



# UNIVERSITY OF JAMMU

(NAAC ACCREDITED 'A' GRADE UNIVERSITY)

Baba Sahib Ambedkar Road, Jammu-180006 (J&K)

## NOTIFICATION

(19/July/Adp/15)

It is hereby notified for the information of all concerned that the Vice-Chancellor, in anticipation of the approval of the Academic Council, is pleased to authorize the adoption of revised Syllabi and Courses of Study in the subject of **Chemistry** for the following semesters under the **Choice Based Credit System** at the Undergraduate level (as given in the Annexure) for the examinations to be held in the years indicated against each semester as under:-

Subject	Semester	For the examinations to be held in the year	Course Code	%of change
Chemistry	Semester-I	Dec. 2019, 2020 and 2021	UCHTC101	No Change
			UCHTP102	No Change
	Semester-II	May 2020, 2021 and 2022	<b>UCHTC201</b>	<b>&lt;5% change</b>
			UCHPC202	No Change
	Semester-III	Dec. 2020, 2021 and 2022	UCHTC301	No Change
			UCHPC302	No Change
			UCHTS303	No Change
	Semester-IV	May 2021, 2022 and 2023	UCHTC401	No Change
			UCHPC402	No Change
			UCHTS403	No Change
	Semester-V	Dec. 2021, 2022 and 2023	UCHTE501	No Change
			UCHPE502	No Change
			UCHTS503	No Change
	Semester-VI	May 2022, 2023 and 2021	<b>UCHTE601</b>	<b>&lt;5% change</b>
			UCHPE602	No Change
UCHTS603			No Change	

The alternative question papers are required to be set as per the University regulation given as under:-

- I. If the change in the syllabi and courses of study is less than 25%, no alternative question paper will be set
- II. If the change is 25% and above but below 50%, alternative Question paper be set for one year
- III. If the change is 50% and above or whole scheme is changed, alternative Question paper be set for two years.

The Syllabi of the courses is available on the University website: [www.jammuuniversity.in](http://www.jammuuniversity.in)

Sd/-  
DEAN ACADEMIC AFFAIRS

No. F.Acd/II/19/3756-3805

Dated: 22-7-19

Copy to:

- 1) Dean, Faculty of Science
- 2) HOD/Convener, Board of Studies in Chemistry
- 3) All members of the Board of Studies
- 4) C.A. to the Controller of Examinations
- 5) Director, Computer Centre, University of Jammu
- 6) Asst. Registrar (Conf. /Exams. UG)
- 7) Incharge University Website for necessary action please

Assistant Registrar (Academic)

22/7/19

# **CHOICE BASED CREDIT SYSTEM**

## **B. Sc. WITH CHEMISTRY**

### **PROGRAMME SPECIFIC OUT COMES (PSO)**

The curriculum of Choice Based Credit System of B.Sc. program in Chemistry is designed to motivate undergraduate students to achieve the following program specific outcomes:

1. To enable the students to model, simulate and validate the basic concepts related to different branches of Chemistry.
2. To practice and solve numerical problems and also to understand the mechanism of some basic organic reactions.
3. To develop communication and other skills for use in a wide range of industrial areas.
4. To understand the basics of, for example, analytical techniques, detections of elements, gravimetric and volumetric analysis, simple spectroscopic techniques, etc.

## Syllabus and Courses of study in Chemistry for B.Sc. Semester I-VI (CBCS)

Semester	Course Number	Course Title	Credits	Nature of Course
I	UCHTC101	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	4	C
	UCHPC102	Laboratory Course: Chemistry-I	2	C
II	UCHTC201	Chemical Energetics, Equilibria & Functional Organic Chemistry	4	C
	UCHPC202	Laboratory Course: Chemistry-II	2	C
III	UCHTC301	Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry	4	C
	UCHPC302	Laboratory Course: Chemistry-III	2	C
	UCHTS303	Cosmetics, Perfumes and Medicinal Agents from Natural Sources (Skill Enhancement Course)	4	SEC
IV	UCHTC401	Coordination Chemistry, States Of Matter & Chemical Kinetics	4	C
	UCHPC402	Laboratory Course: Chemistry-IV	2	C
	UCHTS403	Pesticide Chemistry (Skill Enhancement Course)	4	SEC
V	UCHTE501	Spectroscopy, Photochemistry and Organo Metallics and Bioinorganic Chemistry	4	DSE
	UCHPE502	Laboratory Course: Chemistry-V	2	DSE
	UCHTS503	Fuel Chemistry (Skill Enhancement Course)	4	SEC
VI	UCHTE601	Inorganic Materials of Industrial Importance and Organic Spectroscopy	4	DSE
	UCHPE602	Laboratory Course: Chemistry-VI	2	DSE
	UCHTS603	Green Methods in Chemistry (Skill Enhancement Course)	4	SEC

C = Core Course; DSE = Discipline Specific Elective Course; SEC = Skill Enhancement Course

(For examinations to be held in the years Dec. 2019, 2020 & 2021)

### **SEMESTER-I**

**Course No.:** UCHTC101

**Theory:** 60 Lectures

**Title:** ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

**Credits:** 04

**Maximum Marks:** 100

**Duration:** 2½ hours

**External Examination:** 80 marks

**Internal Assessment:** 20 marks

*Course Outcome:* This course will help to understand the aspects of atomic structure, bonding involved, molecular structure, etc. The fundamentals of organic chemistry coupled with basic stereochemistry are introduced in this semester.

#### ***Section A: Inorganic Chemistry-1***

##### **Atomic Structure**

**(14 Lectures)**

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  $m_l$  and  $m_s$ , Shapes of  $s$ ,  $p$  and  $d$  atomic orbitals, nodal planes.

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.

##### **Chemical Bonding and Molecular Structure**

**(16 Lectures)**

*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 compounds.

(For examinations to be held in the years Dec. 2019, 2020 & 2021)

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<sup>+</sup>. Comparison of VB and MO approaches.

### **Section B: Organic Chemistry-1**

#### **Fundamentals of Organic Chemistry**

**(16 Lectures)**

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.

#### **Stereochemistry**

**(14 Lectures)**

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).

#### **Reference Books:**

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

(For examinations to be held in the years Dec. 2019, 2020 & 2021)

### **NOTE FOR PAPER SETTERS**

#### **Internal Assessment (Total Marks: 20; Time Duration: 1 hour)**

The internal assessment shall be held on completion of about 50% of the prescribed syllabus. It will consist of two parts of weightage of 10 marks each.

Part A will have eight short answers to questions. The candidate will have to attempt five questions of two marks each.

Part B will have two long answers to questions. The candidate will have to attempt one question of ten marks.

#### **External End Semester Examination (Total Marks: 80; Time Duration: 2½ hours)**

The question paper will have three sections.

Section A will consist of five short answers to questions (without detailed explanation having 70 to 80 words) of three marks each, covering the entire syllabus. The candidate shall have to attempt all the questions (Total: 15 marks).

Section B will consist of five medium answers to questions (with explanation having 250 to 300 words) of seven marks each, covering the entire syllabus. The candidate shall have to attempt all the questions (Total: 35 marks).

Section C will consist of five long answers to questions (with detailed explanation having 500 to 600 words) of fifteen marks each, covering the entire syllabus. The candidate shall have to attempt any two questions (Total marks: 30).

(For examinations to be held in the years Dec. 2019, 2020 & 2021)

### SEMESTER-I

**Course No.:** UCHPC102

**Title:** Laboratory Course: Chemistry-I

**Maximum Marks:** 50

**Credits:** 02

**Duration:** 4 hours

**Course Outcome:** *The students will be trained in volumetric analysis, detection of elements and separation of mixtures by chromatography. Use of paper chromatography as a separation technique will be an additional advantage.*

#### **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 using TLC (combination of two compounds to be given)
  - (a) Identify and separate the components of a given mixture of two 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:**

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

#### **DISTRIBUTION OF MARKS**

A.	Daily evaluation of practical records/viva-voce/attendance	Attendance: 05 marks
		Viva-voce: 05 marks
		Day to day performance: 15 marks
B.	External Examination (Time: 04 hours) (100% syllabus)	Examination: 20 marks (Two practicals of 10 marks each)
		Viva-voce: 05 marks

(For examinations to be held in the years May 2020, 2021 & 2022)

## **SEMESTER-II**

**Course No.:** UCHTC201

**Theory:** 60 Lectures

**Title:** CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY

**Credits:** 04

**Maximum Marks:** 100

**Duration:** 2½ hours

**External Examination:** 80 marks

**Internal Assessment:** 20 marks

***Course Outcome:** This course covers principles of thermo chemistry, thermodynamics and chemical/ionic equilibrium. The basic fundamentals of organic chemistry and aliphatic as well as aromatic hydrocarbons will help the students in laying the foundation for the advance studies of organic chemistry.*

### ***Section A: Physical Chemistry-1***

#### **Chemical Energetics**

**(10 Lectures)**

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 ó Kirchhoff's equation.

Brief overview of first and second laws of thermodynamics.

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

#### **Chemical Equilibrium**

**(8 Lectures)**

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between  $G$  and  $G^{\circ}$ , Le Chatelier's principle. Relationships between  $K_p$ ,  $K_c$  and  $K_x$  for reactions involving ideal gases.

#### **Ionic Equilibria**

**(12 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. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts ó applications of solubility product principle.



(For examinations to be held in the years May 2020, 2021 & 2022)

### **Section B: Organic Chemistry-II**

#### **Aromatic hydrocarbons**

**(8 Lectures)**

*Preparation* (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

*Reactions*: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Crafts reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

#### **Alkyl and Aryl Halides**

**(8 Lectures)**

**Alkyl Halides** (Upto 5 Carbons) Types of Nucleophilic Substitution ( $S_N1$ ,  $S_N2$  and  $S_Ni$ ) reactions.

*Preparation*: from alkenes and alcohols.

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

*Reactions (Chlorobenzene)*: Aromatic nucleophilic substitution (replacement by  $\text{OH}$  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.

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

**(14 Lectures)**

**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.  $\text{KMnO}_4$ , acidic dichromate, conc.  $\text{HNO}_3$ ). Oppeneauer oxidation.

**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.

**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.

(For examinations to be held in the years May 2020, 2021 & 2022)

Reactions ó Reaction with HCN, ROH, NaHSO<sub>3</sub>, NH<sub>2</sub> -G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Ponndorf Verley reduction.

#### Reference Books:

- Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7<sup>th</sup> Ed. Cengage Learning India Edition, 2013.
- Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
- Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
- Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
- Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
- Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
- Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
- Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
- Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

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(For examinations to be held in the years May 2020, 2021 & 2022)

## SEMESTER-II

**Course No.:** UCHPC202

**Title:** Laboratory Course: Chemistry-II

**Maximum Marks:** 50

**Credits:** 02

**Duration:** 4 hours

**Course Outcome:** *The practical component involves some theoretical aspects studied in this semester in the form of practical shape. The experiments on thermochemistry, purification and preparation of organic compounds will create confidence amongst the students.*

### **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 *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**

- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

(For examinations to be held in the years May 2020, 2021 & 2022)

- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).

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B.	External Examination (Time: 04 hours) (100% syllabus)	Examination: 20 marks (Two practicals of 10 marks each)
		Viva-voce: 05 marks

(For examinations to be held in the years Dec. 2020, 2021 & 2022)

### **SEMESTER-III**

**Course No.:** UCHTC301

**Theory:** 60 Lectures

**Title:** SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE,  
ELECTROCHEMISTRY & FUNCTIONAL GROUP ORGANIC CHEMISTRY

**Credits:** 04

**Maximum Marks:** 100

**Duration:** 2½ hours

**External Examination:** 80 marks

**Internal Assessment:** 20 marks

**Course Outcome:** The ideas of solutions, phase equilibrium, conductance, electrochemistry from Physical Chemistry and aliphatic/ aromatic acids, amino acids, peptides, proteins, carbohydrates from Organic Chemistry will be dealt in details.

#### ***Section A: Physical Chemistry-II***

##### **Solutions**

**(8 Lectures)**

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

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

##### **Phase Equilibrium**

**(8 Lectures)**

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius & Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems (lead-silver, FeCl<sub>3</sub>-H<sub>2</sub>O).

##### **Conductance**

**(6 Lectures)**

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions.

Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

##### **Electrochemistry**

**(8 Lectures)**

(For examinations to be held in the years Dec. 2020, 2021 & 2022)

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties:  $G$ ,  $H$ ,  $S$  and equilibrium constant from EMF data.

Concentration cells with transference and without transference.

pH determination using hydrogen electrode and quinhydrone electrode.

Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).

### ***Section B: Organic Chemistry-III***

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

#### **Carboxylic acids and their derivatives**

**(6 Lectures)**

Carboxylic acids (aliphatic and aromatic)

*Preparation:* Acidic and Alkaline hydrolysis of esters.

*Reactions:* Hell ó Vohlard - Zelinsky Reaction.

#### **Carboxylic acid derivatives (aliphatic): (Upto 5 carbons)**

*Preparation:* Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion.

*Reactions:* Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.

#### **Amines and Diazonium Salts**

**( 6 Lectures)**

Amines (Aliphatic and Aromatic): (Upto 5 carbons)

*Preparation:* from alkyl halides, Gabrielø Phthalimide synthesis, Hofmann Bromamide reaction.

*Reactions:* Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with  $\text{HNO}_2$ , Schotten ó Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

**Diazonium salts:** *Preparation:* from aromatic amines.

*Reactions:* conversion to benzene, phenol, dyes.

(For examinations to be held in the years Dec. 2020, 2021 & 2022)

**Amino Acids, Peptides and Proteins:**

**(10 Lectures)**

*Preparation of Amino Acids:* Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis.

*Reactions of Amino acids:* ester of  $\alpha$ COOH group, acetylation of  $\alpha$ NH<sub>2</sub> group, complexation with Cu<sup>2+</sup> ions, ninhydrin test.

Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal) and C-terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis.

**Carbohydrates:**

**( 8 Lectures)**

Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disaccharides (sucrose, cellobiose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

**Reference Books:**

- Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
- Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry*, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
- Mahan, B.H. *University Chemistry*, 3rd Ed. Narosa (1998).
- Petrucci, R.H. *General Chemistry*, 5th Ed., Macmillan Publishing Co.: New York (1985).
- 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).
- Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry* 7<sup>th</sup> Ed., W. H. Freeman.
- Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.

**NOTE FOR PAPER SETTERS**

**Internal Assessment (Total Marks: 20; Time Duration: 1 hour)**

The internal assessment shall be held on completion of about 50% of the prescribed syllabus. It will consist of two parts of weightage of 10 marks each.

Part A will have eight short answers to questions. The candidate will have to attempt five questions of two marks each.

(For examinations to be held in the years Dec. 2020, 2021 & 2022)

Part B will have two long answers to questions. The candidate will have to attempt one question of ten marks.

**External End Semester Examination (Total Marks: 80; Time Duration: 2½ hours)**

The question paper will have three sections.

Section A will consist of five short answers to questions (without detailed explanation having 70 to 80 words) of three marks each, covering the entire syllabus. The candidate shall have to attempt all the questions (Total: 15 marks).

Section B will consist of five medium answers to questions (with explanation having 250 to 300 words) of seven marks each, covering the entire syllabus. The candidate shall have to attempt all the questions (Total: 35 marks).

Section C will consist of five long answers to questions (with detailed explanation having 500 to 600 words) of fifteen marks each, covering the entire syllabus. The candidate shall have to attempt any two questions (Total marks: 30).



(For examinations to be held in the years Dec. 2020, 2021 & 2022)

### **SEMESTER-III**

**Course No.:** UCHPC302

**Title:** Laboratory Course: Chemistry-III

**Maximum Marks:** 50

**Credits:** 02

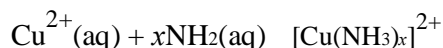
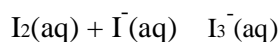
**Duration:** 4 hours

**Course Outcome:** The experiments on distribution, law, conductance, potentiometer, qualitative analysis of organic compounds will be conducted.

#### ***Section A: Physical Chemistry***

##### **Distribution**

Study of the equilibrium of one of the following reactions by the distribution method:



##### **Phase equilibria**

- Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
- Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.
- Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

##### **Conductance**

- Determination of cell constant
- Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
- Perform the following conductometric titrations:
  - Strong acid vs. strong base
  - Weak acid vs. strong base

##### **Potentiometry**

Perform the following potentiometric titrations:

- Strong acid vs. strong base
- Weak acid vs. strong base
- Potassium dichromate vs. Mohr's salt

#### ***Section B: Organic Chemistry***

(For examinations to be held in the years Dec. 2020, 2021 & 2022)

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

**II**

1. Separation of amino acids by paper chromatography
2. Determination of the concentration of glycine solution by formylation method.
3. Titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. Differentiation between a reducing and a nonreducing sugar.

**Reference Books:**

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

**DISTRIBUTION OF MARKS**

A.	Daily evaluation of practical records/viva-voce/attendance	Attendance: 05 marks
		Viva-voce: 05 marks
		Day to day performance: 15 marks
B.	External Examination (Time: 04 hours) (100% syllabus)	Examination: 20 marks (Two practicals of 10 marks each)
		Viva-voce: 05 marks

(For examinations to be held in the years Dec. 2020, 2021 & 2022)

### **SEMESTER-III**

**Course No.: UCHTS303**

**Title: COSMETICS, PERFUMES AND MEDICINAL AGENTS FROM NATURAL SOURCES (Skill Enhancement Course)**

**Credits: 04**

**Maximum Marks: 100**

**Duration: 2½ hours**

**External Examination: 80 marks**

**Internal Assessment: 20 marks**

**Course Outcome:** *The skill enhancement course in 3<sup>rd</sup> semester will help the students to know the products used in daily life. The brief practical training regarding preparation of talcum powder, shampoo, enamels, face cream hair remover, etc. will form the highlights of this course.*

A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours.

Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

Different systems of classification of drugs of natural origin their merits & demerits.

Study of mineral ingredients. Kaolin, Bentonite, Talc., Fuller's earth.

Study of the following with reference to their sources, characters, chemical constituents, identification tests and cosmetic uses.

- i) Carbohydrate ó Starches, Agar, Gum Acacia.
- ii) Lipids ó A study of following; Caster oil, Linseed oil, Sesame oil, Coconut oil.
- iii) Wheat germ. Oil, Jojoba oil, rice bran oil, Spermaceti.

Cosmeceuticals ó study of hair care herbs and skin care herbs as active ingredients.

Tannins ó Classification, identification and study of the following ó Black Catechu, Tannic Acid, Amla, Behra, Hirda, Arjun, Ashok.

#### **Practicals**

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

#### **Reference Books:**

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

(For examinations to be held in the years Dec. 2020, 2021 & 2022)

- Text book of Pharmacognosy ó Trease and Evanø.
- Pharmacognosy ó By Clasu and Tayler.
- Text Book of Pharmacognosy ó T.E. Wallis.
- Materia Medica ó By Nadkarni.

(For examinations to be held in the years May 2021, 2022 & 2023)

### **SEMESTER-IV**

**Course No.:** UCHTC401

**Theory:** 60 Lectures

**Title:** COORDINATION CHEMISTRY, STATES OF MATTER & CHEMICAL KINETICS

**Credits:** 04

**Maximum Marks:** 100

**Duration:** 2½ hours

**External Examination:** 80 marks

**Internal Assessment:** 20 marks

**Course Outcome:** *This course consists of some parts from Inorganic Chemistry and some parts of Physical Chemistry. Good familiarity with transition elements, coordination chemistry and crystal field theory will help the students to develop interest in the advanced areas of this study. The Physical Chemistry section deals with states of matter, namely, solids, liquids and gases. Additionally, basic kinetic studies are introduced in this section.*

#### ***Section A: Inorganic Chemistry-II***

##### **Transition Elements (3d series)**

**(12 Lectures)**

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

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

##### **Coordination Chemistry**

**(8 Lectures)**

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

Drawbacks of VBT. IUPAC system of nomenclature.

##### **Crystal Field Theory**

**(10 Lectures)**

Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for  $O_h$  and  $T_d$  complexes, Tetragonal distortion of octahedral geometry.

Jahn-Teller distortion, Square planar coordination.

#### ***Section B: Physical Chemistry-III***

##### **Kinetic Theory of Gases**

**(8 Lectures)**

(For examinations to be held in the years May 2021, 2022 & 2023)

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<sub>2</sub>.

Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation ó 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.

### **Liquids**

**(6 Lectures)**

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

Liquid Crystals: Introduction and types (nematic, smectic & cholesteric).

### **Solids**

**(8 Lectures)**

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

### **Chemical Kinetics**

**(8 Lectures)**

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

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

### **Reference Books:**

- Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
- Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).

(For examinations to be held in the years May 2021, 2022 & 2023)

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

### **NOTE FOR PAPER SETTERS**

#### **Internal Assessment (Total Marks: 20; Time Duration: 1 hour)**

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Part B will have two long answers to questions. The candidate will have to attempt one question of ten marks.

#### **External End Semester Examination (Total Marks: 80; Time Duration: 2½ hours)**

The question paper will have three sections.

Section A will consist of five short answers to questions (without detailed explanation having 70 to 80 words) of three marks each, covering the entire syllabus. The candidate shall have to attempt all the questions (Total: 15 marks).

Section B will consist of five medium answers to questions (with explanation having 250 to 300 words) of seven marks each, covering the entire syllabus. The candidate shall have to attempt all the questions (Total: 35 marks).

Section C will consist of five long answers to questions (with detailed explanation having 500 to 600 words) of fifteen marks each, covering the entire syllabus. The candidate shall have to attempt any two questions (Total marks: 30).

(For examinations to be held in the years May 2021, 2022 & 2023)

### **SEMESTER-IV**

**Course No.:** UCHPC402

**Title:- Laboratory Course: Chemistry-IV**

**Maximum Marks: 50**

**Credits: 02**

**Duration: 4 hours**

**Course Outcome:** The students will be involved in analysing salts qualitatively along with quantitative estimation. They will also be trained in the experiments in solution chemistry as well as in determining the order of reaction.

#### ***Section A: Inorganic Chemistry***

Semi-micro qualitative analysis using H<sub>2</sub>S of mixtures - not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations : NH<sub>4</sub><sup>+</sup>, Pb<sup>2+</sup>, Ag<sup>+</sup>, Bi<sup>3+</sup>, Cu<sup>2+</sup>, Cd<sup>2+</sup>, Sn<sup>2+</sup>, Fe<sup>3+</sup>, Al<sup>3+</sup>, Co<sup>2+</sup>, Cr<sup>3+</sup>, Ni<sup>2+</sup>, Mn<sup>2+</sup>, Zn<sup>2+</sup>, Ba<sup>2+</sup>, Sr<sup>2+</sup>, Ca<sup>2+</sup>, K<sup>+</sup>

Anions : CO<sub>3</sub><sup>2-</sup>, S<sup>2-</sup>, SO<sub>3</sub><sup>2-</sup>, S<sub>2</sub>O<sub>3</sub><sup>2-</sup>, NO<sub>3</sub><sup>-</sup>, CH<sub>3</sub>COO<sup>-</sup>, Cl<sup>-</sup>, Br<sup>-</sup>, I<sup>-</sup>, NO<sub>3</sub><sup>-</sup>, SO<sub>4</sub><sup>2-</sup>, PO<sub>4</sub><sup>3-</sup>, BO<sub>3</sub><sup>3-</sup>, C<sub>2</sub>O<sub>4</sub><sup>2-</sup>, F<sup>-</sup>

*(Spot tests should be carried out wherever feasible)*

1. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximate) nickel(II) or aluminium as oximate in a given solution gravimetrically.
2. Draw calibration curve (absorbance at <sub>max</sub> vs. concentration) for various concentrations of a given coloured compound (KMnO<sub>4</sub>/ CuSO<sub>4</sub>) and estimate the concentration of the same in a given solution.
3. Determine the composition of the Fe<sup>3+</sup>-salicylic acid complex solution by Jobø method.
4. Estimation of (i) Mg<sup>2+</sup> or (ii) Zn<sup>2+</sup> by complexometric titrations using EDTA.
5. Estimation of total hardness of a given sample of water by complexometric titration.
6. Determination of concentration of Na<sup>+</sup> and K<sup>+</sup> using Flame Photometry.

#### ***Section B: Physical Chemistry***

(I) Surface tension measurement (use of organic solvents excluded).

- a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.
  - b) Study of the variation of surface tension of a detergent solution with concentration.
- c)

(II) Viscosity measurement (use of organic solvents excluded).

- a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwaldø viscometer.
- b) Study of the variation of viscosity of an aqueous solution with concentration of solute.



(For examinations to be held in the years May 2021, 2022 & 2023)

(III) Chemical Kinetics

Study the kinetics of the following reactions.

1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:
  - a. Acid hydrolysis of methyl acetate with hydrochloric acid.
  - b. Saponification of ethyl acetate.
  - c. Compare the strengths of HCl and H<sub>2</sub>SO<sub>4</sub> by studying kinetics of hydrolysis of methyl acetate

**Reference Books:**

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

**DISTRIBUTION OF MARKS**

A.	Daily evaluation of practical records/viva-voce/attendance	Attendance: 05 marks
		Viva-voce: 05 marks
		Day to day performance: 15 marks
B.	External Examination (Time: 04 hours) (100% syllabus)	Examination: 20 marks (Two practicals of 10 marks each)
		Viva-voce: 05 marks

(For examinations to be held in the years May 2021, 2022 & 2023)

### **SEMESTER-IV**

**Course No.: UCHTS403**

**Title: PESTICIDE CHEMISTRY (Skill Enhancement Course)**

**Credits: 04**

**Maximum Marks: 100**

**Duration: 2½ hours**

**External Examination: 80 marks**

**Internal Assessment: 20 marks**

**Course Outcome:** *It is a skill enhancement course which deals in pesticide chemistry useful for agricultural purposes.*

General introduction to pesticides (natural and synthetic), benefits and adverse effects, Peptide management, Peptide classification on use, chemical nature, formulation, toxicity and action.

Changing concepts of pesticides, structure activity relationship.

Synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Lindane, Aldrin, Dieldrin, Gammexene); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

#### **Practicals**

- 1 To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
- 2 Preparation of simple organophosphates, phosphonates and thiophosphates.
- 3 Different technologies used in pesticide residue analysis.

#### **Reference Book:**

- Cremlyn, R. *Pesticides. Preparation and Modes of Action*, John Wiley & Sons, New York, 1978.
- R.P. Bateman, *Pesticide Applications*, AAB Press, 2004.

(For examinations to be held in the years Dec. 2021, 2022 & 2023)

### SEMESTER-V

**Course No.:** UCHTE501

**Theory:** 60 Lectures

**Title:** SPECTROSCOPY, PHOTOCHEMISTRY AND ORGANO METALLICS AND BIOINORGANIC CHEMISTRY

**Credits:** 04

**Maximum Marks:** 100

**Duration:** 2½ hours

**External Examination:** 80 marks

**Internal Assessment:** 20 marks

*Course Outcome:* The course deals in Chemistry of 3d elements, organometallic compounds and bioinorganic chemistry. The fundamentals of molecular spectroscopy will help in understanding the molecular spectroscopy.

#### *Section A: Physical Chemistry-IV*

##### **Molecular Spectroscopy:**

**(10 Lectures)**

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules.

##### **Photochemistry**

**(10 Lectures)**

Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photosensitized reactions, quenching.

##### **Physical properties and Molecular Structure:**

**(10 Lectures)**

Optical activity, Polarization  $\rho$  (Clausius-Mossotti equation), Orientation of dipoles in an electric field, Dipole moment, Induced dipole moment, Measurement of dipole moment: temperature method and refractivity method, Dipole moment and structure of molecules, Magnetic properties: paramagnetism, diamagnetism and ferromagnetism.

#### *Section B: Inorganic Chemistry-III*

(For examinations to be held in the years Dec. 2021, 2022 & 2023)

### **Chemistry of 3d metals**

**(6 Lectures)**

Oxidation states displayed by Cr, Fe, Co, Ni and Cu.

A study of the following compounds (including preparation and important properties);

Peroxo compounds of Cr,  $K_2Cr_2O_7$ ,  $KMnO_4$ ,  $K_4[Fe(CN)_6]$ , sodium nitroprusside,  $[Co(NH_3)_6]Cl_3$ ,  $Na_3[Co(NO_2)_6]$ .

### **Organometallic Compounds**

**(12 Lectures)**

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behaviour of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IR frequencies).

### **Bio-Inorganic Chemistry**

**(12 Lectures)**

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

#### **Reference Books:**

- Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4<sup>th</sup> Ed. Tata McGraw-Hill: New Delhi (2006).
- Kakkar, R. *Atomic & Molecular Spectroscopy: Concepts & Applications*, Cambridge University Press (2015).
- James E. Huheey, Ellen Keiter & Richard Keiter: *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Publication.
- G.L. Miessler & Donald A. Tarr: *Inorganic Chemistry*, Pearson Publication.
- J.D. Lee: *A New Concise Inorganic Chemistry*, E.L.B.S.
- F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley & Sons.

#### **NOTE FOR PAPER SETTERS**

##### **Internal Assessment (Total Marks: 20; Time Duration: 1 hour)**

The internal assessment shall be held on completion of about 50% of the prescribed syllabus. It will consist of two parts of weightage of 10 marks each.

Part A will have eight short answers to questions. The candidate will have to attempt five questions of two marks each.

Part B will have two long answers to questions. The candidate will have to attempt one question of ten marks.

##### **External End Semester Examination (Total Marks: 80; Time Duration: 2½ hours)**

(For examinations to be held in the years Dec. 2021, 2022 & 2023)

The question paper will have three sections.

Section A will consist of five short answers to questions (without detailed explanation having 70 to 80 words) of three marks each, covering the entire syllabus. The candidate shall have to attempt all the questions (Total: 15 marks).

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Section C will consist of five long answers to questions (with detailed explanation having 500 to 600 words) of fifteen marks each, covering the entire syllabus. The candidate shall have to attempt any two questions (Total marks: 30).

(For examinations to be held in the years Dec. 2021, 2022 & 2023)

### SEMESTER-V

**Course No.:** UCHPC502

**Title:**Laboratory Course: Chemistry-V

**Maximum Marks: 50**

**Credits: 02**

**Duration: 4 hours**

**Course Outcome:** The lab course involves some experiments based on instrumentation.

#### **UV/Visible spectroscopy**

- I. Study the 200-500 nm absorbance spectra of  $\text{KMnO}_4$  and  $\text{K}_2\text{Cr}_2\text{O}_7$  (in 0.1 M  $\text{H}_2\text{SO}_4$ ) and determine the  $\lambda_{\text{max}}$  values. Calculate the energies of the two transitions in different units ( $\text{J molecule}^{-1}$ ,  $\text{kJ mol}^{-1}$ ,  $\text{cm}^{-1}$ , eV).
- II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of  $\text{K}_2\text{Cr}_2\text{O}_7$ .
- III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

#### **Colourimetry**

- I. Verify Lambert-Beer's law and determine the concentration of  $\text{CuSO}_4/\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$  in a solution of unknown concentration.
- II. Determine the concentrations of  $\text{KMnO}_4$  and  $\text{K}_2\text{Cr}_2\text{O}_7$  in a mixture.
- III. Determine the dissociation constant of an indicator (phenolphthalein).
- IV. Analyse the given vibration-rotation spectrum of  $\text{HCl(g)}$ .

#### **Reference Books**

- Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
- Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8<sup>th</sup> Ed.*; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3<sup>rd</sup> Ed.*; W.H. Freeman & Co.: New York (2003).
- Advance Practical Physical Chemistry by J.B. Yadav, Goel Publication, Meerut.
- Practical Physical Chemistry by B. Vishwanathan and P.S. Raghvan, Viva Books Pvt. Ltd.

#### **DISTRIBUTION OF MARKS**

A.	Daily evaluation of practical records/viva-voce/attendance	Attendance: 05 marks
		Viva-voce: 05 marks
		Day to day performance: 15 marks
B.	External Examination (Time: 04 hours) (100% syllabus)	Examination: 20 marks (Two practicals of 10 marks each)
		Viva-voce: 05 marks

(For examinations to be held in the years Dec. 2021, 2022 & 2023)

### **SEMESTER-V**

**Course No.: UCHTS503**

**Title: FUEL CHEMISTRY (Skill Enhancement Course)**

**Credits: 04**

**Maximum Marks: 100**

**Duration: 2½ hours**

**External Examination: 80 marks**

**Internal Assessment: 20 marks**

**Course Outcome:** *It is also skill enhancement course which deals in coal, petroleum products, Fuel Chemistry, lubricants, etc.*

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

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

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

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

*Lubricants:* Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants.

Properties of lubricants (viscosity index, cloud point, pour point) and their determination.

**Reference Books:**

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

(For examinations to be held in the years May 2022, 2023 & 2024)

### **SEMESTER-VI**

**Course No.:** UCHTE601

**Theory:** 60 Lectures

**Title:** INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE AND ORGANIC SPECTROSCOPY

**Credits:** 04

**Maximum Marks:** 100

**Duration:** 2½ hours

**External Examination:** 80 marks

**Internal Assessment:** 20 marks

*Course Outcome: The study of inorganic materials of industrial importance and study of UV/Visible and NMR Spectroscopy of simple organic compounds forms the foundations of this course.*

#### ***Section A: Inorganic Chemistry-IV***

##### **Recapitulation of s- and p-Block Elements**

**(4 Lectures)**

Periodicity in s- and p-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mulliken, and Alfred-Rochow scales). Allotropy in C, S, and P.

Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first member of each group.

##### **Fertilizers:**

**(7 Lectures)**

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; compound and mixed fertilizers.

##### **Batteries:**

**(9 Lectures)**

Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery & Li-ion battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

##### **Catalysis:**

**(6 Lectures)**

General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts.

##### **Chemical explosives:**

**(4 Lectures)**



(For examinations to be held in the years May 2022, 2023 & 2024)

Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.

### **Section B: Organic Chemistry-IV**

#### **Active methylene compounds:**

**(8 Lectures)**

*Preparation:* Claisen ester condensation. Keto-enol tautomerism.

*Reactions:* Synthetic uses of ethylacetoacetate (2-hexanone, Pentanoic acid and -ketoester).

#### **Application of Spectroscopy to Simple Organic Molecules**

##### **a) Electromagnetic spectrum**

**(12 Lectures)**

Ultraviolet (UV) absorption spectroscopy ó absorption laws (Beer Lambert law), molar absorptivity, types of electronic transitions, effect of conjugation. Concept of Chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts, effect of solvents. UV spectra of conjugated enes and enones (Woodward - Fieser rules).

Infrared (IR) absorption spectroscopy ó molecular vibrations. Hooke's law, selection rules, intensity and position of IR bands, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds (benzaldehyde, benzoyl chloride, acetophenone, benzamide, salicylic acid, p-hydroxybenzoic acid, p-nitroaniline, p-nitrophenol, benzonitrile, , -unsaturated ketones).

##### **b) Spectroscopy**

**(10 Lectures)**

Nuclear magnetic resonance (NMR) spectroscopy. Proton magnetic resonance (<sup>1</sup>H NMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone.

#### **Reference Books:**

- R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
- J. A. Kent: *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
- R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
- B. K. Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut.
- J.D. Lee: *A New Concise Inorganic Chemistry*, E.L.B.S.
- F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley & Sons.
- I.L. Finar: *Organic Chemistry* (Vol. I & II), E.L.B.S.
- John R. Dyer: *Applications of Absorption Spectroscopy of Organic Compounds*,

(For examinations to be held in the years May 2022, 2023 & 2024)

Prentice Hall.

- R.M. Silverstein, G.C. Bassler & T.C. Morrill: *Spectroscopic Identification of Organic Compounds*, John Wiley & Sons.
- R.T. Morrison & R.N. Boyd: *Organic Chemistry*, Prentice Hall.
- Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman.
- Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry*, S. Chand.
- V.K. Ahluwalia and R.K. Parashar: *Organic Reaction Mechanism*, Narosa.

### **NOTE FOR PAPER SETTERS**

#### **Internal Assessment (Total Marks: 20; Time Duration: 1 hour)**

The internal assessment shall be held on completion of about 50% of the prescribed syllabus. It will consist of two parts of weightage of 10 marks each.

Part A will have eight short answers to questions. The candidate will have to attempt five questions of two marks each.

Part B will have two long answers to questions. The candidate will have to attempt one question of ten marks.

#### **External End Semester Examination (Total Marks: 80; Time Duration: 2½ hours)**

The question paper will have three sections.

Section A will consist of five short answers to questions (without detailed explanation having 70 to 80 words) of three marks each, covering the entire syllabus. The candidate shall have to attempt all the questions (Total: 15 marks).

Section B will consist of five medium answers to questions (with explanation having 250 to 300 words) of seven marks each, covering the entire syllabus. The candidate shall have to attempt all the questions (Total: 35 marks).

Section C will consist of five long answers to questions (with detailed explanation having 500 to 600 words) of fifteen marks each, covering the entire syllabus. The candidate shall have to attempt any two questions (Total marks: 30).

(For examinations to be held in the years May 2022, 2023 & 2024)

### SEMESTER-VI

**Course No.:** UCHPC602

**Title:- Laboratory Course: Chemistry-VI**

**Maximum Marks: 50**

**Credits: 02**

**Duration: 4 hours**

**Course Outcome:** *The experiments on analysis of industrial products, including cement, fertilizers, pigments and preparation and spectroscopic study of simple organic compounds will be covered in the course.*

1. Determination of free acidity in ammonium sulphate fertilizer.
  2. Estimation of calcium in calcium ammonium nitrate fertilizer.
  3. Estimation of phosphoric acid in superphosphate fertilizer.
  4. Electroless metallic coatings on ceramic and plastic material.
  5. Determination of composition of dolomite (by complexometric titration).
  6. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.
  7. Analysis of Cement.
  8. Preparation of pigment (zinc oxide).
  9. Preparations:
    - (i) Beckmann rearrangement of Benzophenone oxime
    - (ii) Benzilic acid from benzyl
    - (iii) 4-nitroacetanilide from acetanilide
    - (iv) Acetanilide from aniline with Zn/AcOH
- The students will be provided the hardcopies of Spectral data [UV, IR, NMR] for analysis of products and starting materials of above preparations.

#### **Reference Books:**

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
- W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.
- J. A. Kent: *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
- P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
- R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.

#### **DISTRIBUTION OF MARKS**

A.	Daily evaluation of practical records/viva-voce/attendance	Attendance: 05 marks
		Viva-voce: 05 marks
		Day to day performance: 15 marks
B.	External Examination (Time: 04 hours) (100% syllabus)	Examination: 20 marks
		(Two practicals of 10 marks each)
		Viva-voce: 05 marks

(For examinations to be held in the years May 2022, 2023 & 2024)

## **SEMESTER VI**

**Course No.: UCHTS603**

**Title: GREEN METHODS IN CHEMISTRY (Skill Enhancement Course)**

**Credits: 04**

**Maximum Marks: 100**

**Duration: 2½ hours**

**External Examination: 80 marks**

**Internal Assessment: 20 marks**

**Course Outcome:** *Skill development course in which usefulness of green methods in chemistry will be discussed.*

### ***Theory and Hand-on Experiments***

Introduction: Definitions of Green Chemistry. Brief introduction of twelve principles of Green Chemistry, with examples, special emphasis on atom economy, reducing toxicity, green solvents, Green Chemistry and catalysis and alternative sources of energy, Green energy and sustainability

**The following Real world Cases in Green Chemistry should be discussed:**

- Surfactants for carbon dioxide ó Replacing smog producing and ozone depleting solvents with CO<sub>2</sub> for precision cleaning and dry cleaning of garments.
- Designing of environmentally safe marine antifoulant.
- Rightfit pigment: Synthetic azo pigments to replace toxic organic and inorganic pigments.
- An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.

### **Practicals**

- Preparation and characterization of biodiesel from vegetable oil.
- Extraction of D-limonene from orange peel using liquid CO<sub>2</sub> prepared from dry ice.
- Mechano chemical solvent free synthesis of azomethine.
- Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper(II).

### **Reference Books:**

- Anastas, P.T. & Warner, J.K. *Green Chemistry- Theory and Practical*, Oxford University Press (1998).
- Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
- Cann, M.C. & Connely, M.E. *Real-World cases in Green Chemistry*, American Chemical Society, Washington (2000).
- Ryan, M.A. & Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).

(For examinations to be held in the years May 2022, 2023 & 2024)

- Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. *Green Chemistry Experiments: A monograph* I.K. International Publishing House Pvt Ltd. New Delhi, Bangalore.
- Lancaster, M. *Green Chemistry: An introductory text* RSC publishing, 2nd Edition.
- Sidhwani, I.T., Saini, G., Chowdhury, S., Garg, D., Malovika, Garg, N. Wealth from waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated “*A Social Awareness Project*”, *Delhi University Journal of Undergraduate Research and Innovation*, **1(1)**: 2015.