

**SYLLABUS FOR B.Sc. BIOTECHNOLOGY (HONOURS) DEGREE PROGRAM UNDER CBCS w.e.f 2017-18 OF**

**SEM I & II**

**Course Structure for B.Sc. Biotechnology (Honours) Program**

<b>SEMESTER I (F.Y. B.Sc)</b>				
<b>PAPER CODE</b>	<b>TITLE</b>		<b>CREDITS</b>	<b>TOTAL CREDITS</b>
BT DSC I	Biochemistry & Metabolism	Theory	04	<b>06</b>
		Practical	02	
BT DSC II	Cell Biology	Theory	04	<b>06</b>
		Practical	02	
BT DSC III	Chemistry I for Biotechnology	Theory	04	<b>06</b>
		Practical	02	
BT GEC I	Biotechnology & Human Welfare	Theory	03	<b>04</b>
		Practical	01	
AECC 1	English/EVS/MIL communication	Theory	04	<b>04</b>
<b>SEMESTER II</b>				
BT DSC IV	General Microbiology	Theory	04	<b>06</b>
		Practical	02	
BT DSC V	Plant Physiology	Theory	04	<b>06</b>
		Practical	02	
BT DSC VI	Chemistry II For Biotechnology	Theory	04	<b>06</b>
		Practical	02	
BT GEC II	Entrepreneurship Development	Theory	03	<b>04</b>
		Practical	01	
AECC 2	English/EVS/MIL communication	Theory	04	<b>04</b>
<b>SEMESTER III (S.Y.B.S.c)</b>				
<b>PAPER CODE</b>	<b>TITLE</b>		<b>CREDITS</b>	<b>TOTAL CREDITS</b>
BT DSC VII	Mammalian Physiology	Theory	04	<b>06</b>
		Practical	02	
BT DSC VIII	Genetics	Theory	04	<b>06</b>
		Practical	02	
BT DSC IX	Bio Analytical tools	Theory	04	<b>06</b>
		Practical	02	
BT SEC I	Basic of forensic Science	Theory	03	<b>04</b>
		Practical	01	
BT GEC III	Bioethics & Biosafety	Theory	03	<b>04</b>
		Practical	01	
<b>SEMESTER IV</b>				
BT DSC X	Molecular Biology	Theory	04	<b>06</b>
		Practical	02	
BT DSC XI	Immunology	Theory	04	<b>06</b>
		Practical	02	
BT DSC XII	Bioprocess Technology	Theory	04	<b>06</b>
		Practical	02	
BT SEC II	Molecular Diagnostics	Theory	03	<b>04</b>
		Practical	01	
BT GEC IV	Developmental Biology	Theory	03	<b>04</b>
		Practical	01	
<b>SEMESTER V (T.Y.B.S.c)</b>				
<b>PAPER CODE</b>	<b>TITLE</b>		<b>CREDITS</b>	<b>TOTAL CREDITS</b>
BT DSC XIII	Recombinant DNA Technology	Theory	04	<b>06</b>
		Practical	02	
BT DSEI	Animal Diversity	Theory	04	<b>06</b>
		Practical	02	
BT DSE II	Plant Diversity	Theory	04	<b>06</b>

		Practical	02	
BT SEC III	Enzymology	Theory	03	<b>04</b>
		Practical	01	
<b>SEMESTER VI</b>				
BT DSC XIV	Genomics and Proteomics	Theory	04	<b>06</b>
		Practical	02	
BT DSEIV	Environmental Biotechnology	Theory	04	<b>06</b>
		Practical	02	
BT DSE V	Plant Biotechnology	Theory	04	<b>06</b>
		Practical	02	
BT SEC IV	Industrial Fermentation	Theory	03	<b>04</b>
		Practical	01	
BT DSP*	Project			<b>06</b>

\*In lieu of any one DSE

## BT DSC I - BIOCHEMISTRY & METABOLISM

### UNIT I: Introduction to Biochemistry: (10 Lectures )

A historical prospective.

Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions

### UNIT II (10 Lectures)

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA

### UNIT III (20 Lectures)

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD<sup>+</sup>, NADP<sup>+</sup>, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate, lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions

### UNIT IV (20 Lectures)

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation.  $\beta$ -oxidation of fatty acids.

### PRACTICALS

1. To study activity of any enzyme under optimum conditions.
2. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
3. Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.
4. Estimation of blood glucose by glucose oxidase method.
5. Principles of Colorimetry: **(i)** Verification of Beer's law, estimation of protein.  
**(ii)** To study relation between absorbance and % transmission.
6. Preparation of buffers.
7. Separation of Amino acids by paper chromatography.
8. Qualitative tests for Carbohydrates, lipids and proteins

## BT DSC II - CELL BIOLOGY

### UNIT I (10 Lectures)

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation.

Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

### UNIT II (15 Lectures)

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.

Endoplasmic reticulum: Structure, function including role in protein segregation.

Golgi complex: Structure, biogenesis and functions including role in protein secretion.

### UNIT III (20 Lectures )

Lysosomes: Vacuoles and micro bodies: Structure and functions

Ribosomes: Structures and function including role in protein synthesis.

Mitochondria: Structure and function, Genomes, biogenesis.

Chloroplasts: Structure and function, genomes, biogenesis

Nucleus: Structure and function, chromosomes and their structure.

### UNIT IV (15 Lectures)

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

### PRACTICALS

1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
5. Study of structure of any Prokaryotic and Eukaryotic cell.
6. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
7. Cell division in onion root tip/ insect gonads.
8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

**BT DSC III - CHEMISTRY I FOR BIOTECHNOLOGY**  
**ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC**  
**(Credits: Theory-4, Practicals-2)**

**THEORY**

**Lectures: 60**

**Section A: Inorganic Chemistry-1**

**(30 Lectures)**

**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  $\psi$  and  $\psi^2$ , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wavefunctions (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  $ml$  and  $ms$ . Shapes of  $s$ ,  $p$  and  $d$  atomic orbitals, nodal planes.

Discovery of spin, spin quantum number ( $s$ ) and magnetic spin quantum number ( $ms$ ).

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 in various inorganic and organic compounds.

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 Lectures (including idea of  $s-p$  mixing) and heteronuclear diatomic molecules such as CO, NO and NO<sup>+</sup>. 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 (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).

**(10 Lectures)****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's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

**Alkenes:** (Upto 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<sub>4</sub>) 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<sub>2</sub> 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<sub>4</sub>, ozonolysis and oxidation with hot alk. KMnO<sub>4</sub>.

**(12 Lectures)****Reference Books:**

- J. D. Lee: *A new Concise Inorganic Chemistry*, E L. B. S. 18
- F. A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley.
- Douglas, McDaniel and Alexander: *Concepts and Models in Inorganic Chemistry*, John Wiley.
- James E. Huheey, Ellen Keiter and Richard Keiter: *Inorganic Chemistry: Principles of 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.

- L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
  - R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
  - Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry*, S. Chand
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## **CHEMISTRY LAB: ATOMIC STRUCTURE, BONDING, GENERAL**

### **ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS**

#### ***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  $\text{KMnO}_4$ .
3. Estimation of water of crystallization in Mohr's salt by titrating with  $\text{KMnO}_4$ .
4. Estimation of Fe (II) ions by titrating it with  $\text{K}_2\text{Cr}_2\text{O}_7$  using internal indicator.
5. Estimation of Cu (II) ions iodometrically using  $\text{Na}_2\text{S}_2\text{O}_3$ .

#### ***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  $R_f$  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:**

- Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
- Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition. 19
- Textbook of Practical Organic Chemistry, A.I. Vogel, Prentice Hall, 5th edition.
- Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

## BT GEC I - BIOTECHNOLOGY AND HUMAN WELFARE

### UNIT I (10 Lectures)

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

### UNIT II (10 Lectures )

Agriculture: N<sub>2</sub> fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

### UNIT III (15 Lectures)

Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB..

### UNIT IV (12 Lectures)

Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

### UNIT V (13 Lectures)

Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E.coli*, human genome project.

### PRACTICALS

*(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated*

*through any other material or medium including videos/virtual labs etc.)*

1. Perform of ethanolicfermentaion using Baker's yeast
2. Study of a plant part infected with a microbe
3. To perform quantitative estimation of residual chlorine in water samples
4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)



## BT DSC IV - GENERAL MICROBIOLOGY

### UNIT I (10 Lectures)

Fundamentals, History and Evolution of Microbiology.

Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.

Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

### UNIT II (10 Lectures)

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

### UNIT III (20 Lectures)

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways

Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

### UNIT IV (20 Lectures )

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents

Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.

Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria.

Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

### PRACTICALS

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.

## BT DSC V - PLANT PHYSIOLOGY

### UNIT I: Anatomy (10 Lectures)

The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf)

### UNIT II: Plant water relations and micro & macro nutrients (12 Lectures)

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing.

Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport

### UNIT III: Carbon and nitrogen metabolism (20 Lectures)

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photophosphorylation, calvin cycle, CAM plants, photorespiration, compensation point

Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

### UNIT IV: Growth and development (18 Lectures)

Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene)

Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization

### PRACTICALS

1. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.
2. Demonstration of plasmolysis by *Tradescantia* leaf peel.
3. Demonstration of opening & closing of stomata
4. Demonstration of guttation on leaf tips of grass and garden nasturtium.
5. Separation of photosynthetic pigments by paper chromatography.
6. Demonstration of aerobic respiration.
7. Preparation of root nodules from a leguminous plant.

**BT DSC VI - CHEMISTRY II FOR BIOTECHNOLOGY**  
**CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL**  
**ORGANIC CHEMISTRY I**  
**(Credits: Theory-4, Practicals-2)**

**THEORY**

**Lectures: 60**

**Section A: Physical Chemistry-1 (30 Lectures)**

**Chemical Energetics**

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchoff's equation.

Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.  
**(10 Lectures)**

**Chemical Equilibrium:**

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between  $\Delta G$  and  $\Delta G^\circ$ , Le Chatelier's principle.

Relationships between  $K_p$ ,  $K_c$  and  $K_x$  for reactions involving ideal gases.

**(8 Lectures)**

**Ionic Equilibria:**

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.

**(12 Lectures)**

**Section B: Organic Chemistry-2 (30 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** (Upto 5 Carbons) Types of Nucleophilic Substitution ( $SN_1$ ,  $SN_2$  and  $SN_i$ )

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:  $\text{KNH}_2/\text{NH}_3$  (or  $\text{NaNH}_2/\text{NH}_3$ ).

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

**(8 Lectures)**

**Alcohols, Phenols and Ethers** (Upto 5 Carbons)

**Alcohols:** *Preparation:* Preparation of 1o, 2o and 3o 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.  $\text{KMnO}_4$ , acidic dichromate, conc.  $\text{HNO}_3$ ). 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):** (Formaldehyde, acetaldehyde, acetone and benzaldehyde)

*Preparation:* from acid chlorides and from nitriles.

*Reactions* – Reaction with HCN, ROH,  $\text{NaHSO}_3$ ,  $\text{NH}_2\text{-G}$  derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Ponndorf Verley reduction.

**(14 Lectures)**

**Reference Books:**

- T. W. Graham Solomons: *Organic Chemistry, John Wiley and Sons.*
- Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry, Orient Longman.*
- I.L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: *Organic Chemistry, Prentice Hall.*
- Arun Bahl 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* Cengage Learning
- India Pvt. Ltd., New Delhi (2009).

- B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
  - R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York
  - (1985).
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**CHEMISTRY LAB: CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY**

**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<sub>3</sub>, NH<sub>4</sub>Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of  $\Delta H$ .

**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**

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
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).
- B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

## **BT GEC II - ENTREPRENEURSHIP DEVELOPMENT**

### **UNIT I INTRODUCTION (10 Lectures)**

Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

### **UNIT II ESTABLISHING AN ENTERPRISE (12 Lectures)**

Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility.

### **UNIT III FINANCING THE ENTERPRISE (15 Lectures)**

Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.

### **UNIT IV MARKETING MANAGEMENT (13 Lectures )**

Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product like cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.

### **UNIT V ENTREPRENEURSHIP AND INTERNATIONAL BUSINESS (10 Lectures)**

Meaning of International business, Selection of a product, Selection of a market for international business, Export financing, Institutional support for exports.

**Project Report on a selected product should be prepared and submitted.**