Examine various legal issues related toIPR
- Relate to various cyber issues concerning IPR

Keywords:

Copyright act, IPR and WTO, Patents, Bioprospecting, Biopiracy, Database

Unit I: Introduction to Intellectual PropertyRight(IPR) **(7 lectures)**

Copyright Act and IPR, Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).Objectives, Rights, Patent Act 1970 and itsamendments.

Unit II: Patents, CopyrightsandTrademarks **(7lectures)**

Procedure of obtaining patents, working of patents. Infringement of patents, Copyrights: work protected under copyright laws, Rights, Transfer of Copyright, Infringement. Trademarks: Objectives of trademarks, Types, Rights, Protection of goodwill, Infringement, Passing off, Defenses, Domain name.

Unit III: Protection of Traditional Knowledge, Industrial Designs and Plant Varieties

(7 lectures)

Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bioprospecting and Bio-piracy, Alternative ways, Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Plant varieties protection in India. Rights of farmers, National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

Unit IV: Information Technology Related IPR **(7 lectures)**

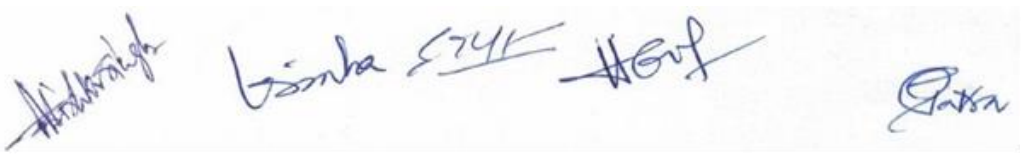
Computer Software and Intellectual Property, Database and Data Protection, Protection of Semiconductor chips, Domain Name Protection. Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, and Moral Issues in Patenting Biotechnological inventions.

Practical:

The students are expected to prepare some project report based on the Success stories of Traditional Patents secured by India. Likewise, prepare a database for Indian products wherein is issue is still under consideration of the competent authorities. Prepare the dos and don'ts on Patents for Botanists.

Suggested Readings

1. N.S. Gopalakrishnan and T.G. Agitha, (2009) Principles of Intellectual Property Eastern Book Company,Lucknow.



SKILL ENHANCEMENT COURSES

Semester	Course	Name of the course	Credits
I,II,V,VI	SEC 1	Personality Development	Theory: 2

Learning outcomes:

After the completion of this course, the learner will be able to:

- Develop understanding of the concepts and principles of basic psychologicalskills
- Apply techniques and methods to enhance productivity and timemanagement
- Develop critical thinkingskills
- Organize human resources with improved leadershipqualities

Keywords:

Mental heuristics, Mental priming, Checklists, Stress management, Cognitive biases, Leadership qualities

Unit I: BasicPsychologySkills **8Lectures**

Mental Heuristics and Priming, Cialdini's six psychological principles, Charisma and charisma enhancements, facing interviews

Unit II: Productivity andTimeManagement **7 Lectures**

Eisenhower Matrix, Pomodoro Technique, Dealing with Procrastination, Journaling methods, Checklists, to-do lists and scheduling theevents

Unit III:DealingNegativity **7 Lectures**

Work-life balance, stress management, coping with failures anddepression

Unit IV: Critical Thinking andHumanresources **8 Lectures**

Logical fallacies, Cognitive biases, Mental Models, Critical Thinking. Evaluation and improvement; Leadershipqualities.

Suggested Readings

1. Bast, F. (2016). Crux of time management for students. Available at:https://www.ias.ac.in/article/fulltext/reso/021/01/0071-0088
2. Cialdini, R.B. (2001). Influence: The Psychology of Persuasion, Revised Edition. Harper Collius.
3. Green, C.J. (2015). Leadership and soft skills for students: Empowered to succeed in High School, College and beyond. Dog EarPublishing.
4. Velayudhan, A. and Amudhadevi, N. V. (2012). Personality Development for College Students. LAP Lambert AcademicPublishing.

Semester	Course	Name of the course	Credits
I,II,V,VI	SEC 2	Computer Applications in Chemistry	Theory: 2

Learning outcomes:

After the completion of this course the learner will be able to:

- Apply the basic operations of spreadsheetapplications
- Recognize advanced resources for accessing scholarly literature frominternet
- Utilize bibliography management software while typing and downloadingcitations
- Operate various software resources with advanced functions and its open office substitutes

Keywords:

Spreadsheet, Google search, Subscription, Bibliography, MS office, Image processing

Unit I:SpreadsheetApplications **8 Lectures**

Introduction of spreadsheet (MS Excel), application, formulas and functions, performing basic statistics using spreadsheet applications, creating basic graphs using spreadsheet applications, logical (Boolean) operators.

Unit II:InternetResources **7Lectures**

Advanced Google search operators and Boolean functions, Introduction to Google Scholar and accessing scholarly literature from Internet, Fake News and spotting the fake news, multimedia resources and podcasts, RSS/XML Feeds and feed subscription using a feed reader.

Unit III:Bibliographymanagement **8 Lectures**

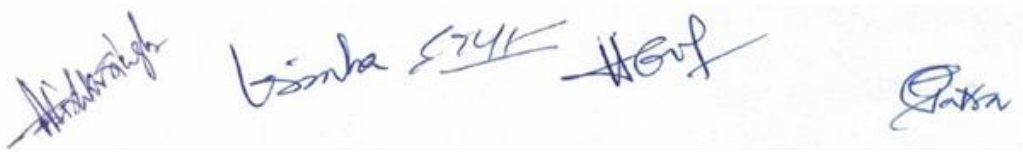
Introducing a bibliography management software (for e.g. Endnote), Styles and Templates, Changing the bibliography style as per journal format, Citing while typing in the office application, downloading citations from Google Scholar.

Unit IV: Othersoftwareresources **7 Lectures**

Introduction to advanced functions of MS Word and its Open Office substitutes including tracking changes, inserting page numbers and automatic table of contents, Google Docs and Forms, MS Power point, Microphotography and scale calibration with ImageJ, digital image processing (Paint.net or GIMP).

Suggested Readings

1. User manual and online user manual of respective soft wares for the most updated content
2. Published books are not recommended as versions keep on updating very frequently; therefore, it is not easy tofollow.

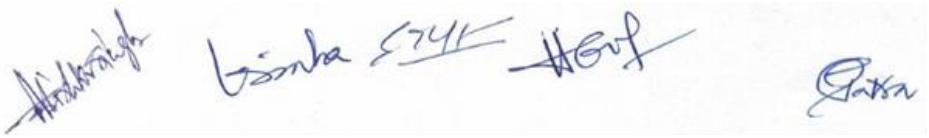


CERTIFICATE COURSEs/VALUE ADDED COURSES

Semester	Course	Name of the course	Credits=02
I-VI	VAC-3	Fuel Chemistry	Theory+ Practical

1. **Department** Chemistry
2. **Name of the Course:** Certificate Course in Fuel Chemistry
   Nature of Course(Certificate/ Value Added): Certificate
3. **Mode of Course:** Hybrid Mode (Online + Offline)
   Online / Offline / Physical
4. **Number of Seats:** 20
5. **Eligibility Criteria for Admission:** 12th Pass, Ongoing B Sc in any discipline with Chemistry as a paper.
6. **Introduction and relevance of Course**:

   In the present scenario energy are first and foremost requirement for the socio-economic development of the society and nation as well which is also recognized by United Nations (UN) as one of the very important and inevitable common goals for the sustainable development goals (SDGs). This course will enable the scientific knowledge, skill and hands-on experience about the most non-renewable energy sources fossil fuels (coal, petroleum, and natural gas) to meet out the energy demand of the country. This will assist them to be industry ready to contribute effectively in the field of coal, petroleum chemistry and technology. In the Bilaspur city the regional research centre of CSIR-Central Institute of Mining and Fuel Research (CIMFR) is located where they recruit the project assistant and project fellow having the knowledge and experience on fuel chemistry, therefore, this course will provide job opportunities too.
7. **Objectives of the course**: The course will have the following objectives
   - To know about the sources of energies.
   - To study the fuel as the main source of energy particularly fossil fuels.
   - To know the chemical compositions of different fuels
   - To study Domestic and industrial applications of coal.
   - To understand about petroleum and petrochemical industry.
   - Various prospects of lubricants
8. **Learning outcome of the course**:
   - Understand both conventional based fuels, and alternative & renewable fuels.



- Understand the chemistry that underpins coal and petroleum fuel science and technology.
- They will understand the refining processes used to produce fuels and lubricants and will know how differences in chemical composition affect properties of fuels and their usage in different applications.
- Understand the fuel product specifications, various test methods used to qualifydifferent types of fuels as well characterization methods.
- They will get experimental experience on fossil fuels like coal, petroleum, and natural gas)
- Students can get job opportunities in various projects of of CSIR-Central Institute of Mining and Fuel Research (CIMFR).

9. Number of lectures: 2 hour per week (02 Credit)

10. Number of practical's (if any): 2 hour per week (01 Credit)

11. List of experiments (If any)-

- Determination of flash point & fire point of given fuel sample.
- Determination of viscosity index, cloud point, pour point of given fuel sample.
- Determination of calorific value of given fuel sample/coal sample using bomb calorimeter. Proximate analysis of given coal sample.
- Determination of the iodine number of oil.
- Determination of the saponification number of oil.

12. Syllabus:

Credits: 02 **30 Lectures**

Unit 1

Review of energy sources (renewable and non-renewable). Energy from natural sources (i.e. solar and renewable forms), from fossil fuels and from nuclear fission.Classification of fuels and their calorific value. Solid, liquid and gaseous fuels, ultimate and proximate analysis of solid fuel

Unit II

Coal as Fuel: Determination of calorific value of solid, liquid and gaseous fuels, Flash point and fire point. 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.

Unit III

Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining anddifferent 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.

Unit IV

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

13. Suggestive Readings:

- Industrial Chemistr by Stocchi, E. Vol-I, Ellis Horwood Ltd. UK (1990).
- Engineering Chemistry by Jain, P.C. & Jain, M. Dhanpat Rai & Sons, Delhi.
- A Text Book of Engineering Chemistry S. S. Dara S Chand & Company
- Industrial Chemistry by Sharma, B.K. & Gaur, H. Goel Publishing House, Meerut (1996).
- Chemistry of Fossil Fuels and Biofuels by Harold Schobert , Cambridge University Press 2013.
- The Chemistry and Technology of Coal by James G. Speight, CRC Press Boca Raton (2012)
- Water for Energy and Fuel Production, Yatish T. Shah, CRC Press Boca Raton (2014)
- Process Chemistry of Coal Utilization: Impacts of Coal Quality and Operating Conditions by Stephen Niksa, Elsevier 2019
- Chemistry of Coal Conversion by Richard H. Schlosberg Springer (1985).
- The Chemistry and Technology of Petroleum by James G. Speight CRC, Boca Raton (2014).
- Lubricants and Lubrication by Wilfried Dresel, Wiley (2017).

14. Course Coordinator (Name & Designation)

Dr S S Thakur, Assistant Professor

Prof G, K Patra, Professor

15. Evaluation Criteria:

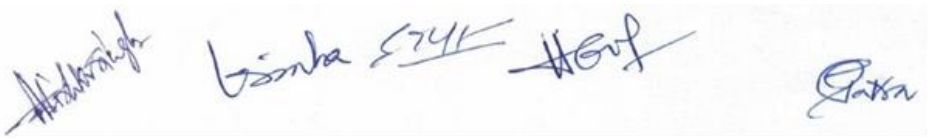
Components	Class Test	Hands on Experiment	End Semester	Total
Weightage (%)	20	20	60	100

16. Infra Structure requirements (if any): Basic laboratory with small instrument like flash and fire point apparatus, Bomb Calorimeter, viscometer, consumables chemicals etc.

17. Financial Requirement (if any): Rs. 50,000/- for instrument and chemicals

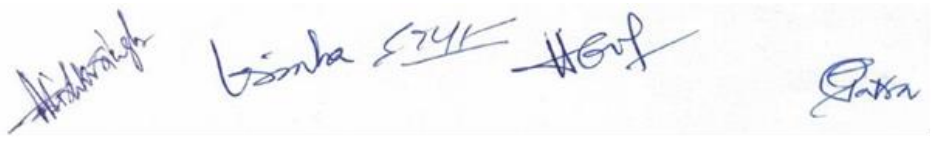
18. Proposed fee for the Course (if any): 5000/- (or as per direction of the university)

19. Budgetary provisions : 50, 000/-



Semester	Course	Name of the course	Credits=02
I-VI	VAC-5	POLYMER CHEMISTRY	Theory+ Practical

1. **Department:** Chemistry
2. **Name of the Course:** Certificate Course in Polymer Chemistry
3. **Nature of Course:** Certificate or Value Added Course: Certificate
4. **Mode of Course:** Online / Offline / Physical: Hybrid Mode (online + Offline 60:40 %)
5. **Number of Seats:** 20
6. **Eligibility Criteria for Admission:** Intermediate/ B Sc in any discipline with Chemistry as a paper
7. **Introduction and relevance of Course**: Polymer is a natural or artificial chemical compound consisting of large molecules which are made up of smaller, joined-together molecules called monomers. Due to their broad spectrum of properties, both synthetic and natural polymers play essential and versatile roles in everyday life.Polymers range from familiar synthetic plastics such as polystyrene to natural biopolymers such as DNA and proteins that are fundamental to biological structure and function. Polymers, both natural and synthetic, are created via polymerization of many small molecules, known as monomers. This course will provide the opportunity to the learner to get job in polymer industries. Learner can start own small level work based on polymer Processing that are one of the part of Syllabus
8. **Objectives of the course:**
   - To study the methods for preparation of variety of Polymers
   - To study the utilization of polymer in the preparation of different industrial articles along with other important compounds.
9. **Learning outcome of the course:** This course will educate the students on the subject of polymers that constitute one of the most important materials used presently. The course will include fundamentals of synthesis, characterization, properties and also include discussion on the applications of polymers, as well as challenges pertaining to contemporary polymer research.
10. **Number of lectures (I hour =1 credit per week):**2 (02 hour)
11. **Number of practical's (if any)(2 hours = 1 Credit per week):** 1(2 Hour)
12. **List of experiments (If any)**- attached with annexure I
13. **Syllabus:** See annexure 1
14. **Suggestive Readings:** See annexure 1
15. **Course Coordinator (Name & Designation):** Dr Arti Srivastava, Assistant Professor



16. **Evaluation Criteria** (to be decided by HOD and Course Teacher) by Written examination of theory and practical.
17. **Infra Structure requirements (if any):** Available in the department, 01 instrument required
18. **Financial Requirement (if any):**
19. **Proposed fee for the Course (if any):** 5000/-
20. **Budgetary provisions** – See annexure II

Syllabus on Polymer Chemistry (Certificate Course)

Credits: 02 **30 Lectures**

Unit 1

Introduction: Background, Nomenclature, Classifications, Examples and Applications, Principles of Polymerization

Unit II

Synthesis of Polymers: Step-Growth Polymerization, Radical Chain Polymerization, Controlled Radical Polymerization, Copolymerization Ionic Chain Polymerization, Coordination Polymerization, Ring-Opening Polymerization, Polymerization techniques.

Unit III

Characterization of Polymers: Determination of Molecular Weight, Frictional Properties of Polymers in Solution, Hydrodynamic Size, DSC, TGA and SEM.

Unit IV

Polymer Properties: Crystallinity in polymers, Glass transition temperature, Rheological properties, Mechanical, Optical, Electrical, Surface and Other Industrially Relevant Properties Degradation of polymers.

Unit V

Some industrially important Polymer reactions, Polymer Processing: Polymer additives, compounding and processing techniques

21. **Books recommended**:

1. F. W. Billmayer, Jr., Text Book of Polymer Science, 3rd Edition (1984), Willey-Interscience, New York.
2. G. Odian, P. W. Atkins, Physical Chemistry, 6th Edition, Oxford University Press, New York.
3. G. Odian, Principles of Polymerization, 3rd edition (1991) John Wiley, Singapore
4. P.Bahadur and N.V. Sastry, Principle of Polymer Sciences , Narosa Publishing House, New Delhi (2002)
5. V.R. Gowarikar, N.V. Vishwanathan, J. Shreedhar , Polymer Sciences, Wiley Eastern, New Delhi