SEMESTER I

UCCHA20 - GENERAL CHEMISTRY – I

Year: I	Course Code	Title of the Course	Course Type	Course Category	H/W	Credits	Marks
SEM: I	UCCHA20	General Chemistry	Theory	Core	6	5	100

Learning Objectives:

1. To impart knowledge on periodicity of properties and to learn the theory behind inorganic qualitative analysis.
2. To learn the IUPAC system of nomenclature of organic compounds and shapes of molecules based on hybridization.
3. To help the students to recapitulate the fundamentals in gaseous state, liquid state and quantum chemistry.

Course Outcomes:

The Learners will be able to

1. Recall and understand the concepts of valency, oxidation and reduction, classify the elements in the periodic table and explain the periodicity of properties.

2. Recall the concepts and theories of acid - base, buffer solutions, understand the principle of inorganic qualitative analysis and apply it in practicals.

3. Apply IUPAC nomenclature in naming organic compounds and the concept of hybridization to identify the geometry and shape of the simple organic molecules.

4. Analyse and apply the concepts of liquid and gaseous states.

5. Recall the concepts of classical and quantum mechanics and solve related problems.

CO	PSO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	M	H	H	H	H
CO2	H	M	H	H	H	H
CO3	H	M	H	H	H	H
CO4	H	M	H	H	H	H
CO5	H	M	H	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

Unit I:(18 hours)

1.1 Valency, oxidation number, oxidation and reduction in terms of oxidation number, calculation of oxidation state- acids, bases, salts, oxidizing and reducing agents. (K1, K2, K3 & K4)

1.2 Oxidation, reduction and redox reactions (definition and examples). Oxidizing and reducing agents (definition and examples). Balancing chemical equations - oxidation number and ion electron methods. (K1, K2, K3 & K4)

1.3 Modern periodic law, general classification of elements in the periodic table, general characteristics of s, p, d, and f block elements. (K1, K2, K3 & K4)

1.4 Periodicity of properties – definition, factors affecting and periodicity of the following properties - atomic radii, ionic radii, ionization potential and electron affinity. (K1, K2, K3 & K4)

1.5 Factors affecting and periodicity of electronegativity. (K1, K2, K3 & K4)

1.6 Determination of electronegativity – Pauling's scale and Mulliken's scale. (K1, K2, K3 & K4)

Unit II: (18 hours)

2.1 Acids and Bases-concepts- Arrhenius, Lowry-Bronsted and Lewis acid – base theory, acid- base equilibria. (K1, K2, K3 & K4)

2.2 Definition of pH of strong and weak acid solutions, calculation. Hard and soft acids and bases – definition. (K1, K2, K3 & K4)

2.3 Buffer solutions, relative strength of acids and bases from k_a and k_b values, Henderson-Hasselbalch equations.) (K1, K2, K3 & K4)

2.4 Common ion effect, concept of sparingly soluble salts, solubility product principle, relation between solubility and solubility product. (K1, K2, K3 & K4)

2.5 Application of common ion effect and solubility product principle in inorganic qualitative analysis, eliminating the interfering radicals, significance of sodium carbonate extract. (K1, K2, K3 & K4)

2.6 Spot test reagents – Magneson, Aluminon, Nesslers, Thiourea, Cupferon and DMG(K1, K2, K3 & K4)

Unit III:(18 hours)

3.1 IUPAC system of nomenclature of organic compounds- introduction, rules of IUPAC system of nomenclature of organic compounds. (K1, K2, K3 & K4)

3.2 IUPAC system of nomenclature for complex organic compounds, alkanes, substituted alkanes, alkyl halides, alkenes, alkynes, alkyl substituents and cycloalkanes. (K1, K2, K3 & K4)

3.3 Nomenclature of compounds having functional groups - alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, nitro compounds. (K1, K2, K3 & K4)

3.4 Nomenclature of aromatic compounds and substituted aromatic compounds, poly functional and heterocyclic compounds, bicyclic and spiro compounds. (K1, K2, K3 & K4)

3.5 Concept of Hybridization – definition, characteristics of hybrid orbitals, modes of hybridization. (K1, K2, K3 & K4)

3.6 Hybridization – tetra valency of carbon, geometry of molecules - methane, ethane, ethylene, acetylene and benzene. (K1, K2, K3 & K4)

Unit IV: (18 hours)

4.1 Gaseous state - kinetic gas equation, derivation, gas laws from the kinetic gas equation, types of velocities - Mean, Root Mean Square Velocity (RMS), Most Probable Velocities (MPV), calculation of molecular velocities. (No derivation). (K1,K2, K3 & K4)

4.2 Maxwell's distribution of molecular velocities (derivation), equipartition of energy, collision number, Collision diameter, mean free path, definition.(No derivation). (K1, K2, K3 & K4)

4.3 Real gases – deviation from ideal behavior – van der Waal's equation- Virial equation of state, Boyle's temperature (No derivation). (K1, K2, K3 & K4)

4.4 Joule's law, Joule Thomson effect, Joule Thomson Coefficient and its derivation, inversion temperature and its significance. (No derivation) (K1, K2, K3 & K4)

4.5 Liquid State - qualitative treatment of the structure of liquids, surface tension – definition, effects of surface tension, experimental determination – capillary rise method – drop weight method, applications. (K1, K2, K3 & K4)

4.6 Viscosity – definition, effect of viscosity on temperature and pressure, experimental determination - Saybolt Viscometer and Ostwald's Viscometer method (Including problems). (K1, K2, K3 & K4)

Unit V: (18 hours)

5.1 Classical Mechanics –the e/m of an electron, Rutherford's scattering experiments, Rutherford atomic model. (K1, K2, K3 & K4)

5.2 The Bohr theory of hydrogen atom, Sommerfeld extension of the Bohr theory. (K1, K2, K3 & K4)

5.3 Photoelectric effect and Compton effect- Wave mechanical concept of the atom, de Broglie's relationship. (K1, K2, K3 & K4)

5.4 Davisson and Germer experiment, wave nature of electron, Heisenberg's uncertainty principle. (K1, K2, K3 & K4)

5.5 Quantum mechanics- postulates of quantum mechanics, concept of operators, angular wave function, Eigen values, Schrodinger wave equation (no derivation), and significance of wave functions. (K1, K2, K3 & K4)

5.6 Radial and angular wave functions, probability distribution of electrons, radial probability distribution curves. (K1, K2, K3 & K4)

*Related problems to be worked out

Text Books:

1. R.D.Madan, Modern Inorganic Chemistry, 2nd Edition, S. Chand & Co, Reprint 2004.
2. B.SBahl and Arun Bahl, Advanced Organic Chemistry, Sultan Chand and Co. Ltd., Reprint 2008.
3. B. R. Puri, L. R Sharma and M.SPathania, Principles of Physical Chemistry, 43rd Edition, Vishal Publishing Co., 2008.

Reference Books:

1. P.L Soni and Mohan Katyal, Textbook of Inorganic Chemistry, 20th Edition, Sultan Chand & Sons, Reprint 2001.
2. P.L Soni and H.M Chawla, Textbook of Organic Chemistry, 25th Revised Edition, Sultan Chand & Sons, 1992.
3. Arun Bahl and B.S.Bahl, Advanced Organic Chemistry, 1st Revised Multicolour Edition 2012.
4. M.K. Jain and S.C. Sharma, Modern Organic Chemistry, Vishal Publishing Co, New Delhi, Golden Jubilee Year Edition, 2017.
5. K.S Tewari and M.K Vishnoi, A Textbook of Organic Chemistry, 3rd Edition, Vikas Publishing House Pvt. Ltd., 2006.
6. M.K Jain and S.C Sharma, Modern Organic Chemistry, Vishal Publishing Co, 2004.
7. P.L Soni, O.P Dharmarha and U.N Dash, Textbook of Physical Chemistry, 21st Revised Edition, S. Chand & Co, Reprint 2000.
8. P.K Mani and A.O Thomas, A Textbook of Practical Chemistry, Scientific Publication, 1973.
9. O.P. Pandey, D. N. Bajpai and S.Giri, Practical Chemistry, 8th Edition, S. Chand & Co, 2001.
10. R.K.Prasad, Quantum Chemistry through problems and solutions, New Age International Publishers, New Delhi,1997.

OER:

1. https://nroer.gov.in/55ab34ff81fccb4f1d806025/file/5e79007116b51c232c3fb959

(Classification of elements and periodic properties)

2. https://nptel.ac.in/courses/104/101/104101121/(Properties of elements)
3. https://nptel.ac.in/courses/104/103/104103071/ (IUPAC Nomenclature)
4. V-labs- http://www.olabs.edu.in/
5. https://nroer.gov.in/55ab34ff81fccb4f1d806025/file/5b20c14016b51c01f3e567b5 (pH scale)
6. https://nroer.gov.in/55ab34ff81fccb4f1d806025/file/5e79007216b51c232c3fb95b

(Hybridization)

7. https://chem.libretexts.org/Bookshelves/General_Chemistry/Map%3A_Principles_of_Modern_Chemistry_(Oxtoby_et_al.)/UNIT_3%3A_THE_STATES_OF_MATTER/09%3A_The_Gaseous_State
8. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5 – (PO2 -Physical Chemistry-1-Quantum Chemistry, MO2- Fundamentals of quantum mechanics-1)

SEMESTER II

UCCHB20 - GENERAL CHEMISTRY – II

Year: I	Course Code	Title of the Course	Course Type	Course Category	H/W	Credits	Marks
SEM: II	UCCHB20	General Chemistry	Theory	Core	6	5	100

Learning Objectives:

1. To throw light on alkali metals and their compounds, different types of bonding and its importance in inorganic compounds.
2. To understand the importance of VSEPR and MO theories.
3. To give a detailed knowledge on electron displacement effects and reaction intermediates, the mechanistic aspects of free radical substitution reactions in alkanes and addition reactions in alkenes and dienes.
4. To understand the properties of liquid crystals and solutions.

Course Outcomes:

The Learners will be able to

1. Illustrate the different types of bonds with examples and apply the knowledge of VSEPR theory to determine geometries of molecules.

2. Interpret the molecular orbital theory of homo and hetero nuclear diatomic molecules, compare the chemical and physical properties of alkali metals and their compounds and understand the chemistry of lithium.

3. Analyse and apply the electronic displacement effects, reactions, generation, structure and stability of reaction intermediates.

4. Examine and analyse the reactions and mechanisms of alkanes, alkenes, dienes and alkynes.

5. Analyse the laws and concepts of ideal and non ideal solutions, mesomorphic and colloidal states.

CO	PSO					
	1	2	3	4	5	6
CO1	H	M	H	H	H	H
CO2	H	M	H	H	H	H
CO3	H	M	H	H	H	H
CO4	H	M	H	H	H	H
CO5	H	M	H	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

Unit I: (18 hours)

1.1 Chemical bonding: Introduction- Types of bonds - Ionic, Covalent, and Coordinate bonds- characteristics and examples. (K1,K2, K3 &K4)

1.2. Ionic bond - conditions for the formation of ionic bond. (K1,K2, K3 &K4)

1.3. Characteristics and general properties, radius ratio rule and its limitation - Comparison of ionic and covalent bonds. (K1,K2, K3 &K4)

1.4. Hydration energy, lattice energy and their applications. (K1,K2, K3 &K4)

1.5. Born-Haber cycle – Hydrogen bond - Fajan's rule. (K1,K2, K3 &K4)

1.6. VSEPR theory- geometry of NH_3, H_2O, XeF_2, XeF_4, XeF_6, XeF_5^-, $XeOF_5^-$, XeF_8^{2-}, IF_7 and NH_4^+ . (K1,K2, K3 &K4)

Unit II: (18 hours)

2.1 Molecular orbital theory - Postulates of MOT, formation of bonding and antibonding molecular orbitals. (K1,K2, K3 &K4)

2.2 Bond order – Stability and magnetic property of the molecules. (K1,K2, K3 &K4)

2.3 MO diagrams of homo nuclear diatomic molecules H_2, O_2, O_2^+, N_2 and hetero nuclear diatomic molecules- CO, NO. (K1,K2, K3 &K4)

2.4 Chemical and physical properties of alkali metals, Comparative study of the elements andthe compounds of alkali metals- carbonates, oxides, hydroxides and halides. (K1,K2, K3 &K4)

2.5 Exceptional properties of lithium, diagonal relationship of lithium and magnesium. (K1,K2, K3 &K4)

2.6Lithium- occurrence, ores, extraction from phosphate and silicate ores and uses. Preparation, properties and uses of lithium carbonate. (K1,K2, K3 &K4)

Unit III: (18 hours)

3.1 Electron displacement effects- inductive effect- effect on bond length, dipole moment, reactivity of alkyl halides, strength of carboxylic acids and basic character of amines. (K1,K2, K3 &K4)

3.2 Electromeric effect, comparison with inductive effect, mesomeric effect, comparison with inductive effect. (K1,K2, K3 &K4)

3.3 Hyperconjugative effect and steric effect.(K1,K2, K3 &K4)

3.4 Bond fission- homolytic fission, heterolytic fission. Reaction intermediates- Carbocations – generation, structure, stability and reactions. (K1,K2, K3 &K4)

3.5 Generation, structure, stability and reactions of carbanions and free radicals. (K1,K2, K3 &K4)

3.6 Generation of benzyne, nitrenes and carbenes. (K1,K2, K3 &K4)

Unit IV: (18 hours)

4.1 Alkanes - chemical properties, mechanism of free radical reactions, halogenation of alkanes.(K1,K2, K3 &K4)

4.2 Alkenes - addition reactions of alkenes with hydrogen, halogens, hydrogen halides- Markownikoff's rule and anti Markownikoff's rule (peroxide effect), sulphuric acid, water. (K1,K2, K3 &K4)
4.3 Hydroboration, ozonolysis, hydroxylation with $KMnO_4$, allylic substitution by NBS. (K1,K2, K3 &K4)
4.4 Dienes - types, stability and 1,2 and 1,4 addition reactions - Diels –Alder reaction.(K1,K2, K3 &K4)
4.5 Alkynes- acidity of alkynes, formation of acetylides, addition reactions with water, hydrogen halides, halogens. (K1,K2, K3 &K4)
4.6 Alkynes- oxidation, ozonolysis and hydroxylation with $KMnO_4$. (K1,K2, K3 &K4)

Unit V: (18 hours)

5.1 Mesomorphic state - Liquid crystals – classification, thermotropic and lyotropic, Smectic, Nematic and Cholestric liquid crystals and the molecular arrangements and its applications.(K1,K2, K3 &K4)
5.2 Solutions - solutions of gases in liquids, Henry's law- solutions of liquids in liquids-Raoult's law, binary liquid mixtures, ideal solutions. (K1,K2, K3 &K4)
5.3 Deviations from ideal behaviour, vapour pressure-composition curves and boiling point, composition curves. (K1,K2, K3 &K4)
5.4 Distillation -types of distillation, fractional distillation, steam distillation, vacuum distillation, column distillation and azeotropic distillation. (K1,K2, K3 &K4)
5.5 Colloidal State - colloidal systems- classification of colloids, preparation of colloidal solutions, dispersion methods and condensation methods. (K1,K2, K3 &K4)
5.6 Properties of colloidal systems –Tyndall effect, importance and applications of colloids. (K1,K2, K3 &K4)

*Related problems to be worked out

Text Books:

1. R.D.Madan, Modern Inorganic Chemistry, 2nd Edition, S. Chand & Co., Reprint 2004.
2. B.SBahl and Arun Bahl, Advanced Organic Chemistry, Sultan Chand and Co.Ltd., Reprint 2008.
3. B. R. Puri, L. R Sharma and M.SPathania, Principles of Physical Chemistry, 43rd Edition, Vishal Publishing Co., 2008.

Reference Books:

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2. P.L Soni and H.M Chawla, Textbook of Organic Chemistry, 25th Revised Edition, Sultan Chand & Sons, 1992.

3. Arun Bahl and B.S.Bahl, Advanced Organic Chemistry, 1st Revised Multicolour Edition 2012.
4. M.K. Jain and S.C. Sharma, Modern Organic Chemistry, Vishal Publishing Co., New Delhi, Golden Jubilee Year Edition, 2017.
5. K.S Tewari and M.K Vishnoi, A Text book of Organic Chemistry, 3rd Edition, Vikas Publishing House Pvt. Ltd., 2006.
6. M.K. Jain and S.C. Sharma, Modern Organic Chemistry, Vishal Publishing Co, 2004.
7. P.L. Soni, O.P. Dharmarha and U.N. Dash, Textbook of Physical Chemistry, 21st Revised Edition, S. Chand & Co, Reprint 2000.
8. P.K Mani and A.O Thomas, A Textbook of Practical Chemistry, Scientific Publication, 1973.
9. O.P. Pandey, D. N. Bajpai and S.Giri, Practical Chemistry, 8th Edition, S. Chand & Co., 2001.

OER:

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5 – (P-05–Reaction intermediate)
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5 – (P-09- Organic Chemistry-III Reaction mechanism-2)
3. https://nroer.gov.in/55ab34ff81fccb4f1d806025/file/57cfec5816b51c6b39a8075f (Solutions)
4. https://nptel.ac.in/courses/104/103/104103071/(Molecular orbital theory)
5. https://nptel.ac.in/courses/104/103/104103069/ (VSEPR Theory)
6. https://chem.libretexts.org/Bookshelves/General_Chemistry/Book%3AChemistry_(OpenSTAX)/11%3A(Solutions_and_Colloids)

SEMESTER II

UCCHC20- PRACTICAL I: INORGANIC QUALITATIVE ANALYSIS

Year : I	Course Code	Title of the Course	Course Type	Course Category	H/W	Credits	Marks
SEM :II	UCCHC20	Inorganic Qualitative Analysis	Practical	Core	3	4	100

Course Outcomes

The Learners will be able to

1. Recall the principles of inorganic qualitative analysis.

2. Apply the concepts of semimicro analysis in inorganic qualitative analysis.

3. Develop skill to analyse systematically the given inorganic mixture and identify the acid and basic radicals.

4. Understand the importance of eliminating the interfering radical.

5. Eliminate the interfering acid radical for group separation and identification of basic radicals.

CO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	M	H	H	H	H
CO2	H	M	H	H	H	H
CO3	H	M	H	H	H	H
CO4	H	M	H	H	H	H
CO5	H	M	H	H	H	H

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

Analysis of a mixture containing two cations and two anions, one of which will be an interfering ion. Semi micro methods using the conventional scheme may be adopted.

Reactions of the following anions to be analysed:

carbonate, sulphide, sulphate, fluoride, chromate, bromide, chloride, nitrate, oxalate, phosphate and borate.

Reactions of the following cations to be analysed:

Lead, copper, cadmium, bismuth, aluminium, iron, manganese, zinc, cobalt, nickel, calcium, strontium, barium, magnesium and ammonium.

Text Books:

1. Departmental Under Graduate Laboratory Manual.
2. Dr. V. V. Ramanujam, Inorganic Semimicro Qualitative Analysis, National Publishing Company.

Reference Books:

1. Dr. O. P. Pandey, D. N. Bajpai, Dr. S. Giri, Practical Chemistry, S. Chand Ltd., Revised Edition, 2013.
2. Vogel's Text book of Qualitative Inorganic Analysis, Pearson, 7th Edition, 2012.

OER:

1. https://amrita.olabs.edu.in/?sub=73&brch=7&sim=180&cnt=515(Analysisof anions)
2. http://amrita.olabs.edu.in/?sub=73&brch=7&sim=31&cnt=1 (Analysisof cations)
3. http://web.mst.edu/~gbert/qual/qual.html (Analysisof cations)
4. https://nroer.gov.in/55ab34ff81fccb4f1d806025/file/58664a1e472d4a6379bd98a5 (Analysis of anions)
5. https://nroer.gov.in/55ab34ff81fccb4f1d806025/file/58664a74472d4a6379bd98c7 (Analysis of cations)

Continuous Assessment - 40 marks

I CA - 50

II CA - 50

Average - 25

Performance during regular practicals -10

Regularity in submission of observation note-book and record – 5

Semester Practical Examination - 60 marks

Viva-Voce	- 5
Record	- 10
Qualitative Analysis	- 45
Simple Acid Radical	- 8
Eliminating Radical	- 10
Each Basic Radical	- 9 (9 x 2 = 18)
Other tests	- 9
Total	**- 100**

(Note: For each radical spotting - 2 marks)

SEMESTER III

UCCHD20 - GENERAL CHEMISTRY – III

Year: II SEM: III	Course Code	Title of the Course	Course Type	Course Category	H/W	Credits	Marks
	UCCHD20	General Chemistry - III	Theory	Core	7	5	100

Learning Objectives:

1. To understand the principles of volumetric analysis.
2. To gain knowledge on alkaline earth metals and their compounds.
3. To learn the reactivity of cycloalkanes, carbonyl compounds, carboxylic acids, alcohols, ethers and epoxides.
4. To provide knowledge on solid-state chemistry.

Course Outcomes:

The Learners will be able to

1. Define and calculate equivalent weights and concentration terms and explain the principles of volumetric analysis, and illustrate the theories of different types of titrations and indicators.
2. Discuss the trend in periodicity of Beryllium, Boron and Carbon family elements and their compounds.

3.Describe the methods of preparation and properties of cycloalkanes, dicarboxylic acids and carbonyl compounds, and apply the concept of acidity and acid strength of carboxylic acids.

4. Describe the methods of preparation and properties of alcohols, ethers and epoxides.

5. Elaborate the basic concepts of solid-state chemistry including solid state defects and semiconductors.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	H	H	H	H
CO2	H	M	H	H	H	H
CO3	H	M	H	H	H	H
CO4	H	H	H	H	H	H
CO5	H	M	H	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

Unit I: (21 hours)

1.1 Definition of Mole, Molarity, Molality, Normality, Mole fraction, Equivalent Weights of acid, base, oxidizing agent, reducing agent and salt. (K1, K2, K3 & K4)

1.2 Volumetric analysis - principle, titrand, titrant, indicator, preparation of solutions and standardization of commercial acids. (K1, K2, K3 & K4)

1.3 Primary and secondary standards – characteristics and examples. Standardisation of solutions. (K1, K2, K3 & K4)

1.4 Theories of acid-base titrations, redox, complexometric and iodometric and iodimetric titrations. (K1, K2, K3 & K4)

1.5 Theories of acid-base, redox, metal ion and adsorption indicators, choice of indicators. (K1, K2, K3 & K4)

1.6 Types of errors, minimizing the errors, accuracy and precision, significant figures. (K1, K2, K3 & K4)

Unit II:(21 hours)

2.1 Alkaline earth metals - Be, Mg, Ca, Sr, Ba - occurrence, comparative study of elements and compounds- oxides, halides, hydroxides, sulphates and carbonates. (K1, K2, K3 & K4)

2.2 Exceptional properties of Beryllium –Diagonal relationship between Be and Al, extraction of magnesium. (K1, K2, K3 & K4)

2.3 p -block elements -Boron family-comparative study of elements and compounds- oxides, hydroxides, halides and hydrides. (K1, K2, K3 & K4)

2.4 Preparation, properties, uses and structures of $LiAlH_4$, $NaBH_4$, diborane and Borazole. (K1, K2, K3& K4)

2.5 Carbon family - comparative study of elements and compounds- hydrides, oxides and halides. (K1, K2, K3 & K4)

2.6 Classification of silicates, chemistry of silicones and their applications. (K1, K2, K3 & K4)

Unit III:(21 hours)

3.1 Cycloalkanes – preparation using Wurtz's reaction, Dieckmann's ring closure and reduction of aromatic hydrocarbons. (K1, K2, K3 & K4)

3.2 Substitution and ring opening reactions, Baeyer's strain theory, theory of strainless rings.(K1, K2, K3 & K4)

3.3 Carboxylic acid- ionization of carboxylic acids, acidity constants,comparison of acid strengths of substituted halo acids, acid strengths of substituted benzoic acids. Conversion of acids to their derivatives. (K1, K2, K3& K4)

3.4 Dicarboxylic acids- preparation and properties of oxalic, malonic, succinic, glutaric and adipic acids.(K1, K2, K3 & K4)

3.5 Carbonyl compounds- preparation from alcohols, alkene, alkyne, acid chloride, Grignard reagent, chemical reactions, relative reactivities of aldehydes and ketones. (K1, K2, K3 & K4)

3.6 Acidity of α-hydrogen, nucleophilic addition reactions (bisulphite, HCN, Grignard and alcohol). (K1, K2, K3 & K4)

Unit IV:(21 hours)

4.1 Alcohols - reactions of alcohols with Na, HX, esterification, oxidation with alk. $KMnO_4$, acidic dichromate, con HNO_3, catalytic dehydrogenation.(K1, K2, K3 & K4)

4.2 Dihydric alcohol -Glycol- preparation, properties and uses. (K1, K2, K3 & K4)

4.3 Trihydric alcohol - Glycerol- preparation, properties and uses.(K1, K2, K3 & K4)

4.4 Ethers- isomerism, preparation by Williamson synthesis, reactions of ethers. (K1, K2, K3 & K4)

4.5 Epoxides- preparation from alkene, ring opening reactions. (K1, K2, K3 & K4)

4.6 Reactionsof epoxides with alcohol, ammonia derivative and $LiAlH_4$.(K1, K2, K3 & K4)

Unit V:(21 hours)

5.1 The Solid State - difference between crystalline and amorphous solids, symmetry in crystal systems - elements of symmetry, space lattice, unit cell, Bravais lattices, law of rational indices and Miller indices. (K1, K2, K3 & K4)

5.2 X - ray diffraction – derivation of the Bragg's equation – experimental methods – Laue's method and powder method. (K1, K2, K3 & K4)

5.3 Types of crystals – characteristics of molecular, covalent, metallic and ionic crystals. (K1, K2, K3 & K4)

5.4 Three-dimensional close packing of spheres – ccp and hcp – characteristics of hcp, ccp and bcc structures, interstitial sites in closely packed arrangement of atoms – triangular, tetrahedral and octahedral sites, radius ratio rule and its effect on the shapes of ionic crystals, structures of ionic crystals-NaCl, CsCl, ZnS, Wurtzite, Fluorite and Rutile. (K1, K2, K3 & K4)

5.5 Imperfections in crystal systems – Schottky and Frenkel defects, metal excess and metal deficiency defects.(K1, K2, K3 & K4)

5.6 Semiconductors – band theory of solids, intrinsic semiconductors, extrinsic semiconductors - n-type and p-type semiconductors. (K1, K2, K3 & K4)

*Related problems to be worked out

Text Books:

1. R.D.Madan, Modern Inorganic Chemistry, 3rd Edition, S. Chand & Co., Reprint 2016.
2. B.S.Bahl and ArunBahl, Advanced Organic Chemistry, Sultan Chand and Co.Ltd., Reprint 2012.
3. B. R. Puri, L. R Sharma and M.S. Pathania, Principles of Physical Chemistry, 47th Edition, Vishal Publishing Co., 2017.

Reference Books:

1. P. L. Soni and Mohan Katyal, Textbook of Inorganic Chemistry, 20th Edition, Sultan Chand &Sons, Reprint 2015.
2. P. L. Soni and H. M. Chawla, Textbook of Organic Chemistry, 29th Revised Edition, Sultan Chand & Sons, 2012.
3. K. S. Tewari and M. K. Vishnoi, A Textbook of Organic Chemistry, 3rd Edition, VikasPublishing House Pvt. Ltd., 2015.
4. M.K. Jain and S.C. Sharma, Modern Organic Chemistry, Vishal Publishing Co., 2019.
5. P. L. Soni, O. P. Dharmarha and U. N. Dash, Textbook of Physical Chemistry, 23rd Revised Edition, S. Chand & Co., Reprint, 2016.
6. P.K. Mani and A.O. Thomas, A Textbook of Practical Chemistry, Scientific Publication, 1973.
7. O.P. Pandey, D. N. Bajpai and S.Giri, Practical Chemistry, 8th Edition, S. Chand & Co, 2016.
8. J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, Vogel's Textbook of Quantitative Inorganic Analysis-ELBS.
9. J.N. Gurtu, Solid State Chemistry, Second Edition, PragatiPrakashan Publishers, 2015.

Open Educational Resources (OER):

1. https://phet.colorado.edu/en/simulation/acid-base-solutions

2. https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Modules_and_Websites_(Inorganic_Chemistry)/Descriptive_Chemistry
3. https://chem.libretexts.org/Courses/Athabasca_University/Chemistry_360%3A_Organic_ChemistryII
4. https://www.khanacademy.org/science/chemistry/chemical-bonds
5. https://www.khanacademy.org/science/organic-chemistry/aldehydes-ketones

SEMESTER III

USCHA320 - SKILL BASED ELECTIVE: INDUSTRIAL CHEMISTRY

Year: II SEM:III	Course Code USCHA320	Title of the Course Industrial Chemistry	Course Type Theory	Course category Skill Based Elective	H/W 2	Credits 2	Marks 100

Learning Objectives:

1. To acquire an in depth knowledge on various areas of industrial chemistry like polymers, leathers, textile, fuels, glasses, ceramics, cements and paints.
2. To help the students enhance the reasoning skills and understand the working of industrial processes.

Course Outcomes:

The Learners will be able to

1. Discuss the composition, characteristics and manufacture of various industrial products. (Polymer, Leather, Textile, Glass, Ceramics, Cements, Paints and Pigments).
2. Explain the various process involved in the manufacture of leathers and leather products.
3. Describe the importance of natural and synthetic fibres in textile industry.
4. Understand the classifications of fuels and learn the common terms related to it.
5. Understand how to implement the conceptsin industrial working environment.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

Unit I: (6 Hours)

1.1 Introduction- terms involved in polymers. (K1 & K2)
1.2 Classification of polymers. (K1, K2& K3)
1.3 Polymerization, types of polymerization. (K1, K2 & K3)
1.4 Preparation, properties and uses of natural polymers. (K1 & K2)
1.5 Preparation, properties and uses of synthetic rubber- polyvinyl chloride, polyester, polyamide. (K1, K2 & K3)
1.6 Biodegradable polymers. (K1 & K2)

Unit II: (6 Hours)

2.1 Introduction-constituent of animal skin. (K1 & K2)
2.2 Preparation of hides for tanning. (K1 & K2)
2.3 Process - cleaning and soaking, liming and unhairing, deliming, bating and pickling. (K1, K2 & K3)
2.4 Leather tanning-vegetable and chrome tanning. (K1, K2 & K3)
2.5 Finishing process- dyeing and fat liquoring. (K1, K2 & K3)
2.6 Cleaner processing and practices in beam house, Effluent treatment (K1, K2 & K3)

Unit III: (6 Hours)

3.1 Introduction to textile fibres-Classificationof textile fibres. (K1 & K2)
3.2 Differences between natural and synthetic fibres. (K1 & K2)
3.3 Synthetic fibres- Preparation and properties of Rayon and Nylon. (K1, K2 & K3)
3.4 Textile chemical processing for the fibres-Singeing, de-sizing, scouring, bleaching, mercerization. (K1, K2, K3 & K4)
3.5 Textile dyes- difference between pigments and dyes. (K1 & K2)
3.6 Classification of dyes- vat dyes, Azo dyes, chrome dyes, Acid and base dyes. (K1 & K2)

Unit IV: (6 Hours)

4.1 Introduction- Classification of fuels. (K1 & K2)

4.2 Solid fuel-coal and coke- composition and properties. (K1 & K2)

4.3 Liquid fuel- Petroleum processing and fractions, Biofuels.(K1 & K2)

4.4 Cracking- catalytic cracking and methods-Knocking- octane number and cetane number. (K1, K2 & K3)

4.5 Synthetic petrol-Fischer Tropsch and Bergius processes. (K1, K2 & K3)

4.6 Fuel gases- Natural gas and Water gas. (K1 & K2)

Unit V: (6 Hours)

5.1 Glass- Raw materials- characteristics. (K1 & K2)

5.2 Methods of Manufacture- melting, shaping, annealing, finishing- special glasses. (K1, K2 & K3)

5.3 Refractories- characteristics, classification and properties. (K1 & K2)

5.4 General methods of manufacture of refractories. (K1, K2 & K3)

5.5 Cement- composition, setting of cement- crystalline and colloidal theory. (K1, K2 & K3)

5.6 Paints and pigments- Constituent of paints, pigments- white lead, ultramarine, Chrome yellow. (K1, K2 & K3)

References:

1. B.K. Sharma, Industrial Chemistry, Goel Publishing House, Meerut, 2016.
2. B.N.Chakrabarty, Industrial Chemistry, Oxford & IBH Publishing Co, New Delhi, 1981.
3. P.C. Jain, Monika Jain, Engineering Chemistry, Dhanpat Rai Publishing Co (P) Ltd, 2018.
4. K. SeshaMaheswaramma, MridulaChugh, Engineering Chemistry, Pearson Education India, 2016.
5. Thomas Bechtold, Tung Pham, Textile Chemistry, Walter de Gruyter GmbH & Co, 2019.
6. Jayashree Ghosh, A Textbook of Pharmaceutical Chemistry, S.Chand and Company Ltd., Reprint 2013.

Open Educational Resources (OER):

1. https://plastics.americanchemistry.com/How-Plastics-Are-Made/
2. http://wwwchem.uwimona.edu.jm/courses/CHEM2402/Textiles/Leather.html
3. http://www.petroleum.co.uk/
4. https://nios.ac.in/media/documents/313courseE/L34A.pdf

SEMESTER IV

UCCHE20 - GENERAL CHEMISTRY – IV

Year: II	Course Code	Title of the Course	Course Type	Course Category	H/W	Credits	Marks
SEM: IV	UCCHE20	General Chemistry - IV	Theory	Core	5	5	100

Learning Objectives:

1. To give in depth knowledge about nitrogen family, oxygen family, halogen family and zero group elements.
2. To learn the mechanistic details of electrophilic and nucleophilic substitution in aromatic compounds.
3. To gain knowledge on heterocyclic compounds and phenols.
4. To learn the laws of thermodynamics and their applications.

Course Outcomes:

The Learners will be able to

1. Explain the periodic properties of Nitrogen, Oxygen and Halogen family elements and their compounds, and reason out the position of noble gases in the periodic table and describe the preparation and properties of xenon compounds.
2. Illustrate the mechanisms of aliphatic, aromatic nucleophilic substitution and elimination reactions.
3. Recall and apply Huckel's rule, illustrate the preparation, properties and uses of heterocyclic compounds, dihydric and trihydric phenols, and related named reactions.
4. Define the terms involved in thermodynamics, the laws of thermodynamics and their developments.
5. Describe the concept of entropy and calculate the entropy changes during various processes, and to explain the third law of thermodynamics and its applications.

CO	PSO					
	1	2	3	4	5	6
CO1	H	M	H	H	H	H
CO2	H	M	H	H	H	H
CO3	H	H	H	H	H	H
CO4	H	M	H	H	H	H
CO5	H	M	H	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

Unit I: (15 hours)

1.1 Nitrogen family - preparations, properties and uses of hydrazine.(K1, K2 & K3)

1.2 Structure and properties of oxides, oxyacids of N (N_2O, NO, N_2O_5) and phosphorous (H_3PO_4, H_3PO_3, PCl_3, PCl_5). (K1, K2, K3 & K4)

1.3 Oxygen Family - comparative study of compounds- hydrides, halides, oxides and oxyacids.(K1, K2, K3& K4)

1.4 Halogens - comparative study of elements and compounds of halogens- hydracids, oxyacids and inter halogen compounds. Pseudo halogens- comparison of halogens and pseudo halogens.(K1, K2, K3& K4)

1.5 Noble gases - position in the periodic table, clathrates and their applications. (K1, K2, K3 & K4)

1.6 Preparation and properties of XeF_6, XeO_3 and $XeOF_4$. (K1, K2, K3 & K4)

Unit II:(15 hours)

2.1 Aliphatic Nucleophilic Substitution - mechanism of S_N1, S_N2, and $S_Ni$reactions. (K1, K2, K3 & K4)

2.2 Effect of structure of substrate, solvent, nucleophile and the leaving group.(K1, K2, K3& K4)

2.3 Aromatic nucleophilic substitution - benzyne and intermediate complex mechanism. (K1, K2, K3 & K4)

2.4 Effect of substituents on reactivity, orientation and reactivity in substituted benzenes. (K1, K2, K3 & K4)

2.5 Aromatic electrophilic substitution reactions in benzene and substituted benzenes-nitration, halogenation, sulphonation, Friedel-Craft's acylation and alkylation reactions.(K1, K2, K3& K4)

2.6 Elimination reaction- Hoffmann and Saytzeff's rules. cisandtranseliminations-mechanisms of E1 and E2 reactions, elimination vs substitution. (K1, K2, K3& K4)

Unit III:(15 hours)

3.1 Aromaticity – Huckel's rule and its applications. (K1, K2, K3 & K4)

3.2 Heterocyclic compounds - preparation, properties and uses of furan, thiophene and pyrrole. (K1, K2, K3 & K4)

3.3 Preparation, properties and uses of pyridine, quinoline and isoquinoline. (K1, K2, K3 & K4)

3.4 Phenols - acidic character of phenols, preparation, properties and uses of dihydric phenols.(K1, K2, K3 & K4)

3.5 Preparation, properties and uses of trihydric phenols. (K1, K2, K3 & K4)

3.6 Mechanisms of Kolbe's, Riemer-Tiemann, Gattermann, Mannich and Houben –Hoesch reactions. (K1, K2, K3 & K4)

Unit IV:(15 hours)

4.1 Thermodynamics - types of systems – isolated, closed, open, homogeneous and heterogeneous systems, phase, state of a system, state variables. Thermodynamic equilibrium - thermal, mechanical and chemical equilibria, extensive and intensive properties, processes and their types – isothermal, adiabatic and isobaric processes, reversible and irreversible processes, nature of work and heat. (K1, K2, K3 & K4)

4.2 The first law of thermodynamics - concept of internal energy, statements of I law, state functions, exact and inexact differentials, the Euler reciprocal relation, enthalpy of a system,

enthalpies of vaporization and fusion, heat capacity of a system - relationship between C_p and C_v in gaseous systems. (K1, K2, K3 & K4)

4.3 Calculation of w, ΔU, q and ΔH for expansion and compression of ideal gases under reversible and irreversible isothermal conditions. Adiabatic expansion – calculation of w, ΔU and ΔH, final temperatures in reversible and irreversible adiabatic expansions, Comparison of isothermal and adiabatic expansions. Zeroethlaw of thermodynamics. (K1, K2, K3 & K4)

4.4 Thermochemistry - heat of reaction, exothermic and endothermic reactions, relationship between q_p and q_v, standard enthalpy changes of reactions, standard enthalpies of combustion, neutralization and formation, determination of enthalpies of reactions, variation of enthalpy of reaction with temperature -Kirchhoff's equations. (K1, K2, K3 & K4)

4.5 Bond energies-definition, calculation and applications of bond energies. (K1, K2, K3 & K4)

4.6 The Second law of thermodynamics - need for the second law, statements of II law, spontaneous processes, Carnot's cycle - efficiency of a heat engine-Carnot's theorem (statement only). (K1, K2, K3 & K4)

Unit V:(15 hours)

5.1 Entropy – the concept of entropy, entropy changes in isothermal expansion of an ideal gas, in reversible and irreversible processes, entropy change accompanying change of phase. (K1, K2, K3 & K4)

5.2 Calculation of entropy changes with changes in T, V, and P, entropy changes in different processes, entropy of a mixture of ideal gases, entropy of mixing, physical significance of entropy. (K1, K2, K3 & K4)

5.3 Helmholtz and Gibbs free energy functions, variation of free energy change with T and P. Maxwell's relations, criteria for reversible and irreversible processes, Gibbs-Helmholtz equation. (K1, K2, K3 & K4)

5.4 Partial molar properties – concept of chemical potential, Gibbs-Duhem equation, variation of chemical potential with temperature and pressure, chemical potential in a system of ideal gases. (K1, K2, K3 & K4)

5.5 The Clapeyron-Clausius equation and its applications. (K1, K2, K3 & K4)

5.6 Third law of thermodynamics - Nernst heat theorem, statement of third law, determination of absolute entropies of solids, liquids and gases, residual entropy. (K1, K2, K3 & K4)

*Related problems to be worked out

Text Books:

1. R.D.Madan, Modern Inorganic Chemistry, 3rd Edition, S. Chand & Co., Reprint 2016.
2. B.S. Bahl, and ArunBahl, Advanced Organic Chemistry, Sultan Chand and Co. Ltd., Reprint 2012.
3. B. R. Puri, L. R Sharma and M. S. Pathania, Principles of Physical Chemistry, 47th Edition, Vishal Publishing Co., 2017.

Reference Books:

1. P.L. Soni and Mohan Katyal, Textbook of Inorganic Chemistry, 20th Edition, Sultan Chand & Sons, Reprint 2015.
2. B. R. Puri, L. R. Sharma and Kalia, K. C., Principles of Inorganic Chemistry, 33rd Edition, Shoban Lal, Nagin Chand &Co., 2019.
3. P. L. Soni and H. M. Chawla, Textbook of Organic Chemistry, 29th Revised Edition, Sultan Chand & Sons, 2012.
4. K. S. Tewari and M. K. Vishnoi, A Textbook of Organic Chemistry, 3rd Edition, Vikas Publishing house Pvt. Ltd., 2015.
5. M. K.Jain and S. C. Sharma, Modern Organic Chemistry, Vishal Publishing Co., 2019.
6. P.L. Soni. O. P. Dharmarha, and U.N. Dash, Textbook of Physical Chemistry, 23rd Revised Edition, S. Chand & Co., Reprint 2016.
7. J. Rajaram and J. C. Kuriakose, Thermodynamics, 3rd Edition, Vishal Publications, 2013.
8. J. N. Gurtu, Thermodynamics, 4thEdition, PragatiPrakashan, 2014.

Open Educational Resources (OER):

1. https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Book%3A_Chemistry_of_the_Main_Group_Elements_(Barron)
2. https://www.khanacademy.org/science/organic-chemistry/substitution-elimination-reactions
3. https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/intro1.htm
4. https://nptel.ac.in/courses/104/106/104106107/ (Thermodynamics)
5. https://www.khanacademy.org/science/chemistry/thermodynamics-chemistry

SEMESTER IV

UCCHF20 – PRACTICAL II:VOLUMETRIC ESTIMATION

Year: II	Course Code	Title of the Course	Course Type	Course Category	H/W	Credits	Marks
SEM: IV	UCCHF20	Volumetric Estimation	Practical	Core	3	4	100

Course Outcomes:

The Learners will be able to

1. Use double titration method in volumetric analysis.
2. Prepare standard solutions.
3. Apply volumetric principles to carry out acid-base titrations, complexometric titrations, precipitation titration and redox titrations like permanganometric, dichrometry and iodometric titrations.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	H	H	H	H
CO2	H	H	H	H	H	H
CO3	H	H	H	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	M	M	H
CO2	H	H	H	M	M	H
CO3	H	H	H	M	M	H

Acidimetry

1. Estimation of sodium hydroxide- standard sodium carbonate
2. Estimation of borax-standard sodium carbonate

Permanganometry

3. Estimation of oxalic acid- standard Mohr's salt or ferroussulphate
4. Estimation of sodium nitrite- standard oxalic acid
5. **Estimation of Calcium
6. **Determination of percentage of Manganese dioxide in Pyrolusite

Iodometry

7. Estimation of copper-standard copper sulphate
8. Estimation of potassium dichromate- standard potassium dichromate

Complexometry

9. Estimation of magnesium using EDTA
10. Estimation of nickel using EDTA
11. *Estimation of temporary and permanent hardness of water

Dichrometry

12. Estimation of ferrous ion using diphenylamine/ N-phenyl anthranilic acid as indicator

Precipitation titration

13. *Estimation of chloride in neutral medium

* & **Not to be given for examination.

** To be given as a group experiment.

Continuous Assessment - 40 marks

I C.A. - 50
II C.A. - 50
Average - 25
Performance during regular practicals-10
Regularity in submission of observation note-book and Record - 5

Semester Practical Examination - 60 marks

Short Procedure writing - 5
Viva-voce -5
Record -10

Volumetric Analysis:
≤ 2% - 40 marks
> 1 upto 2% - 35 marks
>2 upto 3% -25 marks
>3 upto 4% -15 marks
> 4% -10 marks

Reference Books:

1. A. I. Vogel, Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, Longman Scientific & Technical, 1989.
2. Peter A C McPherson, Practical Volumetric Analysis, 4th Edition, Cambridge: The Royal Society of Chemistry, 2015.

Open Educational Resources (OER):

1. http://rohmatchemistry.staff.ipb.ac.id/files/2015/07/vogels-textbook-of-quantitative-chemical-analysis.pdf

SEMESTER 1V

USCHB420 - SKILL BASED ELECTIVE: AGRICULTURAL CHEMISTRY

Year: II SEM: IV	Course Code USCHB420	Title of the Course Agricultural Chemistry	Course Type Theory	Course Category Skill Based	H/ W 2	Credits 2	Marks 100

Learning Objectives:

1. To impart elementary ideas of soil chemistry, types of farming, insecticides, fungicides and herbicides.

2. To emphasize the importance of fertilizers.

Course Outcomes:

The Learners will be able to

1. Understand the scope of agriculture in India and Tamil Nadu.
2. Explain the physical and chemical properties of soil.
3. Describe the types of farming.
4. Summarize the certification of organic products.
5. Identify the benefits and adverse effects of pesticides.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

Unit I: (6 Hours)

1.1 Agriculture – Definition – Scope of agriculture in India and Tamil Nadu. (K1 & K2)

1.2 Branches of agriculture. (K1 & K2)

1.3Agronomy – Art, Science and business of crop production. (K1 & K2)

1.4 Agronomical classification of crops - their importance. (K1 & K2)
1.5 Major crops of India and Tamil Nadu, Water resources in Tamil Nadu. (K1 & K2)
1.6Factors affecting crop production – Moisture, aeration, light, temperature and nutrients. (K1 & K2)

UnitII:(6 Hours)

2.1 Soil chemistry – Introduction, soil classification and survey. (K1 & K2)
2.2 Properties of soil – soil texture and soil water. (K1 & K2)
2.3 Soil temperature and soil colloids. (K1 & K2)
2.4 Soil minerals and soil pH. (K1 & K2)
2.5 Soil acidity – alkalinity and buffering soil. (K1 & K2)
2.6 Soil fertility and soil formation. (K1 & K2)

Unit III: (6 Hours)

3.1 Farming – types – subsistence farming and commercial farming. (K1 & K2)
3.2 Plantation farming, mixed farming and conventional farming. (K1 & K2)
3.3 Organic farming, poultry farming and dairy farming. (K1 & K2)
3.4 Advantages of organic farming- limitation of organic farming. (K1 & K2)
3.5 Certification of organic products – OFAI organic labeling system. (K1 & K2)
3.6 Research findings on organic food. (K1 & K2)

Unit IV: (6 Hours)

4.1 Insecticides, Fungicides and Herbicides - Introduction. (K1 & K2)
4.2 Methods of using pest controls. (K1 & K2)
4.3 Insecticides – Arsenic compounds, fluorine compounds and boron compounds. (K1 & K2)
4.4 Insecticides- mercury compounds, copper compounds and sulphur compounds. (K1 & K2)
4.5 Modern insecticides – some important herbicides -Rodenticides. (K1 & K2)
4.6 Benefits of Pesticides, Adverse environmental effects of Pesticides. (K1 & K2)

Unit V: (6 Hours)

5.1 Fertilizers – Classification- Examples of fertilizers. (K1 & K2)
5.2 Nitrogenous fertilizers- phosphate fertilizers- potash fertilizers. (K1 & K2)
5.3 Ill effects of fertilizers. (K1 & K2)
5.4 Manures, compost and saw dust. (K1 & K2)
5.5 Farmyard manure, compost, reinforcing manure and green manure. (K1 & K2)
5.6 Sewage and sludge - biogas production. (K1 & K2)

References:

1. Sankaran, S. and V.T. Subbiah Mudaliar. Principles of Agronomy. The Bangalore Printing and Publishing Co. Ltd., Bangalore. 1997
2. Principles and Practices of Agronomy. Agrobios. Jodhpur - 342 002.
3. Jayashree Ghosh. Fundamental Concepts of Applied Chemistry. S. Chand Publishing Ltd.,

2006.
4. Kirpal Singh. Chemistry in Daily life 1st Edition, Prentice Hall of India Pvt. Ltd., 2008.

Open Educational Resources (OER):

1. https://nptel.ac.in/courses/126/105/126105016/
2. https://nptel.ac.in/courses/126/105/126105016/
3. https://nptel.ac.in/content/storage2/courses/103107086/module1/lecture1/lecture1.pdf
4. https://nptel.ac.in/courses/126/105/126105014/

SEMESTER V

UCCHG20 - INORGANIC CHEMISTRY

Year: III SEM: V	Course Code UCCHG20	Title of the Course Inorganic Chemistry	Course Type Theory	Course Category Core	H/W 4	Credits 4	Marks 100

Learning Objectives:

1. To discuss in detail the general characteristics of d block and f block elements, make a comparative study of a few group elements and the metallurgy of certain elements and compounds.
2. To make an in-depth study on nuclear chemistry.
3. To introduce the field of bioinorganic chemistry.

Course Outcomes:

The Learners will be able to

1.Discuss the general characteristics of d and f block elements, and compare the properties of elements belonging to Ti, V, Cr, Mn and Fe groups.

2.Summarize the various steps involved in metallurgical processes, and illustrate the preparation, properties and uses of Ti, Zr, U, Pt and Th.

3. Recall the basic concepts of nuclear chemistry, and to explain the stability of nuclides by n/p ratio, mass defect and binding energy, packing fraction, magic numbers and natural radioactivity.

4. Explain nuclear transmutation reactions, artificial radioactivity, nuclear fission and fusion reactions.

5. Describe the biological importance of certain elements, chelate therapy, radio pharmaceuticals, contrast agents and toxicity of few metals.

CO	PSO					
	1	2	3	4	5	6
CO1	H	L	H	H	H	H
CO2	H	L	H	H	H	H
CO3	H	L	H	H	H	H
CO4	H	L	H	H	H	H
CO5	H	L	H	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	M	M	H
CO2	H	H	H	M	M	H
CO3	H	H	H	M	M	H
CO4	H	H	H	M	M	H
CO5	H	H	H	M	M	H

Unit I: (12 Hours)

1.1 d-block elements - general characteristics of d block elements. (K1, K2, K3 & K4)
1.2 Group discussion of d-block elements - titanium, vanadium and chromium groups - electronic configuration, occurrence, oxidation states, reactivity, magnetic properties, catalytic properties, colour and comparative study of their compounds. (K1, K2, K3 & K4)
1.3 Comparative account of manganese and iron groups - electronic configuration, occurrence, oxidation states, reactivity, magnetic properties, catalytic properties, colour and comparative study of their compounds. (K1, K2, K3 & K4)
1.4 f-block elements – position in the periodic table, general characteristics of lanthanides - occurrence, electronic configuration, oxidation states, ionic radii – lanthanide contraction, colour, spectra, magnetic properties and formation of complexes. (K1, K2, K3 & K4)
1.5 General characteristics of actinides - occurrence, electronic configuration, oxidation states, ionic radii - actinide contraction, colour, spectra, magnetic properties and formation of complexes. (K1, K2, K3 & K4)
1.6 Comparative account of lanthanides and actinides. (K1, K2, K3 & K4)

Unit II:(12 Hours)

2.1 Principle and processes of metallurgy – minerals and ores, occurrence of metals in nature, various steps of metallurgy – various ore-dressing methods, calcination, roasting, various reduction and refining methods. (K1, K2, K3 & K4)
2.2 Titanium, Zirconium and Platinum – occurrence, extraction, properties and uses. (K1, K2, K3 & K4)
2.3 Uranium – occurrence, extraction from pitchblende - acid and alkali digestion processes, extraction from carnotite, properties and uses. (K1, K2, K3 & K4)
2.4 Chemistry of Thorium – occurrence, extraction from monazite sand, properties and uses. (K1, K2, K3 & K4)
2.5 Preparation and uses of ammonium molybdate, vanadium pentoxide, uranium hexa fluoride. (K1, K2, K3 & K4)
2.6 Heat treatment of steel, uses of steel alloys. (K1, K2, K3 & K4)

Unit III:(12 Hours)

3.1 Nuclear chemistry - sub atomic particles of the nucleus, nucleon terminology, classification of nuclides – based on Z and N values - isotopes, isobars, isotones, mirror nuclei and isomers – based on stability. (K1, K2, K3 & K4)
3.2 Theories of nuclear forces operating between the nucleons inside the nucleus – meson theory and nuclear fluid theory. (K1, K2, K3 & K4)

3.3 Stability of nuclides - odd-even nature of Z and N values, N/P ratio - stability belt, packing fraction, mass defect and nuclear binding energy - calculations involving mass defect and B.E per nucleon. (K1, K2, K3 & K4)
3.4 Liquid drop model, shell model- magic numbers. (K1, K2, K3 & K4)
3.5 Natural radioactivity - general properties of radioactive radiations, properties of alpha, beta and gamma rays, modes of radioactive decay, group displacement law, rate of disintegration and half-life period. (K1, K2, K3 & K4)
3.6 Radioactive series – uranium, thorium, actinium and neptunium series – similarities between radioactive series. (K1, K2, K3 & K4)

Unit IV:(12 Hours)

4.1 Nuclear transmutation – introduction, Bohr's theory of nuclear reactions, classification of nuclear reactions – based on overall energy transformation. (K1, K2, K3 & K4)
4.2 Classification of nuclear reactions – based on the nature of the bombarding particles, nuclear reactions versus chemical reactions. (K1, K2, K3 & K4)
4.3 Artificial radioactivity - discovery, reactions emitting electrons and positrons, preparation of trans-uranium elements. (K1, K2, K3 & K4)
4.4 Nuclear fission – definition, reaction, Q-value, mechanism, uses - atom bomb, nuclear reactor and its components, breeder reactor. (K1, K2, K3 & K4)
4.5 Nuclear fusion – definition - thermonuclear reactions, uses – stellar energy, hydrogen bomb. (K1, K2, K3 & K4)
4.6 Comparison of fission and fusion, atom bomb and hydrogen bomb. (K1, K2, K3 & K4)

Unit V: (12 Hours)

5.1 Bioinorganic Chemistry – micro and macro nutrients, biological aspects of Fe, Co and Zn. (K1, K2, K3 & K4)
5.2 Biological role of Mg, P and Mo. (K1, K2, K3 & K4)
5.3 Biological importance of Na, K and Ca. (K1, K2, K3 & K4)
5.4 Biological importance of copper, sulphur, iodine and selenium. (K1, K2, K3 & K4)
5.5 Inorganic medicinal chemistry - radio pharmaceuticals, chelate therapy, and contrast agents in MRI. (K1, K2, K3 & K4)
5.6 Toxicity of metals – As, Hg, Cd, Pb and Cr toxic effects. (K1, K2, K3 & K4)

Text Books:

1. R. D. Madan, Inorganic Chemistry, 2nd Edition, S. Chand & Co., Reprint 2004.
2. Puri and Sharma Nagin, Inorganic Chemistry, 9th Edition, Sultan Chand & Co., 1979.
3. P.L. Soni, Inorganic Chemistry, 4th Edition, Sultan Chand & Co., 1991.

ReferenceBooks:

1. J.D. Lee, Concise Inorganic Chemistry, 3rd Edition, Von Nostrand, 1997.
2. Cotton and Wilkinson, Advanced Inorganic Chemistry, 5th Edition, Wiley Eastern Ltd., 1988.
3. A. K. De, A Textbook of Inorganic Chemistry, New Age-8th Edition, Wiley Eastern Ltd., 2001.
4. Shriver and Atkins, Inorganic Chemistry, 5th Edition, Wiley Eastern Ltd., 2005.
5. A. K. Srivastava& P. C. Jain, Elements of Nuclear Chemistry, 2nd Edition, S.Chand&Co., 1989.

6. S. Glasstone, Sourcebook on Atomic Energy, 3rd Edition, East- West Press Pvt. Ltd.,1967.
7. H. J. Arnikar, Essentials of Nuclear Chemistry, 3rd Edition, Wiley Eastern Limited, 1990.
8. Shamsuddin M, Physical Chemistry of Metallurgical Processes, 1st Edition, John Wiley, 2016.

Open Educational Resources (OER):

1. https://nptel.ac.in/courses/104/101/104101121/(Extraction of Metals)
2. https://www.khanacademy.org/science/chemistry/nuclear-chemistry
3. http://eacharya.inflibnet.ac.in/index.php/content/index/5a3a00708007be612465cb92 (Biological importance of elements)
4. http://eacharya.inflibnet.ac.in/index.php/content/index/5a3a00708007be612465cb93 (Toxicity of metals)

SEMESTER V
UCCHH20- ORGANIC CHEMISTRY

Year: III SEM: V	Course Code	Title of the Course	Course Type	Course Category	H/W	Credits	Marks
	UCCHH20	Organic Chemistry	Theory	Core	4	4	100

Learning Objectives:

1. To acquire knowledge on active methylene compounds, organic photochemistry and mechanisms of certain named reactions.
2. To give a broad outline of stereochemistry and conformational analysis.
3. To learn the mechanisms of molecular rearrangements.

Course Outcomes:

The Learners will be able to

1. Remember the concepts of stereoisomerism and apply it in identifying the configurations of the optical and geometrical isomers.
2. Illustrate tautomerism and conformational analysis.
3. Explain the preparation and synthetic uses of active methylene compounds, basic concepts of organic photochemistry and illustrate organic photochemical reactions.
4. Apply the knowledge of various named reactions in organic synthesis.
5. Summarize the different types of molecular rearrangements their mechanisms and applications.

CO	PSO					
	1	2	3	4	5	6
CO1	H	M	H	H	H	H
CO2	H	M	H	H	H	H
CO3	H	M	H	H	H	H
CO4	H	M	H	H	H	H
CO5	H	M	H	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

Unit I: (12 **Hours)**

1.1 Stereoisomerism: Optical isomerism – conditions for optical activity. Projection formulae: Fischer, Flying wedge, Sawhorse and Newmann projection formulae. (K1,K2,K3&K4)

1.2 Cahn –Ingold – Prelog rules, R-S notations for optical isomers with one and two asymmetric carbon atoms. (K1,K2,K3&K4)

1.3 Optical activity in compounds not containing asymmetric carbon atoms – biphenyls (atropisomerism), allenes and spiranes. (K1,K2,K3&K4)

1.4 Geometrical isomerism: cis - trans, syn - anti and E-Z notations.(K1,K2,K3&K4)

1.5 Geometrical isomerism in maleic and fumaric acids and unsymmetrical ketoximes.(K1,K2,K3&K4)

1.6 Methods of distinguishing geometrical isomers using chemical and physical methods – cyclisation, by converting into compounds of known configuration, method of optical

activity, acid strengths, dipole moment, melting point, boiling point, solubility, density, refractive index. (K1,K2,K3&K4)

Unit II: (12 Hours)

2.1 Tautomerism – definition, cause of tautomerism, acidity of alpha hydrogen, reasons for acidity. (K1,K2,K3&K4)

2.2 Keto- enol tautomerism- evidences in favour of the keto and enol form, enolisation- acid - base catalysed mechanisms. (K1, K2, K3& K4)

2.3 Nitro-acinitro tautomerism and amido-imidol tautomerism – evidences. (K1,K2,K3&K4)

2.4 Conformational analysis- conformational analysis of ethane including energy diagrams. (K1,K2,K3&K4)

2.5 Conformational analysis of n- butane including energy diagrams. (K1,K2,K3&K4)

2.6 Conformers of cyclohexane – axial and equatorial bonds, ring flipping showing axial equatorial inter conversions, conformers of mono and di substituted cyclohexanes – 1,2 and 1,3 interactions.(K1, K2, K3& K4)

Unit III:(12 Hours)

3.1 Active methylene group – characteristic reactions of active methylene groups in acetoacetic ester and its uses.(K1,K2,K3&K4)

3.2 Characteristic reactions ofmalonicester and cyano acetic esters and their synthetic uses.(K1,K2,K3&K4)

3.3 Basic concepts of organic photochemistry.(K1,K2,K3&K4)

3.4 Photochemistry of carbonyl compounds –Norrish type I and II reactions. (K1,K2,K3&K4)

3.5 Photo reduction, photo addition. (K1,K2,K3&K4)

3.6 Photochemical rearrangement (di-pi methane rearrangement), Paterno- Buchi reaction, Barton reaction and Photo Fries reaction. (K1,K2,K3&K4)

Unit IV: (12 Hours)

4.1 Reaction Mechanisms – mechanism and applications of Aldol, Benzoin and Claisen condensations.(K1, K2, K3& K4)

4.2 Darzencondensation,Cannizaro, Reformatsky and Perkinreactions – mechanism and applications.(K1, K2, K3& K4)

4.3 Michealaddition,Knoevenagal and haloform reactions– mechanism and applications.(K1, K2, K3& K4)

4.4 Dakin, Wittig and Dieckmann reactions – mechanism and applications.(K1, K2, K3& K4)

4.5 Mechanism of reduction with $NaBH_4$ and $LiAlH_4$.(K1, K2, K3& K4)

4.6 Wolf Kishner and MPV reduction – mechanism and applications.(K1, K2, K3& K4)

Unit V: (12 Hours)

5.1 Molecular rearrangements – classification as aniontropic, cationotropic and inter molecular, intra molecular. (K1, K2, K3& K4)

5.2 Mechanism, evidence for carbonium ion intermediate formation, migratory aptitude, inter / intra molecular rearrangement. Migration to electron deficient carbon atom – Pinacol-Pinacolone rearrangement .(K1, K2, K3& K4)

5.3 Rearrangement involving electron deficient nitrogen atom- Beckmann rearrangement, migration to electron deficient oxygen – Baeyer Villiger oxidation. (K1, K2, K3& K4)

5.4 Rearrangement of aromatic compounds- benzidine rearrangement.(K1, K2, K3& K4)

5.5 Rearrangements involving sigmatropic shifts – Claisen and Paraclaisenrearrangement.(K1, K2, K3& K4)

5.6 Rearrangements to electron rich carbon atom – Favorskiirearrangements.(K1, K2, K3& K4)

Text Books:

1. B.S. Bahl and Arun Bahl, Advanced Organic Chemistry, 5th Edition, Sultan Chand &Co., 2014.
2. K.S.Tewari, S.N.Mehrotra,K.Vishnoi, A Text book of Organic Chemistry,Vikas Publishing House, Reprint, 2017.
3. P.L.Soni, Text book of Organic Chemistry, Sultan and Chand, Reprint, 2019.
4. M.K. Jain and S.C.Sharma, Modern Organic Chemistry, S. Chand & Co, Reprint, 2019.

Reference Books:

1. O.P Agarwal, Organic Chemistry, Reactions and Reagents, 55th Edition, GOEL Publishing House, 2017.
2. P.S Kalsi, Stereo Chemistry, Conformations and Mechanisms, New Age International Pvt. Ltd., 10th Edition, 2019.
3. D. Nasipuri, Stereochemistry of Organic Compounds – Principles and Applications, New Age International, 3rd Edition, 2011.
4. Gurdeep R. Chatwaal, Reaction Mechanism and Reagents in Organic Chemistry, 4th Edition, Himalaya Publishing House, 2005.
5. R.T.Morrison and Boyd, Organic Chemistry, 6thEdition, Prentice Hall India Pvt. Ltd., 2001.
6. I.L. Finar, Organic Chemistry, Vol I, 5th Edition, Addison Wesley, 2000.
7. Jerry March, Reaction Mechanism and Structure, 4th Edition, John Wiley and Sons, 1992.
8. A.K.Bansal, A Textbook of Organic Chemistry, New Age International Pvt. Ltd., 1990.
9. Peter Sykes, A Guidebook to Mechanism in Organic Chemistry, 6th Edition, 1988.

Open Educational Resources (OER):

1. Infowledge -https://www.youtube.com/watch?v=h0rUn2jzGjs(R and S)
2. Infowledge - https://www.youtube.com/watch?v=w74NxOkvXg8(E and Z)
3. Infowledge -https://www.youtube.com/watch?v=A5ROLfgxFFw(Tautomerism)
4. Infowledge -https://www.youtube.com/watch?v=MDa-waAbJ30(Tautomerism)
5. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5PO9(Conformational analysis)
6. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5PO1(Named reactions)

SEMESTER V

UCCHI20– PHYSICAL CHEMISTRY

Year: III SEM: V	Course Code UCCHI20	Title of the Course Physical Chemistry	Course Type Theory	Course Category Core	H/W 5	Credits 4	Marks 100

Learning Objectives:

1. To understand the importance of chemical kinetics and the theories on reaction rates, catalysis and adsorption.
2. To gain knowledge about photophysical and photochemical processes.
3. To understand the applications of phase rule through the study of one component and two component systems.
4. To gain an understanding on catalysis, adsorption and enzyme catalysis.

Course Outcomes:

The Learners will be able to

1. Demonstrate the plausible mechanisms based on the study ofthekinetics of chemical reactions.
2. Describe the theories developed to understand the reaction kinetics of simple andcomplexreactions.
3. Explain the basic principles of photochemistry,deduce rate laws of photochemical reactions and discuss the applications of photo physical processes.
4. Apply Phase rule to study one component and two component systems and interpret phase diagrams.
5. Apply the knowledge gained about catalysis and adsorption to deduce the kinetics of homogeneous and heterogeneous surface reactions.

CO	PSO					
	1	2	3	4	5	6
CO1	H	M	H	H	H	M
CO2	H	M	H	H	H	M
CO3	H	M	H	H	H	M
CO4	H	M	H	H	H	M
CO5	H	M	H	H	H	M

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	M	M	H
CO2	H	H	H	L	M	H
CO3	H	H	H	M	M	H
CO4	H	H	H	L	M	H
CO5	H	H	H	M	M	H

Unit I: (15 Hours)

1.1 Chemical Kinetics – scope of chemical kinetics, rate, rate constant and rate law. Factors that affect the rate of the reaction. Measurements of reaction rates.Order and molecularity of chemical reactions- Differences between order and molecularity. Methods to determine the rate of the reactions.(K1,K2,K3 & K4)

1.2 Derivation of rate constants of first, second, third and zero order reactions and derivation for time for half change.(K1,K2,K3 & K4)

1.3 Examples of first, second, third and zero order reactions and study of kinetics of hydrolysis of ester, inversion of cane sugar, decomposition of H_2O_2, thermal decomposition of acetaldehyde and gaseous reactions involving NO. (K1,K2,K3 & K4)

1.4 Methods to determine the order of chemical reactions – Integration method, Graphical method, Vant Hoff differential method, Method using half life period and Ostwald's dilution method.(K1,K2,K3 & K4)

1.5 Experimental methods in the study of kinetics of reactions- Volumetry, Manometry, Polarimetry, Dilatometry and Colorimetry. (K1,K2,K3 & K4)

1.6 Effect of temperature on the rate of reactions –Arrhenius equation and concept of energy of activation.(K1,K2,K3 & K4)

Unit II:(15 Hours)

2.1 The Collision theory of bimolecular reactions and derivation of rate constant.(K1,K2,K3 & K4)

2.2 Theory of unimolecular reactions- Lindemann's theory, draw backs of collision theory.(K1,K2,K3 & K4)

2.3 Theory of Absolute Reaction Rates based on thermodynamics. Derivation for the rate constant of a bimolecular reaction based on ARRT.(K1,K2,K3 & K4)

2.4 Comparison of Collision theory and ARRT.(K1,K2,K3 & K4)

2.5 Significance of entropy, enthalpy and free energy of activation and determination of ΔG^*, ΔH^* and ΔS^*.(K1,K2,K3 & K4)

2.6 Complex reactions: types – consecutive, parallel, reversible and chain reactions (no derivation, only examples). (K1,K2,K3 & K4)

Unit III:(15 Hours)

3.1 Photochemistry- differences between thermal and photochemical reactions. Laws of light absorption – Beer's law and Beer Lambert's law. (K1,K2,K3 & K4)

3.2 Laws of photochemistry – Grotthus Draper's law and Stark Einstein's law. (K1,K2,K3 & K4)

3.3 Jablonski diagram –singlet and triplet states, qualitative description of fluorescence and phosphorescence. (K1,K2,K3 & K4)

3.4 Primary and secondary reactions – quantum yield – experimental determination by using Eder's and Uranyl oxalate actinometers. (K1,K2,K3 & K4)

3.5 Kinetics of Hydrogen – Bromine reaction, photolysis of aldehyde- Rice Herzfeld mechanism. (K1,K2,K3 & K4)

3.6 Photosensitization, chemiluminescence and biochemiluminescence. (K1,K2,K3 & K4)

Unit IV: **(15 Hours)**

4.1 Phase equilibria – Gibbs phase rule –statement, definition of terms and derivation of phase rule.(K1,K2,K3 & K4)

4.2 One component systems – water system and sulphursystem. (K1,K2,K3 & K4)

4.3 Reduced phase rule – two component systems: Pb – Ag system, desilverization of Pb-Pattinson's process. Thermal analysis and cooling curves. (K1,K2,K3 & K4)

4.4 Compound formation with congruent melting point: Zn-Mg system and $FeCl_3$-H_2O system, Freezing mixtures. (K1,K2,K3 & K4)

4.5 Incongruent melting point: Na-K system. (K1,K2,K3 & K4)

4.6 CST and effect of impurity on Phenol – Water system.(K1,K2,K3 & K4)

Unit V:**(15 Hours)**

5.1 Catalysis-definition and characteristics of a catalyst –homogeneous catalysis-function of a catalyst in terms of Gibbs free energy of activation.(K1,K2,K3 & K4)

5.2 Heterogeneous catalysis- Mechanisms of surface reactions –Simple decompositions on surfaces - Kinetics of unimolecular surface reactions-Langmuir Hinshelwood mechanism.(K1,K2,K3 & K4)

5.3 Enzyme catalysis- characteristics of enzymes. Derivation of Michaelis Mentonequation.(K1,K2,K3 & K4)

5.4 Adsorption – physisorption and chemisorption -differences. (K1,K2,K3 & K4)

5.5 Freundlich adsorption isotherm - Langmuir adsorption isotherm. (K1,K2,K3 & K4)

5.6 BET equation (no derivation) - applications of adsorption. (K1,K2,K3 & K4)

Text Books:

1. B. R. Puri, L. R Sharma and M.S. Pathania, Principles of Physical Chemistry, 47th Edition, Vishal Publishing Co., 2017.
2. P.L.Soni, Textbook of Physical Chemistry, Sultan Chand & Co., Reprint 2000.
3. Negi and Anand, Physical Chemistry, 2nd Edition, New Age copy right, Eastern Wiley Pvt. Ltd., 1985.
4. Kundu and Jain, Physical Chemistry, 2nd Edition, S.Chand&Co., 1987.

Books for Reference:

1. S.Glasstone, A Textbook of Physical Chemistry, 5thEdition, MacMillan (India) Ltd, New Delhi, Reprint1978.
2. G.W.Castellan,Physical Chemistry, 3rd Edition, Addison-Wesley, 1983.
3. Walter J.Moore, Physical Chemistry, 5th Edition Prentice Hall, 1972.
4. Jainudeen, Chemical Kinetics and Photochemistry, 1st Edition, Jazeeme Publication, 1982.
5. Gurtu, Phase Rule, 2nd Edition, Pragathi Prakash Publications, 1972.
6. Laidler, K.J, Chemical Kinetics, 3rd Edition, Harper and Row, 1987.
7. Dogra, S. K., and Dogra S, Physical Chemistry through Problems, Wiley Eastern Ltd., 1984.
8. J. Rajaram and J.C. Kuriacose, Kinetics and Mechanism of Chemical Transformations. Mac Millan India Ltd., 1993.

Open Educational Resources (OER):

1. https://www.khanacademy.org/science/chemistry/chem-kinetics(20 videos)
2. https://ocw.mit.edu/courses/chemistry/5-111sc-principles-of-chemical-science-fall-2014/unit-v-chemical-kinetics/lecture-30/
3. https://application.wiley-vch.de/books/sample/3527316728_c01.pdf

SEMESTER V - MAJOR ELECTIVE1 A
UECHA20- ANALYTICAL CHEMISTRY

Year: III SEM: V	Course Code UECHA20	Title of the Course Analytical Chemistry	Course Type Theory	Course Category Core	H/W 5	Credits 5	Marks 100

Learning Objectives:

1. To learn the principles behind gravimetric analysis.
2. To acquire anin depth knowledge on the principle, instrumentation, working and applications of NMR, IR, Raman, UV-Visible, Raman and Mass Spectroscopy.

Course Outcomes:

The Learners will be able to

1. Summarize the various steps involvedin gravimetric analysis.
2. Demonstrate the principles and techniques involved in paper, column, TLC and ion exchange chromatography and their applications.
3. Explain the absorption laws, instrumentation and working of UV-Visible spectrophotometers.
4. Elaborate the principle, instrumentation of IR spectroscopy for the identification of simple organic molecules.
5. Explain the principle involved in NMR and interpret NMR spectra of simple organic compounds,describe the principle, instrumentation of Mass spectroscopy and determine the molecular formulae of simple organic molecules.

CO	PSO					
	1	2	3	4	5	6
CO1	H	M	H	H	H	H
CO2	H	M	H	H	H	H
CO3	H	M	H	H	H	H
CO4	H	M	H	H	H	H
CO5	H	M	H	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

Unit I: (15 Hours)

1.1 Principles of gravimetric analysis–characteristics of precipitating agents, choice of precipitants and conditions of precipitation.(K1, K2, K3 & K4)

1.2 Organic precipitants, specific and selective precipitants.(K1, K2, K3 & K4)

1.3 Steps in gravimetric analysis- sequestering agents, co-precipitation-mechanism of co-precipitation.(K1, K2, K3 & K4)

1.4 Post precipitation,differences between co precipitation and post precipitation.(K1, K2, K3 & K4)

1.5 Solubility product and precipitation- reduction of error-precipitation from homogeneous solutions.(K1, K2, K3 & K4)

1.6 Types, care and use of crucibles. (K1, K2, K3 & K4)

Unit II: (15 Hours)

2.1 Chromatography –principle, classifications.(K1, K2, K3 & K4)

2.2 Column chromatography –principle, adsorbents, solvents, apparatus, experimental procedure,applications.(K1, K2, K3 & K4)

2.3 Paper chromatography – principle, experimental procedure, $R_f$value- factors affecting R_f value,technique.(K1, K2, K3 & K4)

2.4 Precautions taken and applications of paper chromatography, two dimensional-radial paper chromatography.(K1, K2, K3 & K4)

2.5 Thin layer chromatography- principle, experimental method,superiority of TLC, $R_f$value, factors affecting R_f value. (K1, K2, K3 & K4)

2.6 Ion exchange chromatography- principle-types and properties of ion exchangers, applications. Specific examples- separation of chloride and bromide, cadmium and zinc.(K1, K2, K3 & K4)

Unit III:(15 Hours)

3.1 Concepts in spectroscopy- introduction, types of spectra-radiant energy,wave and particle properties of electromagnetic radiation.(K1, K2, K3 & K4)

3.2 Flame photometer – Principle and working.(K1, K2, K3 & K4)
3.3 UV – Visible spectroscopy– Born-Oppenheimer approximation, absorption laws,deviation from Beer- Lambert's law.(K1, K2, K3 & K4)
3.4 Instrumentation –photocolorimeter and spectrophotometer, block diagrams with description of components, working and applications.(K1, K2, K3 & K4)
3.5 Electronic transitions –types- chromophore and auxochromes, factors influencing λmax and Σmax.(K1, K2, K3 & K4)
3.6 Sensors–definition- chemical and physical sensors with examples. (K1, K2, K3 & K4)

Unit IV: (15 Hours)

4.1 Infrared Spectroscopy –principle, molecular vibrations, types with reference to linear and nonlinearmolecules.(K1, K2, K3 & K4)
4.2 Vibrational frequencies,factors influencing vibrational frequencies.(K1, K2, K3 & K4)
4.3 Instrumentation –block diagram, source, monochromator and sample cell. (K1, K2, K3 & K4)
4.4 Sampling techniques.(K1, K2, K3 & K4)
4.5 Detectors and recorder, working of IR.(K1, K2, K3 & K4)
4.6 Identification of simple organic molecules from characteristic absorption bands.(K1, K2, K3 & K4)

Unit V: (15 Hours)

5.1 Nuclear magnetic resonance spectroscopy –principle,instrumentation, block diagramwith different components, chemical shift, factors influencing chemical shift, number of signals.(K1, K2, K3 & K4)
5.2 Shielding mechanism – spin-spin splitting or coupling, coupling constants.(K1, K2, K3 & K4)
5.3 NMR spectra of simple organic compounds- alcohols, aldehydes and ketones.(K1, K2, K3 & K4)
5.4 Mass Spectroscopy–basic principles,instrumentation with block diagram.(K1, K2, K3 & K4)
5.5 Molecular peak – base peak, isotopic peak, metastable peak, their uses, fragmentation of alcohols, aldehydes and aromatic hydrocarbons. Nitrogen rule.(K1, K2, K3 & K4)
5.6 Determination of molecular formula with examples.(K1, K2, K3 & K4)

Text Books:

1. R. Gopalan *et al*., Elements of Analytical Chemistry, 2nd Edition, Sultan Chand & Sons, New Delhi, 1993.
2. S. Usha Rani , Analytical Chemistry , Macmillan India Ltd., New Delhi, 2000.

Reference Books:

1. B.K. Sharma, Instrumental Methods of Chemical Analysis, 24th Edition, Goel Publications, 2004.
2. A.K Srivastava and P.C Jain, Chemical Analysis: An Instrumental Approach, 3rdEdition, Sultan Chand and Sons, New Delhi, 1997.

3. Jag Mohan, Organic Analytical Chemistry Theory and Practice, 1st Edition, Narosa Publishing House, New Delhi, 2003.
4. C.R Chatwal, Analytical Spectroscopy, 1st Edition, Himalaya Publishing House, New Delhi, 1996.
5. H. Kaur, Spectroscopy, 1stEdition, PragatiPrakashan Publication, Meerut, 2001.
6. P.S Kalsi, Spectroscopy of Organic Compounds, 2ndEdition, New Age International, New Delhi.
7. Dr. H. Kaur,An Introduction to Chromatography, 1st Edition, Pragati Prakashan Publication, 2001.

Open Educational Resources (OER)

1. https://www.slideshare.net/MarkSelby2/gravimetric-analysis-44916288

SEMESTER V – MAJOR ELECTIVE I B

UECHB20– BASICS OF COMPUTER PROGRAMMING IN C AND ITS APPLICATIONS IN CHEMISTRY

Year: III SEM: V	Course Code UECHB20	Title of the Course Basics of Computer programming in C and its applications in chemistry	Course Type Theory	Course Category Elective	H/W 5	Credits 5	Marks 100

Learning Objectives:

1. To introduce the basics of computers.
2. To learn C language and its applications and solving problems in chemistry.

Course Outcomes:

The Learners will be able to

1. Define and relate software and hardware.
2. Describe the various components of C language.
3. Demonstrate the uses of functions, arrays and pointers.
4. Apply C language for solving problems in chemistry.
5. Apply C language to calculate specific terms in Chemistry.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	M
CO2	H	H	H	H	M	M
CO3	H	H	H	H	M	M
CO4	H	H	H	H	M	M
CO5	H	H	H	H	M	M

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	M	M	H
CO2	H	H	H	M	M	H
CO3	H	H	H	M	M	H
CO4	H	H	H	M	M	H
CO5	H	H	H	M	M	H

Unit I: (15 hours)

1.1 Basic computer organization, processors. (K1, K2, K3 & K4)

1.2 Types of memory- main memory and secondary memory, storage hierarchy.(K1, K2, K3 & K4)

1.3 Basics of operating systems.(K1, K2, K3 & K4)

1.4 Software – relationship between hardware and software – types of software.(K1, K2, K3 & K4)

1.5 Planning the computer program – algorithm and flowcharts.(K1, K2, K3 & K4)

1.6 Computer languages – machine language, assembly language, assembler, compiler, interpreter and programming languages.(K1, K2, K3 & K4)

Unit II:(15 hours)

2.1 C language – introduction and its historical development. (K1, K2, K3 & K4)

2.2 Structure of C Programming – the main () function, character set, variables, constants,operators, input/output functions. (K1, K2, K3 & K4)

2.3 Variables - local variables, global variables and formal parameters, Constants. (K1, K2, K3 & K4)

2.4 Operators - Arithmetic, Relational and logical, Bitwise operators.(K1, K2, K3 & K4)

2.5 Input & Output – Formated input and output – scanf() and printf( ).(K1, K2, K3 & K4)
2.6 Unformatted input and output - getchar(), putchar( ) , gets( ) and puts( ).(K1, K2, K3 & K4)

Unit III:15 hours)

3.1 Control structures –Control statements in C -*if* statement, *if-else* statement, Nested*if-else* statement. (K1, K2,K3 & K4)
3.2 The *switch* statement, *goto*and the *exit ()*function. (K1,K2,K3 & K4)
3.3 Looping in C language –*for* loop, *while* loop, *do-while* loop and continue statements in loops. (K1, K2,K3 & K4)
3.4 Functions - Functions with Arguments, Functions with Non-integer Arguments, Functions with no Arguments and Recursive Functions.(K1, K2,K3 & K4)
3.5 Arrays- initializing array elements, Character arrays, two-dimensional arrays. (K1, K2,K3 & K4)
3.6 Pointers – Array declaration using pointers-Pointers to pointers. (K1, K2, K3 & K4)

Unit IV: (15 hours)

4.1 Applications in Chemistry – calculation of the radius of the first Bohr orbit for an electron. (K1,K2, K3 & K4)
4.2 Calculation of half-life time for an integral order reaction. (K1, K2, K3 & K4)
4.3 Calculation of molarity, molality and normality of a solution. (K1, K2, K3 & K4)
4.4 Calculation of pressure of ideal or Vanderwaal's gas. (K1, K2, K3 & K4)
4.5 Calculation of electronegativity of an element using Pauling's relation.(K1, K2, K3 & K4)
4.6 Determination of lattice energy of a crystal using Born- Landeequation.(K1, K2, K3 & K4)

Unit V: (15 hours)

5.1 Applications in Chemistry – Calculation of empirical formulae of hydro carbon.(K1, K2, K3 & K4)
5.2 Calculation of reduced mass of a few diatomic molecules.(K1, K2, K3 & K4)
5.3 Determination of the wave numbers of spectral lines of hydrogen atom.(K1, K2, K3 & K4)
5.4 Calculation of work of expansion in adiabatic process.(K1, K2, K3 & K4)
5.5 Calculation of pH and solubility product.(K1, K2, K3 & K4)
5.6 Calculation of standard deviation and correlation coefficient.(K1, K2, K3 & K4)

Reference Books:

1. K.V. Raman, Computers in Chemistry, 8th Edition, Tata McGraw Hill, 2005.
2. Venugopal and Prasad, Programming with C, 11th Edition, 2014.
3. E. Balaguruswamy, Programming in C, 8th Edition, 2019.
4. Sudhir K Pundir, Anshu Bansal, Computers for Chemist, PragatiPrakashan Publishers, 2017.

Open Educational Resources:

1. http://mpbou.edu.in/slm/mscche1p5c.pdf
2. https://www.tutorialspoint.com/cprogramming/index.htm
3. https://spoken-tutorial.org/tutorial-search/?search_foss=C+and+Cpp&search_language=English

SEMESTER V

USCHC520-SKILL BASED ELECTIVE: SMALL SCALE CHEMISTRY

Year: III **SEM: V**	**Course Code** USCHC520	**Title of the Course** Small Scale Chemistry	**Course Type** Theory	**Course Category** Skill Based Elective	**H/ W** 2	**Credits** 2	**Marks** 100

Learning Objectives:

1. To impart knowledge on small-scale industries.
2. To acquire skills in the manufacture of various small-scale products.

Course Outcomes:

The Learners will be able to

1. Understand the laws, role and steps involved in startingsmall scale industries.
2. Acquire skills to prepare soaps and detergents.
3. Describe the characteristics and uses of cosmetics and perfumes.
4. Gain skills in the manufacture of selected small-scale products.

CO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	M	H	H	H	H
CO2	H	M	H	H	H	H
CO3	H	M	H	H	H	H
CO4	H	M	H	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H

Unit I: Small - Scale Industry

1.1.Objectives and characteristics of small-scale industries (K1& K2)

1.2. Types of SSI, role of SSI in Indian economy. (K1& K2)

1.3. Steps in starting SSI (K1& K2)

1.4. Laws for SSI, Problems of SSI (K1& K2)

1.5. Finance management, Quality control – definition and advantages. (K1& K2)

1.6.Marketing and branding, Advertising – definition, objectives, advertising media.(K1 &K2)

Unit II: Soaps and Detergents

2.1. Soaps- definition, fatty and non- fatty raw materials.**(**K1& K2)

2.2. Types of soaps, manufacture of laundry soap and bathing soap. **(**K1& K2)

2.3. Mechanism of cleansing action of soap.**(**K1& K2)

2.4. Composition, preparation and advantages of herbal soaps. **(**K1& K2)

2.5. Detergents - classification of surfactive agents (LABSA), manufacture of detergents. **(**K1& K2)

2.6. Shampoo – composition and manufacture of egg and herbal shampoo, anti-dandruff and conditioners.**(**K1& K2)

Unit III: Cosmetics and Perfumes

3.1. Cosmetics – definition and history.**(**K1& K2)

3.2. Kinds of cosmetics. **(**K1& K2)

3.3. Preparation of face powder, face cream and lipstick.**(**K1& K2)

3.4. Perfumes - definition, essential ingredients in perfumes.**(**K1& K2)

3.5. Classification of essential oils.**(**K1& K2)

3.6. Preparation of perfumes.**(**K1& K2)

Unit IV: Miscellaneous Small-Scale Products

4.1. Camphor – production, biosynthesis and applications. **(**K1& K2)

4.2. Bleaching powder – preparation, properties and uses. **(**K1& K2)

4.3. Biogas- composition, production and uses.**(**K1& K2)

4.4. Handmade paper from bagasse- composition of bagasse and uses.**(**K1& K2)

4.5. Asofoetida – composition, cultivation, manufactures and uses.**(**K1& K2)
4.6. Composition and manufacture of safety matches and agarbattis.**(**K1& K2)

Unit V: Miscellaneous Small-Scale Products

5.1. Recycling of synthetic organic polymers – applications of PET and PVC. **(**K1& K2)
5.2. Recycling of synthetic organic polymers – applications of HDPE and polystyrene.**(**K1& K2)
5.3. Reverse osmosis of water – production and applications.**(**K1& K2)
5.4. Coconut oil – manufacture by dry and wet process and uses. **(**K1& K2)
5.5. Vulcanization of rubber, making an eraser.**(**K1& K2)
5.6. Pencils–formsof graphite, adhesion and lengthwise graphitization method &uses.**(**K1& K2)

Reference Books:

1. Dr. V. Balu, Entrepreneurship and Small Business Promotion, First Edition, Sri Venkateswara Publications, 2004.
2. B.N.Chakrabarty, Industrial Chemistry, Oxford & IBH Publishing Co. Pvt. Ltd., 1981.
3. A.N.Zamre, V.G.Ratolikar, A Textbook of Modern Applied Chemistry, M.G.Lomte Edition, S.Chand& Co., 1985.
4. Clarence Henry Eckles, Willes Barnes Combs and Harold Macy, Milk and Milk products, Tata McGraw- Hill Publishing Company, 2002.
5. B.K.Sharma, Industrial Chemistry, Goel Publishing House, 2008.
6. H.Panda, Herbal soaps detergents Hand Book, National Institute of Industrial Research,2011.

Open Educational Resources (OER)

1. https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Supplemental_Modules_(Organic_Chemistry)/Lipids/Properties_and_Classification_of_Lipids/Soaps_and_Detergents(Soaps and Detergents)
2. https://www.pdfdrive.com/perfumes-cosmetics-and-soaps-modern-cosmetics-d157713809.html (Perfumes, Cosmetics and Soaps e- book).

SEMESTER VI

UCCHJ20 – COORDINATION CHEMISTRY

Year: III SEM: VI	Course Code UCCHJ20	Title of the Course Coordination Chemistry	Course Type Theory	Course Category Core	H/W 4	Credits 4	Marks 100

Learning Objective:

1. To give students a thorough knowledge on Coordination Chemistry.

Course Outcomes:

The Learners will be able to

1.Define the terms involved in coordination chemistry and recall IUPAC nomenclature of coordination compounds and to explain the concept of chelation and illustrate the isomerism exhibited by coordination complexes.

2. Explain and compare Werner, Sidgwick and Valence Bond theories of bonding in coordination compounds.

4. Describe the various aspects of Crystal Field Theory and its applications.

5. Explain the importance of MOT, construct molecular orbital diagrams and to compare MOT with CFT.

6. Describe the synthesis, properties, uses,bonding, hybridization and structures of carbonyls of Ni, Cr, Fe, Co, Mn, Mo and W.

CO	PSO					
	1	2	3	4	5	6
CO1	H	L	H	H	H	H
CO2	H	L	H	H	H	H
CO3	H	L	H	H	H	H
CO4	H	L	H	H	H	H
CO5	H	L	H	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	M	M	H
CO2	H	H	H	M	M	H
CO3	H	H	H	M	M	H
CO4	H	H	H	M	M	H
CO5	H	H	H	M	M	H

Unit I: (12 Hours)

1.1 Co-ordination compounds: Molecular compounds, difference between double salts and complex compounds, definition of terms used, classification of ligands – based on denticity and charge. (K1, K2, K3 & K4)

1.2 Chelation – tendency of poly dentate ligands to form chelates and applications of chelate formation. (K1, K2, K3 & K4)

1.3 Nomenclature of coordination compounds. (K1, K2, K3 & K4)

1.4 Isomerism in complexes: structural isomerism - conformation isomerism, ionization isomerism, hydrate isomerism, linkage isomerism, ligand isomerism, co-ordination isomerism, coordination position isomerism and polymerization isomerism. (K1, K2, K3 & K4)

1.5 Geometrical isomerism in 4- and 6- coordinate complexes. (K1, K2, K3 & K4)

1.6 Optical isomerism - optical activity, conditions, optical isomerism in 4- and 6- coordinated complexes. (K1, K2, K3 & K4)

Unit II: (12 Hours)

2.1 Theories of coordination compounds - Werner's theory – postulates, designation and formation of Co(III) ammine complexes, experimental verification. (K1, K2, K3 & K4)

2.2 Sidgwick theory – electronic concept of coordinate bond, EAN rule, limitations. (K1, K2, K3 & K4)

2.3 Theory of bonding - valence bond theory – postulates. (K1, K2, K3 & K4)

2.4 VBT as applied to outer orbital and inner orbital octahedral complexes. (K1, K2, K3 & K4)

2.5 VBT as applied to tetrahedral and square planar complexes - hybridization, geometry and magnetic properties. (K1, K2, K3 & K4)

2.6 Failures of Werner's, Sidgwick's and Pauling's theories. (K1, K2, K3 & K4)

Unit III: (12 Hours)

3.1 Crystal Field theory – salient features, splitting of d - orbitals in octahedral, tetrahedral and square planar complexes. (K1, K2, K3 & K4)

3.2 Crystal field stabilization energy - factors affecting the magnitude of Δ_o - spectrochemical series. (K1, K2, K3 & K4)

3.3 Filling up t_{2g} and e_g orbitals with electrons in octahedral and tetrahedral complexes - low spin and high spin complexes. (K1, K2, K3 & K4)

3.4 Calculation of crystal field stabilization energy values of octahedral and tetrahedral complexes, uses of CFSE values. (K1, K2, K3 & K4)

3.5 Applications of CFT - explanation of magnetic properties, colour and geometry. (K1, K2, K3 & K4)

3.6 Limitations of CFT, comparison between VBT and CFT. (K1, K2, K3 & K4)

Unit IV: (12 Hours)

4.1 Molecular Orbital theory – need, introduction, construction of Coulson's MO diagram for CO. (K1, K2, K3 & K4)

4.2 Covalency in transition metal complexes - evidences for covalency. Molecular Orbital theory - postulates, metal orbitals and LGOs suitable for σ-bonding in octahedral geometry. (K1, K2, K3 & K4)

4.3 Construction of qualitative MO energy level diagrams for σ –bonding in octahedral complexes. (K1, K2, K3 & K4)

4.4 Metal orbitals and LGOs suitable for π -bonding in octahedral geometry. (K1, K2, K3 & K4)

4.5 Effect of π-bonding on the magnitude of Δ_o – construction of π MOs for donor and acceptor ligands, relation between pi bonding ability of ligands and spectrochemical series. (K1, K2, K3 & K4)

4.6 Comparison between CFT and MOT - similarities and differences. (K1, K2, K3 & K4)

Unit V: (12 Hours)

5.1 Pi acceptor ligands: metallic carbonyls – synergic effect, synthesis, properties and uses of carbonyls of Ni, Cr, Mo and W. (K1, K2, K3 & K4)

5.2 Synthesis, properties and uses of carbonyls of iron – $Fe(CO)_5$, $Fe_2(CO)_9$ and $Fe_3(CO)_{12}$. (K1, K2, K3 & K4)
5.3 Carbonyls of Co and Mn – synthesis, properties and uses. (K1, K2, K3 & K4)
5.4 Bonding, hybridization and structures of carbonyls of Ni, Cr, Mo and W. (K1, K2, K3 & K4)
5.5 Bonding, hybridization and structures of carbonyls of Fe. (K1, K2, K3 & K4)
5.6 Bonding, hybridization and structures of carbonyls of Co and Mn. (K1, K2, K3 & K4)

Text Books:

1. R. D. Madan, Inorganic Chemistry, 2nd Edition, S. Chand & Co, Reprint 2004.
2. P.L. Soni, Inorganic Chemistry, 4th Edition. Sultan Chand & Co., 1991.
3. M. Satake Y. Mido, Coordination Chemistry, 1st Edition, 2001.
4. Puri and Sharma Nagin, Inorganic Chemistry, 9th Edition, Sultan Chand & Co, 1979.

Reference Books:

1. J.D. Lee, Concise Inorganic Chemistry, 3rd Edition, Von Nostrand, 1997.
2. Cotton and Wilkinson, Advanced Inorganic Chemistry, 5th Edition, Wiley Eastern Ltd., 1988.
3. A.K.De, A Textbook of Inorganic Chemistry, New age, 8th Edition, Wiley Eastern Ltd., 2001.
4. GurdeepChatwal and M. S. Yadav, Coordination Chemistry, First Edition, Himalaya Publishing House, 1992.
5. R Gopalan and V Ramalingam, Concise Coordination Chemistry, Vikas Publishing House Pvt. Ltd., 2001.
6. Wahid U. Malik, G. D. Tuli and R. D. Madan, Selected Topics in Inorganic Chemistry, S. Chand & Company Ltd., 2005.

Open Educational Resources (OER):

1. https://nptel.ac.in/courses/104/105/104105033/ (Coordination Chemistry)
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5 (CFT and MOT)
3. https://nptel.ac.in/courses/104/106/104106064/ (Metallic Carbonyls)

SEMESTER VI

UCCHK20 – ELECTRO CHEMISTRY

Year: III SEM: VI	Course Code UCCHK20	Title of the Course Electro Chemistry	Course Type Theory	Course Category Core	H/W 4	Credits 4	Marks 100

Learning Objectives:

1. To provide an in-depth study on electrical conductance and electro motive force.
2. To highlight the working of different types of electrodes and electro chemical cells.
3. To throw light on their working and applications.
4. To understand hydrogen over voltage, decomposition potential, lead storage battery and fuel cells.

Course Outcomes:

The Learners will be able to

1. Apply the laws on electrolysis and definitions of specific, equivalent and molar conductance to the working of electrolytic cells.
2. Illustrate the Debye Huckel's theory of strong electrolytes.
3. Explain the use of electrical energy in bringing about chemical reactions and how chemical reactions can produce electrical energy so has to design cells and batteries.
4. Apply chemical cells and concentration cells for determining the valency of mercurous ion, transport number, solubility and solubility product.
5. Demonstrate the knowledge gained in the study of irreversible electrode processes. And ilustrate the principle and applications of fuel cells.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	M
CO2	H	H	H	H	M	M
CO3	H	H	H	H	M	M
CO4	H	H	H	H	M	M
CO5	H	H	H	H	M	M

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	M	M	H
CO2	H	H	H	M	M	H
CO3	H	H	H	M	M	H
CO4	H	H	H	M	M	H
CO5	H	H	H	M	M	H

Unit I: (**12 Hours)**

1.1 Electrochemistry - conductance–metallic and electrolytic conductors, resistance, specific resistance, specific conductance, equivalent conductance and molar conductance – terms, definitions and units. (K1,K2,K3& K4)
1.2 Measurement of conductance based on Wheatstone bridge principle.(K1,K2,K3 & K4)
1.3 Variation of conductance with dilution for strong and weak electrolytes (qualitative explanation) (K1,K2,K3 & K4)
1.4 Transport number and its determination by Hittorf's method by using Pt and Ag electrodes.(K1,K2,K3 & K4)
1.5 Ionic mobility – determination of ionic mobility, effect of temperature and concentration on ionic mobility.(K1,K2,K3 & K4)
1.6 Ionic conductance - Kohlrausch's law and its applications.(K1,K2,K3 & K4)

Unit II:(12 Hours)

2.1 Theory of strong electrolytes - Debye -Huckel'stheory- postulates, Debye Huckel limiting law and verification, Debye Huckel Bronsted equation.(K1,K2,K3& K4)
2.2 Debye HuckelOnsager theory-verification of Onsager equation,Wein effect and Debye Falkenhagen effect.(K1,K2,K3& K4)
2.3 Ionic strength and calculation of ionic strength. (K1,K2,K3& K4)
2.4 Activity and activity coefficients of strong electrolytes. Mean ionic activity and mean ionic activity coefficients. (K1,K2,K3& K4)
2.5 Applications of conductivity measurements – degree of hydrolysis and solubility product. (K1,K2,K3& K4)
2.6 Conductometric titrations- principle, experimental techniques and sketch of curves of various types of titrations – Acid - Base, mixture of acids versus base and Precipitation titrations. Advantages of conductometric titrations. (K1,K2,K3& K4)

Unit III:(12 Hours)

3.1 EMF –construction of an electrochemical cell, definition of electrode and cell potentials, conventions regarding sign of emf, cell reaction and emf, Relationship between heat energy and electrical energy. Galvanic cells-reversible and irreversible cells. (K1,K2,K3 & K4)
3.2 EMF and its measurement based on Poggendorff compensation principle.(K1,K2,K3 & K4)
3.3 Types of electrodes – metal-metal ion, gas, metal-metal insoluble salt, amalgam and oxidation-reduction electrodes. Reference electrodes: Primary reference electrode-Hydrogen electrode, Secondary reference electrode-Calomel electrode.(K1,K2,K3 & K4)
3.4 Derivation of Nernst equation for electrode potentials, Thermodynamics and emf- derivation of ΔG, ΔH, ΔS from emf data.(K1,K2,K3 & K4)
3.5 Standard cell – working of Weston saturated and unsaturated standard cells.(K1,K2,K3 & K4)
3.6 Electrochemical series and its applications. (K1, K2,K3& K4)

Unit IV:(12 Hours)

4.1 Chemical and concentration cells – chemical cells with and without transference and their applications.(K1,K2,K3 & K4)
4.2 Concentration cells – electrode concentration cells without transference.(K1,K2,K3 & K4)

4.3 Electrolytic concentration cells without transference- examples and derivation of expressions for their emf's.(K1,K2,K3 & K4)
4.4 Electrolytic concentration cells with transference - examples and derivation of expressions for their emf's – liquid junction potential. Functions of a salt bridge(K1,K2,K3 & K4)
4.5 Applications of emf measurements-determination of pH using hydrogen, quinhydrone and glass electrodes. (K1,K2,K3 & K4)
4.6 Potentiometric titrations- acid - base, redox and precipitation titrations- advantages of potentiometric titrations. Titration of polybasic acids versus a base.(K1,K2,K3 & K4)

Unit V:(12 Hours)

5.1 Applications of concentration cells – determination of valency of ions and transport number.(K1,K2,K3 & K4)
5.2 Determination of ionic product of water and solubility product.(K1,K2,K3 & K4)
5.3 Polarization – decomposition potential, back emf, definition and experimental determination.(K1,K2,K3 & K4)
5.4 Hydrogen over voltage – definition, experimental determination and application. Electroplating.(K1,K2,K3 & K4)
5.5 Storage cells –lead acid battery – mechanism of discharging and recharging.(K1,K2,K3 & K4)
5.6 Fuel cells – types of fuel cells – low temperature fuel cells and high temperature fuel cells. Hydrogen – Oxygen fuel cell. (K1,K2,K3 & K4)

Text Books:

1. B. R. Puri, L. R Sharma and M.SPathania, Principles of Physical Chemistry, 47th Edition, Vishal Publishing Co., 2017.
2. P.L.Soni, Textbook of Physical Chemistry, Sultan Chand & Co., Reprint 2000.
3. Negi and Anand, Physical Chemistry, 2ndEdition, New Age copy right, Eastern Wiley Pvt. Ltd.,1985
4. Kundu and Jain, Physical Chemistry, 2nd Edition, S.Chand&Co.,1987.

Reference Books:

1. S.Glasstone, A Textbook of Physical Chemistry, 5th Edition, MacMillan (India) Ltd, New Delhi, Reprint1978.
2. G.W.Castellan, Physical Chemistry, 3rdEdition., Addison-Wesley, Mass 1983.
3. Walter J.Moore, Physical Chemistry,-5th Edition Prentice-Hall, 1972.
4. Dogra, S. K., and Dogra S., Physical Chemistry Through Problems, Wiley Eastern Ltd., 1984.
5. Samuel H Maron and Carl F. Prutton., Principles of Physical Chemistry, 4th Edition, Oxford and IBH Publishing Company, New Delhi, 1985.
6. M.S. Yadav, Electrochemistry, Second Revised Edition, Anmol Publications Pvt. Ltd., New Delhi, 2001.
7. B.K Sharma, Electrochemistry, 4th Edition, Goel Publishing House, 1990.

Open Educational Resources (OER)

1. https://www.khanacademy.org/science/chemistry/oxidation-reduction
2. https://www.khanacademy.org/science/chemistry/std cell potential

3. http://www.freebookcentre.net/chemistry-books-download/An-Introduction-To-Electrochemistry-(PDF-577P).html

SEMESTER VI

UECHC20 - CHEMISTRY OF NATURAL PRODUCTS

Year: III SEM: VI	**Course Code** UECHC20	**Title of the Course** Chemistry of Natural Products	**Course Type** Theory	**Course Category** Core Elective	**H/W** 5	**Credits** 5	**Marks** 100

Learning Objectives:

To impart knowledge on natural products such as carbohydrates, amino acids, proteins, terpenes, alkaloids, vitamins, carotenoids, anthocyanins and flavones.

Course Outcomes:

The Learners will be able to

1. Explain the structural elucidation, properties and reactions of glucose, fructose, sucrose, maltose, starch and cellulose.

2. Elaborate the preparation, properties and reactions of alpha aminoacids, synthesis of peptides and classification and structure of proteins.
3. Explain the structure and applications DNA, RNA and processes like transcription and translation in protein synthesis.
4. Illustrate the sources, properties and structural elucidation of alkaloids and terpenoids.
5. Elaborate the sources, properties, structural elucidation and synthesis of flavonoids, carotenoids, anthocyanins and vitamins.

CO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	M	H	H	H	H
CO2	H	M	H	H	H	H
CO3	H	M	H	H	H	H
CO4	H	M	H	H	H	H
CO5	H	M	H	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

Unit I : (15 Hours)

1.1 Carbohydrates - classification, configuration-D,L, Ascending of carbon chain in sugars- Kiliani-Fischer synthesis, descending of carbon chain in sugars- Ruff's synthesis.(K1, K2, K3 & K4)

1.2 Constitution of glucose and fructose. (K1, K2, K3 & K4)

1.3 Reactions of glucose and fructose - osazone formation. Mutarotation and its mechanism. (K1, K2, K3 & K4)

1.4 Cyclic structure - pyranose and furanose forms, determination of ring size - Haworth projection formula. (K1, K2, K3 & K4)

1.5 Epimerisation, inter conversion of aldoses and ketoses. (K1, K2, K3 & K4)

1.6 Sucrose, maltose, starch and cellulose - structural elucidation. (K1, K2, K3 & K4)

Unit II:(15 Hours)

2.1 Amino acids and proteins - classification of amino acids - essential and non-essential amino acids.(K1, K2, K3 & K4)

2.2 Preparation of alpha amino acids- Strecker's synthesis, Gabriel Phthalimide synthesis.(K1, K2, K3 & K4)

2.3 Properties - zwitter ions, isoelectric points, reactions of amino group.(K1, K2, K3 & K4)

2.4 Reactions of carboxyl and both amino and carboxyl groups. (K1, K2, K3 & K4)

2.5 Peptide bond, Peptide synthesis, Proteins - classification based on physical and chemical properties and on physiological functions.(K1, K2, K3 & K4)

2.6 Primary and secondary structures of proteins - Helical and sheet structures, tertiary and quaternary structure. Denaturation and renaturation of proteins. (K1, K2, K3 & K4)

Unit III: (15 Hours)

3.1 Nucleic acids – nucleoside, nucleotide, types of nucleic acids.(K1, K2, K3 & K4)

3.2 RNA and DNA – structures and differences. (K1, K2, K3 & K4)
3.3 Sequencing of DNA, synthesizing an oligonucleotide array.(K1, K2, K3 & K4)
3.4 DNA replication, transcription and translation - protein synthesis.(K1, K2, K3 & K4)
3.5 Introduction to lipids, classification, oils and fats.(K1, K2, K3 & K4)
3.6 Common fatty acids present in oils and fats, trans fats.(K1, K2, K3 & K4)

Unit IV: (15 Hours)

4.1 Terpenes - classification, isoprene rule, source and structural elucidation of citral.(K1, K2, K3 & K4)
4.2 Source and structural elucidation of geraniol. (K1, K2, K3 & K4)
4.3 Source and structural elucidation of α – pinene.(K1, K2, K3 & K4)
4.4 Alkaloids - classification, general methods of isolation and general methods of structural determination, source and structural elucidation of coniine.(K1, K2, K3 & K4)
4.5 Source and structural elucidation of piperine. (K1, K2, K3 & K4)
4.6 Source and structural elucidation of nicotine. (K1, K2, K3 & K4)

Unit V : (15 Hours)

5.1 Carotenoids- introduction and general methods of structural determination.**(**K1, K2, K3 & K4)
5.2 Anthocyanins- introduction and general methods of structural determination.**(**K1, K2, K3 & K4)
5.3 Flavones- source, isolation, separation, purification. **(**K1, K2, K3 & K4)
5.4 Properties and structural elucidation of flavones. **(**K1, K2, K3 & K4)
5.5 Vitamins- source, classification, structural elucidation of Ascorbic acid. (K1, K2, K3 & K4)
5.6 Structural elucidation of thiamine. (K1, K2, K3 & K4)

Text Books:

1. B.S. Bahl and Arun Bahl, Advanced Organic Chemistry, 5th Edition, Sultan Chand &Co., 2014.
2. K.S.Tewari, S.N.Mehrotra, K.Vishnoi, A Text book of Organic Chemistry, Vikas Publishing House, Reprint, 2017.
3. Gurdeep Chatwal, Organic Chemistry of Natural Products, Vol. I, Himalaya Publishing House, 4th edition, 2015.
4. Gurdeep Chatwal, Organic Chemistry of Natural Products, Vol. II, Himalaya Publishing House, 4th edition, 2015.

Reference Books:

1. O.P.Agarwal, Chemistry of Natural Products Vol I, 26th Edition, Goel Publication House, 2014.

2. O.P.Agarwal, Chemistry of Natural Products Vol II, 24th Edition, Goel Publication House, 20**15**.
3. P.L.Soni, Text book of Organic Chemistry, Sultan and Chand, Reprint, 2019.
4. M.K. Jain and S.C.Sharma, Modern Organic Chemistry, S. Chand & Co, Reprint, 2019.
5. A.K.Bansal, A Textbook of Organic Chemistry, New Age International Pvt. Ltd., 1990.
6. David L. Nelson and Michael M. Cox, Lehninge Principles of Biochemistry, 3rd Edition, Macmillan Worth Publishers, 2002.
7. Stryer, Jeremy M. Berg, John. L Tymoczko, Lubert, Biochemistry, 5th edition, International Edition, 2002.
8. I.L. Finar, Organic Chemistry, Vol II, 5th Edition, Addison Wesley, 2000.
9. R.T.Morrison and Boyd, Organic Chemistry, 6th edition, Prentice Hall India Pvt. Ltd., 2001.

Open Educational Resources (OER)

1. https://nroer.gov.in/55ab34ff81fccb4f1d806025/file/5d43eea016b51c016943e6b6 (Nucleic acids)
2. http://vidyamitra.inflibnet.ac.in/index.php/content/index/5523b9e7e413015c2d65f7a3 (Nucleic acids and proteins)
3. http://vidyamitra.inflibnet.ac.in/index.php/content/index/5523b9e7e413015c2d65f7a1(Carbohydrates and lipids)
4. http://vidyamitra.inflibnet.ac.in/index.php/content/index/5a3a11bf8007bea53365cb7a(Alkaloids)

SEMESTER VI – MAJOR ELECTIVE II B

UECHD20- POLYMER CHEMISTRY

Year: III SEM: VI	**Course Code** UECHD20	**Title of the Course** Polymer Chemistry	**Course Type** Theory	**Course Category** Core-Elective	**H/W** 5	**Credits** 5	**Marks** 100

Learning Objectives:

1. To expose the students to the fascinating trends in the field of polymer chemistry.
2. To study in detail the mechanisms, techniques, characterization and applications of polymers.

Course Outcomes:

The Learners will be able to

1. Classify polymers and determine the molecular weights of polymers by physical and chemical methods.
2. Describe the mechanisms of different types of polymerization reactions.
3. Summarize the types and techniques involved in polymer degradation.

4.Demonstrate the applications of industrial polymers and explain the role of conducting polymers.

5.Illustrate the various polymer processing techniques.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	M
CO2	H	H	H	H	M	M
CO3	H	H	H	H	M	M
CO4	H	H	H	H	M	M
CO5	H	H	H	H	M	M

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	M	M	H
CO2	H	H	H	M	M	H
CO3	H	H	H	M	M	H
CO4	H	H	H	M	M	H
CO5	H	H	H	M	M	H

Unit I: (15 Hours)

1.1 Introduction to Polymer Science: monomers and oligomers. (K1, K2,K3 &K4)

1.2 Polymers and their characteristics.(K1, K2,K3 &K4)

1.3 Polymer structure: copolymers, tacticity, geometric isomers.(K1, K2,K3 &K4)

1.4 Classification of polymers: Natural, synthetic, linear, cross-linked and network, plastics, elastomers, fibres, homopolymers and co-polymers. (K1, K2,K3 &K4)

1.5 Bonding in Polymers: Primary and secondary bond forces in polymers: cohesive energy and decomposition of polymers.(K1, K2,K3 &K4)

1.6 Molecular weight and its determination –Chemical and physical methods. (K1, K2,K3 &K4)

Unit II:(15 Hours)

2.1 Mechanism of Polymerization, chain growth polymerization, cationic andanionic.(K1,K2,K3 & K4)

2.2 Free radical polymerization- initiation, propagation and termination steps.(K1,K2,K3 & K4)

2.3 Coordination polymerization, solution and template polymerization.(K1,K2,K3 & K4)

2.4 Stereo regular polymers - Ziegler Natta polymers.(K1,K2,K3 & K4)

2.5 Step growth polymers – Polycondensation and Polyaddition polymerization.(K1,K2,K3 & K4)

2.6 Bulk and block polymerization, electrochemical polymerization.(K1,K2,K3 & K4)

Unit III:(15 Hours)

3.1 Polymerization Technique –Bulk and Solution polymerization.(K1,K2,K3 & K4)
3.2 Suspension and emulsion polymerization.(K1,K2,K3 & K4)
3.3 Interfacial, plasma and gas phase polymerization.(K1,K2,K3 & K4)
3.4 Polymer Degradation -Types of Polymer Degradation- Thermal degradation, mechanical degradation.(K1,K2,K3 & K4)
3.5 Photodegradation and Photo stabilizers.(K1,K2,K3 & K4)
3.6 Chemical structure determination: Vibrational spectroscopy, Nuclear Magnetic Resonance Spectroscopy.(K1,K2,K3 & K4)

Unit IV: (15 Hours)

4.1 Industrial Polymers: Raw material, preparation, fibre forming polymers, elastomeric material.(K1,K2,K3 & K4)
4.2 Thermoplastics- Polyethylene, Polypropylene, Polystyrene, Polyacrylonitrile, Poly Vinyl Chloride, Poly tetrafluoro ethylene, Nylon and Polyester.(K1,K2,K3 & K4)
4.3 Thermosetting Plastics: Phenol formaldehyde and epoxide resin.(K1,K2,K3 & K4)
4.4 Elastomers- Natural rubber and synthetic rubber, Buna -N, Buna-S and Neoprene.(K1,K2,K3 & K4)
4.5 Conducting Polymers - Elementary ideas; examples: poly sulphur nitriles, poly phenylene, poly aniline, poly pyrrole and poly acetylene.(K1,K2,K3 & K4)
4.6 Biodegradable Polymers.(K1,K2,K3 & K4)

Unit V:(15 Hours)

5.1 Introduction to Polymer Processing –Processes: Mixing, Rolling and kneading, Pelletizing, Shredding and Grinding, Storage and transportation.(K1,K2,K3 & K4)
5.2 Pressureless Processing Techniques – casting, dipping, coating and foaming.(K1,K2,K3 & K4)
5.3 Polymer processing under pressure – Calendaring, Moulding – Compression, injection, extrusion, blow moulding.(K1,K2,K3 & K4)
5.4 Polymer additives- definition, requirement of additives, classification of additives.(K1,K2,K3 & K4)
5.5 Stabilizers – Antioxidants and thermal stabilizers.(K1,K2,K3 & K4)
5.6 Other additives: Fillers, plasticizers,fire retardants and colourants.(K1,K2,K3 & K4)

Reference Books:

1. R. J. Young and P.A. Lovell., Nelson thornes, Introduction to Polymers, 3rd Edition, 2011.
2. P.Bahadur& N. V. Sastry, Principles of Polymer Science, 2nd Edition, Narosa Publishing House, 2005.

3. G.S. Misra, Introductory Polymer Chemistry, 1st Edition, New Age International Publishers, 2018.
4. Bhatnagar M., A Textbook of Polymers, Vol. I, II & III, S. 1st Edition, S. Chand & Co., 2014.
5. Banerji (Samir K), A Textbook of Polymers, Vol I, 2nd Edition, 2003.
6. V.R. Gowarikar, Viswanathan J. Sridhar - Polymer Science - Wiley Eastern, Reprint 2019.

Open Educational Resources (OER)

1. https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Supplemental_Modules_(Organic_Chemistry)/Polymers
2. https://eng.libretexts.org/Bookshelves/Materials_Science/Supplemental_Modules_(Materials_Science)/Polymer_Chemistry/Polymer_Chemistry%3A_Chemical_Composition/Polymer_Chemistry%3A_Polymerization_Reactions
3. https://nptel.ac.in/content/storage2/courses/103103029/pdf/mod7.pdf

SEMESTER VI – MAJOR ELECTIVE III A

UECHE20- APPLIED CHEMISTRY

Year: III SEM: VI	Course Code	Title of the Course	Course Type	Course Category	H/W	Credits	Marks
	UECHE20	Applied Chemistry	Theory	Core-Elective	5	5	100

Learning Objectives:

1. To impart knowledge on biological, dairy, leather, soil and dye chemistry.

Course Outcomes:

The Learners will be able to

1. Describe the digestion and absorption of carbohydrates, proteins and fats and describe the role of enzymes and physiological functions of hormones.
2. Recall the definition, constituents and physico-chemical properties of milk and indicate the composition of creams, butter, ghee and ice creams.
3. Demonstrate the chief processes involved in leather manufacture and treatment of tannery effluents
4. Classify and enumerate the properties of soils.
5. Determine the physico-chemical properties of water and illustrate reverse osmosis and ion-exchange methods.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	M

CO2	H	H	H	H	M	M
CO3	H	H	H	H	M	M
CO4	H	H	H	H	M	M
CO5	H	H	H	H	M	M

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	H	H	M	M	H
CO2	H	H	H	M	M	H
CO3	H	H	H	M	M	H
CO4	H	H	H	M	M	H
CO5	H	H	H	M	M	H

Unit I: (15 Hours)

1.1 Biological Chemistry:Elementary treatment of digestion and absorption of carbohydrates, proteins and fats. (K1, K2, K3 &K4)

1.2 Elementary treatment of enzymes, cofactors, prosthetic groups and theory of enzyme action.(K1, K2, K3 &K4)

1.3 Physiological functions of adrenaline andthyroxin.(K1, K2,K3 &K4)

1.4 Physiological functions of oxytocin and insulin. (K1, K2, K3& K4)

1.5 Physiological functions of sex harmones.(K1, K2,K3 & K4)

1.6 Micronutrients and their biological role in human systems.(K1, K2, K3& K4)

Unit II:(15 Hours)

2.1 Dairy Chemistry: Milk- Definition, Physicochemical properties of milk.(K1, K2,K3 &K4)

2.2 Constituents of milk and their physicochemical properties.(K1, K2,K3 & K4)

2.3 Chemical change taking place in milk due to processing parameters- boiling, pasteurization, sterilization and homogenization.(K1, K2, K3&K4)

2.4 Definition and composition of creams, butter, ghee and icecreams. (K1, K2,K3 &K4)

2.5 Milk powder-definition, need for making powder. (K1, K2,K3 & K4)

2.6 Principles involved in drying process- spray drying and drum drying.(K1, K2,K3 & K4)

Unit III:(15 Hours)

3.1 Leather Chemistry: Introduction, chief process used in leather manufacture.(K1,K2,K3 & K4)

3.2 Structure of hide and skin.(K1, K2,K3 & K4)

3.3 Leather processing-process before tannage. (K1, K2, K3& K4)

3.4 Tanning process- vegetable tanning and chrome tanning. (K1, K2, K3& K4)

3.5 Finishing process - dyeing and fat liquoring. (K1, K2, K3& K4)
3.6 Tannery effluent and by product problems and treatment. (K1, K2, K3& K4)

Unit IV: (15 Hours)

4.1 Soil Chemistry: Introduction-soil classification. (K1, K2,K3 & K4)
4.2 Properties of soil, soil water, soil air, soil temperature, soil minerals, soil colloids, soil reaction and buffering. (K1,K2,K3 & K4)
4.3 Soil pH, soil acidity, soil salinity and alkalinity. (K1, K2,K3 & K4)
4.4 Cation Exchange Capacity and its significance. (K1, K2, K3&K4)
4.5 Soil fertility and soil formation. (K1, K2,K3 &K4)
4.6 Nutrient cycle –Biological nitrogen fixation. (K1, K2, K3& K4)

Unit V: (15 Hours)

5.1 Water Chemistry: Sources of water.K1, K2, K3 &K4)
5.2 Physical characeristics-colour, temperature, turbidity, Total solids, Total Dissolved Solids.(K1, K2, K3 &K4)
5.3 Chemical characteristics - Hardness, degree of hardness, temporary and permanent hardness, Scale formation, removal of hardness.(K1, K2, K3 &K4)
5.4 pH, Alkalinity, Dissolved Oxygen..(K1, K2, K3 &K4)
5.5 Biological characteristics – Biological Oxygen Demand.(K1, K2, K3 &K4)
5.6 Reverse osmosis and ion exchange methods – principle and functions.(K1, K2, K3&K4)

Reference Books:

1. G.R. Agarwal, Kiran Agarwal and O.P. Agarwal, Agarwal's Text Book of Biochemistry, 18th Edition, Goel Publishing House, 2015.
2. Jayashree Ghosh, Fundamental Concepts of Applied Chemistry, 1st Edition, S.Chand& Co. Ltd, New Delhi, 2013.
3. Clarence Henry Eckles, Willes Barnes Combs, Harold Macy, Milk and Milk Products, 4th Edition, Tata McGraw Hill Publishing Company Ltd, Reprint 2002.
4. B.K.Sharma, Industrial Chemistry, 13th Edition, Goel Publishing House, Reprint 2016.
5. Dilip Kumar Das, Introductory Soil Science, 4th Edition, Kalyani Publishers, Reprint 2017.
6. Gurdeep Chatwal, Organic Chemistry of Natural Products, Vol. 2, Himalaya Publishing House, Reprint, 2018.
7. M. Satake, Y. Mido, Chemistry of Colour, 1st Edition, Discovery Publishing House, Reprint 2003.

Open Educational Resources (OER)

1. http://ecoursesonline.iasri.res.in/course/view.php?id=92
2. http://wwwchem.uwimona.edu.jm/courses/CHEM2402/Textiles/Leather.html

3. http://mimoza.marmara.edu.tr/~kyapsakli/enve202/Lecture12_Soil%20Chemistry.pdf
http://inside.mines.edu/~epoeter/_GW/21WaterChem5/WaterChem5pdf.pdf

SEMESTER VI – MAJOR ELECTIVE III B

UECHF20- PHARMACEUTICAL CHEMISTRY

Year : III SEM :VI	Course Code UECHF20	Title of the Course Pharmaceutical Chemistry	Course Type Theory	Course Category Core Elective	H/W 5	Credits 5	Marks 100

Learning Objectives:

1. To give basic knowledge of the different terms used in pharmaceutical chemistry.
2. To know the examples, their actions, chemical compositions and uses of various drugs.
3. To study in detail the causes, symptoms and preventive measures of certain diseases.

Course Outcomes:
The Learners will be able to

1. Explain the basic pharmacological terms are used in pharmaceutical chemistry. Illustrate the selected Indian Medicinal plants and their uses.
2. Elaborate the definition, properties and therapeutic uses of sulphonamides, antibiotics, antiseptics and disinfectants.
3. Explain the role of analgesics and anesthetics.
4. Analyse the causes, symptoms and drugs used for the treatment of Cancer, AIDS, Epilepsy and Hypertension
5. Summarize the characteristics and classifications of cardiovascular drugs. Identify the common organic pharmaceutical aids.

CO	PSO					
	1	2	3	4	5	6
CO1	H	M	H	H	H	H
CO2	H	M	H	H	H	H
CO3	H	M	H	H	H	H

CO4	H	M	H	H	H	H
CO5	H	M	H	H	H	H

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

Unit I: (15 hours)

1.1 Definition of the following terms -drug, nature and sources of drugs, pharmacy, pharmacodynamics, pharmacokinetics, pharmacology, molecular pharmacology, pharmacophore, toxicology. (K1,K2, K3 & K4)

1.2 Bacteria, virus, difference between bacteria and virus, fungi, vaccine. (K1,K2, K3 & K4)

1.3 Causes, symptoms and drugs for anaemia, jaundice, cholera, malaria and filarial. (K1,K2, K3 & K4)

1.4 Causes, symptoms and drugs for dengue fever, chikungunya, typhoid. (K1,K2, K3 & K4)

1.5 Diagnostic test for sugar, salt and cholesterol in blood and urine. (K1,K2, K3 & K4)

1.6 Indian medicinal plants - medicinal uses and chemical present in neem, keezhanelli, mango, adathoda, thoothuvalai, hibiscus,rose, tulsi, turmeric, curry leaves, ficus.(K1,K2, K3 & K4)

Unit II:(15 hours)

2.1 Sulphonamides – definition, synthesis and therapeutic uses of prontosil, sulphathiozole. (K1,K2, K3 & K4)

2.2 Definition, synthesis and therapeutic uses ofsulphafurazole and sulphapyridine. (K1,K2, K3 & K4)

2.3 SAR of prontosil.(K1,K2, K3 & K4)

2.4 Antibiotics – definition, conditions, classifications. Properties, therapeutic uses and structureactivityrelationship of penicillin. (K1,K2, K3 & K4)

2.5 Properties, therapeutic uses and structural activity relationship of chloramphenicol, tetracyclines.(K1,K2, K3 & K4)

2.6 Antiseptics and disinfectants-definition and distinction, phenolic and chlorocompounds(K1,K2, K3 & K4)

Unit III:(15 hours)

3.1 Analgesics – definition, narcotic: natural, morphine and its derivatives, uses, SAR of morphine. (K1,K2, K3 & K4)

3.2 Synthetic - pethidine, methodone, morphinan, benzomorphan – disadvantages and uses. (K1,K2, K3 & K4)

3.3 Non-narcotic analgesics - salicylic acid and its derivatives, para-aminophenol derivatives, pyrazole derivative, indolyl and aryl acetic acid derivatives, ibuprofen, ketoprofen - therapeutic uses and adverse effects. n(K1,K2, K3 & K4)

3.4 Anaesthetics – definition, characteristics, classifications. (K1,K2, K3 & K4)

3.5 Volatile general anaesthetics - ether, vinyl ether, chloroform, halothane, trichloroethylene, ethylchloride, nitrous oxide, cyclopropane – uses and disadvantages. (K1,K2, K3 & K4)

3.6 Non-volatile general anesthetics - thiopental sodium, methohexitone, propanidid. Local anesthetics: requisites, natural- cocaine. Synthetic - benzocaine, procaine-uses, side effects. (K1,K2, K3 & K4)

Unit IV:(15 hours)

4.1 Cancer: definition, causes, treatment, drugs used (antineoplastics), alkylating agents, antimetabolites, plant products. (K1,K2, K3 & K4)

4.2 AIDS - causes, symptoms, prevention, AZT, DDC. (K1,K2, K3 & K4)

4.3 Hypoglycemic drugs, diabetes - types -causes, control, insulin- preparation, uses. Oral hypoglycemic agents. (K1,K2, K3 & K4)

4.4 Anticonvulsant agents - definition, types. Barbiturates, hydantoins, oxazolidenediones, succinimides. (K1,K2, K3 & K4)

4.5 Blood - grouping, composition, R_h factor. (K1,K2, K3 & K4)

4.6 Blood pressure - hypertension and hypotension, treatment. (K1,K2, K3 & K4)

Unit V:(15 hours)

5.1 Cardiovascular drugs – definition, action, cardiac glycosides, anti arrhythmic drugs-characteristics, classification, example - quinidine, propanol hydrochloride and uses. (K1,K2, K3 & K4)

5.2 Anti hypertensive agents – aldomet, pentolinium tartrate, reserpine. (K1,K2, K3 & K4)

5.3 Anti anginal agents – nitrites, dipyridamole, vasodilator, tolazoline hydrochloride, isoxsuprine hydrochloride, sodium nitroprusside, hydrallazine hydrochloride and papaverine. (K1,K2, K3 & K4)

5.4 Organic pharmaceutical aids- preservatives, properties, common preservatives used. (K1,K2, K3 & K4)

5.5 Colouring agents- properties, common colouring agents used. Sweetening agents- properties, common sweetening agents used. (K1,K2, K3 & K4)

5.6 Flavouring agents- properties and common flavouring agents used. (K1,K2, K3 & K4)

1. Jayashree Ghosh, A Textbook of Pharmaceutical Chemistry, 1st Edition, S.Chand& Co. Ltd., New Delhi, 2006.
2. Jayashree Ghosh, Fundamental concepts of Applied Chemistry, S.Chand& Co. Ltd., New Delhi, 2006.

Reference Books:

1. S. Lakshmi - Pharmaceutical Chemistry, Sultan Chand & Sons, 2nd Edition, 1998.
2. P. Sasikala and D. Gajapathy, Pharmaceutical Chemistry, 1990.
3. Gurdeep Chatwal, Organic Chemistry of Natural Products, Vol. 2 - Himalaya Publishing House, Reprint, 2000.

Open Educational Resources (OER):

1. https://www.youtube.com/watch?v=UXaXwDuUNfM (Pharmaceutical Aids)

2. https://carrington.edu/blog/how-to-test-blood-type/(Blood Groups & Rh factors)

SEMESTER VI

USCHD620 - FOOD CHEMISTRY

Year: III SEM: VI	Course Code	Title of the Course	Course Type	Course Category	H/ W	Credits	Marks
	USCHD620	Food Chemistry	Theory	Skill Based Elective	2	2	100

Learning Objectives:

1. To impart elementary ideas of various types of food, food additives, food poisons, food adulteration.
2. To emphasize the importance of vegetable and fruits.

Course Outcomes:

The Learners will be able to

1. Apply simple analytical techniques for detecting food adulterants.
2. Describe the role of food additives, preservatives, flavours, colours and antioxidants.
3. Detect food poisons and apply first aid techniques.
4. Distinguish between alcoholic and nonalcoholic beverages.
5. Describe the importance of saturated and unsaturated fats in edible oils and the nutritive value of fruits and vegetables.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

Unit I: (6 Hours)

1.1 Food and food adulteration, food types, advantages and disadvantages. (K1 & K2).

1.2 Food adulteration- adulteration in food grains, milk and butter. (K1 & K2)

1.3 Food adulteration- adulteration in ghee, ice creams and cakes. (K1 & K2)
1.4 Food adulteration- adulteration in pepper, turmeric and chilli powder. (K1 & K2)
1.5 Food adulteration- adulteration in edible oils, coffee and tea powder. (K1 & K2)
1.6 Detection of adulterants by simple analytical techniques, FSSAI and HACCP laws. (K1 & K2)

UnitII: (6 Hours)

2.1 Food additives - Definition, structure , advantages and disadvantages of artificial sweeteners – sucralose, saccharin, cyclamate and aspartate. (K1 & K2)
2.2 Food flavours-esters, aldehydes and heterocyclic compounds (K1 & K2)
2.3 Food flavours -spices - ajwain, aniseed, asafoetida, bay leaves, cardamom, cinnamon, cloves. (K1 & K2)
2.4 Food colours, emulsifying agents and preservatives . (K1 & K2)
2.5 Leavening agents- baking powder, baking soda, yeast. (K1 & K2)
2.6 Antioxidants- propyl gallate, butylated hydroxyl anisole and butylated hydroxyl toluene. (K1 & K2)

Unit III: (6 Hours)

3.1Food poison - pesticides and chemical poisons. (K1 & K2)
3.2 First aid for poison consumed victims. (K1 & K2)
3.3 Beverages - soft drinks- soda, carbonated drinks, fruit juices. (K1 & K2)
3.4 Alcoholic beverages- examples and composition. (K1 & K2)
3.5 Addiction to alcohol- diseases of liver. (K1 & K2)
3.6 Deaddiction measures. (K1 & K2)

Unit IV: (6 Hours)

4.1 Edible oils - fats, oils, sources of oils, saturated and unsaturated fats. (K1 & K2)
4.2 Importance of MUFA and PUFA. (K1 & K2)
4.3 Iodine value, RM value, saponification values and their significance. (K1 & K2)
4.4 Rancidity- types, hydrolytic and oxidative. (K1 & K2)
4.5 Test for rancidity (K1 & K2)
4.6 Prevention of rancidity. (K1 & K2)

Unit V:(6 Hours)

5.1 Vegetables and Fruits – classification and composition. (K1 & K2)
5.2 Nutritive value of green leafy vegetables, roots and tubers, other vegetables. (K1 & K2)
5.3 Pigments- water insoluble and water soluble pigments. (K1 & K2)
5.4 Vegetable cookery- preparation, changes during cooking, loss of nutrients during cooking. (K1 & K2)
5.5Fruits- classification and composition. (K1 & K2)
5.6 Ripening of fruits, chemical fruit ripening and storage of fruits. (K1 & K2)

Reference Books:

1. Lillian Hoagland Meyer, Food Chemistry, 1st Indian Edition, CBS Publishers and Distributors, 2004.
2. Norman W. Desrosier, James N. Desrosier, The technology of food preservation, 4th Indian Edition, CBS Publishers and Distributors, 1987.
3. Norman N. Potter, Joseph H. Hotchkiss, Food science, 5th Edition, CBS Publishers and Distributors, 1999.
4. Vijay Kaushik., Dietotherapy, 1st Edition, Mangal Deep Publications, 2008.
5. B.Srilakshmi, Food Science, 7th Edition, New Age International publishers, 2018.
6. Seema Yadav, Food Chemistry, 1st Edition, Anmol publications, 2006

Open Educational Resources:

1. https://freevideolectures.com/course/4443/nptel-dairy-food-process-products-technology/7
2. https://nptel.ac.in/content/storage2/courses/103103029/pdf/mod6.pdf
3. https://nptel.ac.in/courses/126/105/126105013/

UCCHL20 -PRACTICAL III: PHYSICAL CHEMISTRY PRACTICAL

Year: III SEM: VI	Course Code	Title of the Course	Course Type	Course Category	H/W	Credits	Marks
	UCCHL20	Physical Chemistry Practical	Practical	Core	2	4	100

Course Outcomes:

The Learners will be able to

1. Demonstrate practical skills in carrying out chemical reactions of different orders to arrive at reaction kinetics.
2. Estimate quantitatively using conductometric and potentiometric titrations
3. Assess the meaning of values and calculations in experiments and learn the techniques of getting rate constants through graphical methods.
4. Understand laboratory practices and safety/First aid rules.
5. Handle electronic equipments with technical skills

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H

CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

1. Kinetics

Determination of the order of the following reactions:

a) Acid catalysed hydrolysis of an ester (methyl or ethyl acetate)
b) Persulphate – Potassium iodide reaction kinetics
c) Iodination of acetone

2. Polarimetry

* Inversion of Sucrose

3. Molecular weight of a solute

Rast's method using naphthalene, metadinitrobenzene and diphenyl as solvents

4. Heterogeneous equilibria
   a) * Phenol- water system- CST

5. Effect of impurity – 2% NaCl or succinic acid solutions on CST of phenol-water system- determination of the concentration of the given solution.

6. Determination of transition temperature of the given salt hydrate

$Na_2S_2O_3.5\ H_2O$, $CH_3COONa.3H_2O$, $SrCl_2.6H_2O$, $MnCl_2.4H_2O$

7. Electrochemistry

Conductivity

a) Conductometric titration of a strong acid against a strong base.

8. Potentiometry
   a) Titration of a strong acid against a strong base

b) Determination of pH

9. To construct the phase diagram of a two-component system (Naphthalene-Biphenyl system) by cooling curve method.

* Not to be given for examination

Continuous Assessment – 40 marks
I C.A. - 50
II C.A. - 50
Average - 25
Performance during regular practicals-10
Regularity in submission of observation note-book and Record –5
Semester Practical examination – 60 marks
Principle writing – 5 marks
Viva-voce – 5marks
Record – 10 marks

1. Kinetics

Graph – 5 marks
Below a factor of 10 – 35 marks
By a factor of 10 – 25 marks
More than the above – 10 mark

2. Molecular weight & Effect of electrolyte

Error up to 10 % - 40 marks
10 – 20 % - 35 marks
21 – 30 % - 20 marks
Above 30% - 10 marks

3. Transition Temperature

Error up to 2^{o}C difference – 40 marks
Error up to 7^{o}C difference –25 marks
Error above 7^{o}C difference – 10 marks

4. Conductivity / Potentiometric titrations /pH

Error up to 10 % - 40 marks
Error up to 15 % - 30 marks
Error up to 20 % - 20 marks
Error above 20 % - 10 marks
(Proportionate marks are reduced for in between % of error)

Reference Books:

1. Departmental Lab Manual, 2018, Reprint 2020.
2. O.P. Pandey, D.N. Bajpai & S. Giri, Practical Chemistry, S. Chand & Company Ltd.,2001.
3. B. D. Khosla, V. C. Garg & A. Gulati, Senior Practical Physical Chemistry, S. Chand & Co.,

New Delhi, 2011.
4. C. W. Garland, J.W. Nibler, & D.P. Shoemaker, Experiments in Physical Chemistry 8th Ed.; McGrawHill: New York, 2003.
5. P.K. Mani and A.O. Thomas, A Textbook of Practical Chemistry, Scientific Publication, 1973.

Open Educational Resources (OER):

i. https://www.sciencebysimulation.com/chemreax/AnalyzerAB.asp (Kinetics)
ii. https://pages.uoregon.edu/tgreenbo/colligative.html (Rast Method)

UCCHM20-PRACTICAL IV: GRAVIMETRIC ESTIMATION

Year: III SEM: VI	Course Code	Title of the Course	Course Type	Course Category	H/W	Credits	Marks
	UCCHM20	Gravimetric Estimation	Practical	Core	2	4	100

Course Learning Outcomes:

The Learners will be able to

1. Quantitatively estimate metal ions using gravimetric analysis.
2. Gain knowledge on the choice of precipitating methods, reagents, crucibles and filtration.
3. Identify common errors in gravimetric analysis.
4. Outline the favourable conditions for precipitation and factors affecting the particle size of the precipitate.
5. Relate particle size of the precipitates with choice of crucibles used in gravimetric estimations.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	H	H	H	H
CO2	H	H	H	H	H	H
CO3	H	H	H	H	H	H
CO4	H	H	H	H	H	H
CO5	H	H	H	H	H	H

CO	PO					
	1	2	3	4	5	6

CO1	H	H	H	H	H	H
CO2	H	H	H	H	H	H
CO3	H	H	H	H	H	H
CO4	H	H	H	H	H	H
CO5	H	H	H	H	H	H

1. Estimation of sulphate as barium sulphate
2. Estimation of barium as barium sulphate
3. Estimation of barium as barium chromate
4. Estimation of lead as lead chromate
5. Estimation of lead as lead sulphate
6. Estimation of nickel as DMG complex

Continuous Assessment – 40 marks

I C.A. - 50
II C.A. - 50
Average - 25
Performance during regular practicals-10
Regularity in submission of observation note-book and Record –5

Semester Practical examination – 60 marks

Viva-voce -5
Record -10
≤ 2% -45 marks
> 2 up to 3% -35 marks
> 3 up to 4% -25 marks
>4 % -15 marks

Open Educational Resources:

1. https://www.khanacademy.org/science/chemistry/chemical-reactions-stoichiome/limiting-reagent-stoichiometry/a/gravimetric-analysis-and-precipitation-gravimetry

UCCHN20 – PRACTICAL V: MICRO SCALE ORGANIC ANALYSIS & PREPARATION

Year: III SEM: VI	**Course Code** UCCHN20	**Title of the Course** Micro Scale Organic Analysis & Preparation	**Course Type** Practical	**Course Category** Core	**H/W** 2	**Credits** 4	**Marks** 100

Course Learning Outcomes:

The Learners will be able to

1. Apply the concepts of micro scale analysis in organic qualitative analysis.
2. Develop skill to analyse systematically the given organic mixture and identify the functional group and special elements.
3. Prepare simple organic compounds.
4. Discuss the importance of laboratory practices and safety/First aid rules for handling the organic chemicals.
5. Explain the significance of organic reactions to understand the theory concepts of organic chemistry.

CO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	H	H	H	H	H
CO2	H	H	H	H	H	H
CO3	H	H	H	H	H	H
CO4	H	H	H	H	H	H
CO5	H	H	H	H	H	H

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	H	H	H	H	H
CO2	H	H	H	H	H	H
CO3	H	H	H	H	H	H
CO4	H	H	H	H	H	H
CO5	H	H	H	H	H	H

1. Organic Preparations
   a) Oxidation (benzaldehyde to benzoic acid)
   b) Hydrolysis (methyl salicylate or ethyl benzoate or benzamide to acid)
   c) Nitration (nitrobenzene to m-dinitrobenzene)

d) Bromination (parabromoacetanilide from acetanilide)
e) Benzoylation (betanaphthol to betanaphthyl benzoate)
f) Acetylation (salicylic acid to aspirin)

2. Organic analysis: Reactions of the following functional groups:
Aldehyde, ketone, carboxylic acid (mono and di), ester, carbohydrate (reducing and non reducing), phenol, aromatic primary amine, amide (mono and di), nitrocompound and anilide.

Analysis of organic compounds containing one or two functional groups and characterization with a derivative.

Continuous Assessment – 40 marks

I C.A.	- 50
II C.A.	- 50
Average	- 25

Performance during regular practicals-10
Regularity in submission of observation note-book and Record –5

Semester Practical examination – 60 marks

Viva-voce	-5
Record	-10
Preparation	- 10 (Quantity-5, Quality-5)
Organic Analysis	- 35
Preliminary Tests	- 3
Special element	- 6
Aliphatic/Aromatic	- 4
Saturated/unsaturated	- 4
Functional group	- 8
Other tests	- 6
Derivative	- 4

References:

1. A.I. Vogel, A.R. Tatchell, B.S. Furnis, A.J. Hannaford and P.W.G. Smith, Vogel's Textbook of Practical Organic Chemistry, 5 th Edition, Pearson,2005.
2. Darshan V. Chaudhary, Organic Chemistry Practicals and Important Reagents, 1st Edition, Createspace Independent Pub, 2016.

Open Educational Resources (OER):

1. https://www.toppr.com/guides/chemistry/organic-chemistry/qualitative-analysis-of-organic-compounds/
2. https://vlab.amrita.edu/?sub=2&brch=191&sim=345&cnt=1

SEMESTER – V/VI

UGCHA520/620 - FOOD AND NUTRITION CHEMISTRY

Year : III SEM : V&VI	**Course Code** UGCHA520/620	**Title of the Course** Food & Nutrition Chemistry	**Course Type** Theory	**Course Category** Elective	**H/ W** 3	**Credits** 2	**Marks** 100

Learning Objectives:

1. To impart knowledge about the importance of food and its impact on human health.
2. To highlight the nutritive value of fruits and vegetables and the importance of balanced diet.

Course Outcomes:

The Learners will be able to

1. Explain the sources, classification, functions, deficiency diseases and metabolism of carbohydrates.
2. Explain the sources, classification, functions, deficiency diseases and metabolism of proteins and fats.
3. Outline the sources, functions and deficiency diseases of fat soluble and water soluble vitamins.
4. Describe the sources, functions, and deficiency diseases and RDA of essential and trace minerals.
5. Appreciate the nutritive values and evaluate the chemical changes and loss of nutrients during cooking and storage of fruits and vegetables.

CO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	M	H	H	H	H
CO2	H	M	H	H	H	H
CO3	H	M	H	H	H	H
CO4	H	M	H	H	H	H
CO5	H	M	H	H	H	H

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H

CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

Unit I: (9 Hours)

1.1. Nutrition and Health – concept. (K1, K2)
1.2. Classification of food. (K1, K2)
1.3. Nutrients - macro and micro nutrients. (K1, K2)
1.4. Carbohydrates - sources, classification, functions, deficiency diseases, energy requirements. (K1, K2)
1.5. Blood sugar level. (K1, K2)
1.6. Carbohydrates metabolism - Glycolysis, Glyconeogenesis, Glycogenolysis. (K1, K2&K3)

Unit II: (9 Hours)

2.1. Proteins - sources, classification, functions. (K1, K2)
2.2. Deficiency diseases, energy requirements. (K1, K2)
2.3. Protein metabolism. (K1, K2&K3)
2.4. Fats - Sources, classification, functions. (K1, K2)
2.5. Deficiency diseases, energy requirements. (K1, K2)
2.6. Fat metabolism. (K1, K2&K3)

Unit III: (9 Hours)

3.1. Vitamins – classification, difference between fat soluble and water soluble vitamins. (K1, K2)
3.2. Fat soluble vitamins (A and D) (K1, K2)
3.3. Fat soluble vitamins (E and K) (K1, K2)
3.4. Water soluble vitamins (Thiamine, Riboflavin, Niacin Pyridoxine, Pantothenic acid,) sources, functions, deficiency diseases and daily requirements. (K1, K2)
3.5. Water soluble vitamins (Foliate, Choline, Biotin,Cyanocobalamin) sources, functions, deficiency diseases and daily requirements. (K1, K2)
3.6. Ascorbic acid - sources, functions, deficiency diseases and daily requirements. (K1, K2)

Unit IV: (9 Hours)

4.1. Minerals – classification. (K1, K2)
4.2. Major elements (Ca, P, Na, K) sources, functions, deficiency diseases and recommended requirements. (K1, K2)
4.3. Major elements (Fe, Mg, I and F), sources, functions, deficiency diseases and recommended requirements. (K1, K2)
4.4. Trace elements (Zn, Cu, Co, Se, Mo) - sources, functions, deficiency diseases and recommended requirements. (K1, K2)
4.5. Balanced diet - Recommended diet for adult - Indian men and women. (K1, K2)
4.6. Diet in pregnancy and lactation. (K1, K2)

Unit V: (9 Hours)

5.1. Vegetables – Nutritive value of green leafy vegetables, roots and tubers. (K1, K2)
5.2. Vegetable cookery (preliminary preparation, changes during cooking, loss of nutrients during cooking). (K1, K2)
5.3. Fruits – Nutritive value of fruits, pigments, water, cellulose and pectic substances, flavour constituents, polyphenols, bitterness in fruits. (K1, K2)
5.4. Ripening of fruits – chemical ripening. (K1, K2)
5.5. Storage of fruits. (K1, K2)
5.6. Antioxidants - antioxidant properties of vegetables and fruits. (K1, K2)

Text Books:

1. B.Srilakshmi, Food Sciences, 5th Edition, New Age International Publishers, 2010.
2. Shrinandan Bansal, Food and Nutrition, 2nd Edition, AI.T.B.S Publishers, India, 2010.

Reference Books:

1. K. Park - Park's Text Book of Preventive and Social Medicine, 20th Edition, Banarsidas Bhanot Publishers, Jabalpur, 2009.
2. G.R.Agarwal, Kiran Agarwal and O.P.Agarwal, Agarwal's Textbook of Biochemistry, 11th Edition, Goel Publishing House, 2000.
3. Ambiga Shanmugam, Fundamentals of Biochemistry for Medical Students, 8th Edition, Reprint 2016.

Open Educational Resources (OER):

1. http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=444 (Different methods of cooking)
2. http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=444 (Classification of carbohydrates)
3. http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=444 (Functions of food)

NON-MAJOR ELECTIVE – II

UGCHB520/620 -COSMETICS AND DYES

Year: III SEM: V/VI	Course Code: UGCHB520/620	Title of the Course: Cosmetics and Dyes	Course Type: Theory	Course Category: Elective	H/W 3	Credits 2	Marks 100

Learning Objectives:

1. To give a basic introduction to cosmetics, their classification and uses.
2. To give a broad overview on the disadvantages of using synthetic cosmetics over herbal cosmetics, cosmetic safety and evaluation method, etc.
3. To give an introduction to dyes and their applications in various industries from textile to pharmacy and food, contribution of various industries to environmental pollution and its effect on human health.

Course Outcomes:

The learners will be able to

1. Define and classify cosmetics, deodorants, antiperspirants, perfumes, aerosols and identify the pros and cons of synthetic cosmetics.
2. Describe the safety assessment methods used by FDA.
3. Prepare and use fruits and vegetables based herbal cosmetics and evaluate the significance of aromatherapy and apply it to human health and beauty.
4. Explain the properties of natural and synthetic dyes.
5. Understand the impact of dyes used in textile and leather industry to environmental pollution and analyse the importance of dyes in pharmaceutical and food industry.

CO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	M	H	H	H	H
CO2	H	M	H	H	H	H
CO3	H	M	H	H	H	H
CO4	H	M	H	H	H	H
CO5	H	M	H	H	H	H

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

Unit I: (9 hours)

1.1 Cosmetics – definition & classification based on use. (K1, K2)

1.2 Components of cosmetics. (K1, K2)

1.3 Deodorants, antiperspirants. (K1, K2)
1.4 Aerosols, perfumes and fragrances. (K1, K2)
1.5 Pros and cons of synthetic cosmetics. (K1, K2, K3)

Unit II: (9 hours)

2.1 Safety of Cosmetics. (K1, K2)
2.2 Basic concept of cosmetic safety. (K1, K2)
2.3 Safety test items. (K1,K2,K3)
2.4 Evaluation method. (K1, K2, K3)
2.5 Skin irritation, sensitization. (K1, K2)
2.6 Testing on human (Patch test, Usage test). (K1, K2)

Unit III: (9 hours)

3.1 Herbal cosmetics. (K1, K2)
3.2 Fruits and vegetables as hair care and skin care (apple, apricot, banana, carrot, cucumber, honey, lemon, tomato). (K1, K2)
3.3 Herbal Perfumes and fragrance. (K1, K2)
3.4 Skin care herbs – olive oil, sesame oil, black pepper, Amla. (K1, K2, K3)
3.5 Aromatherapy – various oils used in aromatherapy and their significance. (K1,K2, K3)
3.6 Standardization of herbs – importance, methods employed for standardization of herbal extracts. (K1, K2)

Unit IV: (9 hours)

4.1 Dyes - definition of dyes and types. (K1, K2)
4.2 Requirements of a good dye i.e.Colour, chromophore and auxochrome, solubility, linearity, coplanarity, fastness, substantivity, definition of fastness and its properties. (K1, K2,K3)
4.3 Mordants Definition with examples. (K1, K2)
4.4 Natural dyes - Definition; Advantages and limitations of natural dyes. (K1, K2)
4.5 Examples and uses of natural dyes with respect to henna, turmeric, saffron, indigo, chlorophyll –names of the chief dyeing material/s in each of the natural dye (structures not expected) (K1, K2)
4.6 Synthetic dyes - definition of synthetic dyes, primaries and intermediates. (K1, K2)

Unit V: (9 hours)

5.1 Textile uses of dyes - impact of the textile and leather dye Industry on the environment with special emphasis on water pollution.(K1, K2, K3, K4)
5.2 Non textile uses of dyes - biomedical uses – Tablets, syrups and capsules. (K1, K2, K3, K4)
5.3 DNA markers and therapeutics. (K1, K2, K3)
5.4 Dyes in food and cosmetics - commonly used food colors and their limits. (K1, K2, K3)
5.5 Properties of dyes used in food and cosmetics. (K1, K2, K3)

5.6 Dyes sensitized solar cells – A tool to overcome the future energy crisis. (K1, K2)

Reference Books:

1. Venkatraman K, Chemistry of Synthetic Dyes, Vol I – VIII, Academic Press 1972.
2. Lubs H.A., Robert E . The Chemistry of Synthetic Dyes and Pigments, Krieger Publishing Company, NY 1995.
3. Shenai V.A., Chemistry of Dyes and Principles of Dyeing, Sevak Publications, 1973.
4. Sodhi. G. S., Fundamental Concepts of Environmental Chemistry, 3rd Edition, Narosa Publishers, 2013.
5. Kirpal Singh, Chemistry in Daily Life, 3rd Edition, Prentice Hall of India Pvt., Ltd., 2012.
6. Dr. J. C. Kurian, Plants that heal, Vol 1., P.H. Lall, Oriental Watchman Publishing House, 1995.
7. C P Khare, Indian Medicinal plants: An illustrated Dictionary, Springer Science, 2007.
8. BehlPN, Srivatsava G., Herbs useful in dermatological Therapy, 2nd Edition, CBS Publishers & Distributors, 2002.
9. H. Panda, Herbal Soaps and Detergents Handbook, NIIR project consultancy services, 2011.
10. Jayashree Ghosh, Fundamental Concepts of Applied Chemistry, 2nd Edition, S. Chand & Company Ltd., New Delhi, 2006.
11. B C Maumdar, P C Mukhopadhyay, Principles and Practice of Herbal Garden, Daya Publishing House, New Delhi, 2006.

Open Educational Resources (OER)

1. http://fsdaup.gov.in/reg-drug-and-costmetic.htm
2. https://www.theherbarie.com/The-Herbarie-Formulary.html
3. https://www.medicalnewstoday.com/articles/10884#essential_oils
4. https://www.britannica.com/technology/dye

SEMESTER I

UACHA20–ALLIED CHEMISTRY I

Year: I SEM: I	Course Code UACHA20	Title of the Course Allied Chemistry I	Course Type Theory	Course Category Allied	H/W 4	Credits 4	Marks 100

Learning Objectives:

1. To help the students understand the concepts in industrial and polymer chemistry.
2. To impart knowledge on aromatic compounds and heterocyclic compounds.
3. To highlight the importance of chemical kinetics.
4. To learn the methods of separation through chromatographic techniques.

Course Outcomes:

The Learners will be able to:

1. Understand and apply the concept of aromaticity, mechanism of electrophilic substitution reaction, and chemistry of heterocyclic compounds.

2. Explain the terms involved in kinetics and methods of determination of order of the reaction, and understand the theories of reaction rates.

3. Classify polymers and explain its preparation, properties and uses.

4.Understand the concepts, types of chromatographic techniques, principles of volumetric analysis, and describe the separation and purification techniques.

5. Understand the composition and uses of fuel gases, cement, glass, explosives and dyes.

CO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	M	H	H	H	H
CO2	H	M	H	H	H	H
CO3	H	M	H	H	H	H
CO4	H	M	H	H	H	H
CO5	H	M	H	H	H	H

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

Unit I: (12 hours)

1.1 Aromatic compounds-aromaticity, Huckel's rule. (K1, K2, K3 & K4)

1.2 Application of Huckel's rule for benzenoid and nonbenzenoid compounds (benzene, naphthalene, anthracene, pyridine and quinoline, azulene and ferrocene). (K1, K2, K3 & K4)

1.3 Preparation, properties and uses of naphthalene. (K1, K2, K3 & K4)

1.4 Heterocyclic compounds-preparation, properties and uses of furan, thiophene, and pyrrole. (K1, K2, K3 & K4)

1.5 Electrophilic substitution in benzene-mechanism of nitration, halogenation, and sulphonation. (K1, K2, K3 & K4)

1.6 Electrophilic substitution in benzene-mechanism of alkylation and acylation(K1, K2, K3 & K4)

Unit II: (12 hours)

2.1 Chemical kinetics-rate of reaction, rate law(K1, K2, K3 & K4)

2.2 Factors affecting rate of the reaction. (K1, K2, K3 & K4)

2.3 Molecularity and Order of the reaction, methods of determining the order of a reaction. (K1, K2, K3 & K4)

2.4 Derivation of rate constant of a first order reaction and half life period. (K1, K2, K3 & K4)

2.5 Arrhenius theory- effect of temperature on reaction rate. (K1, K2, K3 & K4)

2.6 Collision theory for a bimolecular reaction. (K1, K2, K3 & K4)

Unit III:(12 hours)

3.1 Polymer chemistry- classification of polymers. (K1, K2, K3 & K4)

3.2 Natural and synthetic rubbers with examples.(K1, K2, K3 & K4)

3.3 Preparation and uses of nylon 6, 6 and terylene. (K1, K2, K3 & K4)

3.4 Preparation and uses of polyethylene and PVC. (K1, K2, K3 & K4)

3.5 Protein fibers– chemical composition(K1, K2, K3 & K4)

3.6 Properties of wool and silk(K1, K2, K3 & K4)

Unit IV:(12 hours)

4.1 Introduction to qualitative and quantitative analysis(K1, K2, K3 & K4)

4.2 Principles of volumetric analysis. (K1, K2, K3 & K4)

4.3 Separation and purification techniques – extraction, distillation and crystallization.(K1, K2, K3 & K4)

4.4 Chromatography- column chromatography - principle, packing of columns, method of separation, identification of compounds and applications. (K1, K2, K3 & K4)

4.5 Paper chromatography – principle, procedure, R_f value and applications. (K1, K2, K3 & K4)

4.6Thin layer chromatography - principle, procedure, $R_f$value and applications. (K1, K2, K3 & K4)

Unit V:(12 hours)

5.1 Industrial chemistry-fuel gases - natural gas, water gas, semi water gas, carburetted water gas, oil gas and producer gas (composition and uses only).(K1, K2, K3 & K4)
5.2 Cement-composition, setting of cement and uses(K1, K2, K3& K4)
5.3 Types of glasses(K1, K2, K3 & K4)
5.4 Dye chemistry- terms - chromophore, auxochrome, bathochromic shift, hypsochromic shift, hyperchromic shift. (K1, K2, K3 & K4)
5.5 Azo and triphenylmethane dyes - preparation of methyl orange.(K1, K2, K3 & K4)
5.6 Explosives – TNT, nitroglycerine and dynamite(K1, K2, K3 & K4)

References:

1. B.R Puri, L. R Sharma, and Kalia K. C., Principles of Inorganic Chemistry,Shoban Lal, Nagin Chand and Co, 29th Edition, 2004.
2. B.S.Bahl and ArunBahl,Advanced Organic Chemistry, Sultan Chand and Co., Ltd., Reprint 2007.
3. B. R. Puri, L. R Sharma and M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co., January 2019.
4. V.Veeraiyan and A.N.S. Vasudevan, Textbook of Allied Chemistry, High Mount Publishing House, 2003.
5. G.S.Misra, Introduction to Polymer Chemistry, New Age International Publishers, 2005.

Open Educational Resources (OER):

1. https://www.pslc.ws/macrog/kidsmac/wiap.htm - Basics of Polymers
2. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=997 - Polymer
3. https://microbenotes.com/chromatography-principle-types-and-applications/- chromatography

SEMESTER II

UACHB20–ALLIED CHEMISTRY II

Year: I SEM: II	Course Code UACHB20	Title of the Course Allied Chemistry II	Course Type Theory	Course Category Allied	H/W 4	Credits 4	Marks 100

Learning Objectives:

1. To help the students understand the concepts in coordination and medicinal chemistry.
2. To throw light on stereochemistry.
3. To highlight the importance of electrochemistry and photochemistry.
4. To impart knowledge on medicinal chemistry.

Course Outcomes:

The Learners will be able to
1. Understand the nomenclature and theories of coordination compounds.
2. Understand the concepts of isomerism and tautomerism.
3. Explain the concepts of electrolytes and its types, buffer solutions, separation techniques, and construction of electrochemical cell.
4. Understand the basic principles of photochemistry and kinetics of hydrogen-chlorine reaction.
5. Recall the basic terms in medicinal chemistry, and discuss the causes, symptoms and treatment of cancer, diabetes and AIDS.

CO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	M	H	H	H	H
CO2	H	M	H	H	H	H
CO3	H	M	H	H	H	H
CO4	H	M	H	H	H	H
CO5	H	M	H	H	H	H

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	M	H	H	H	H
CO2	H	M	H	H	H	H
CO3	H	M	H	H	H	H
CO4	H	M	H	H	H	H
CO5	H	M	H	H	H	H

Unit I: (12 hours)

1.1 Co-ordination chemistry – definition of the terms - ligands, chelate, chelation.(K1,K2,K3 & K4)

1.2 Nomenclature of mononuclear complexes. (K1,K2,K3 & K4)

1.3 Werner's and Pauling theory, Sidgwick's theory. (K1,K2,K3 & K4)

1.4 Effective Atomic Number rule.(K1,K2,K3 & K4)

1.5 Chemistry of EDTA.(K1,K2,K3 & K4)

1.6 Chemistry of haemoglobin and chlorophyll.(K1,K2,K3 & K4)

Unit II: (12 hours)

2.1 Isomerism- types of isomerism.(K1,K2,K3& K4)

2.2 Stereoisomerism-optical isomerism - cause of optical activity.(K1,K2,K3& K4)

2.3 Optical isomerism of lactic acid and tartaric acid, R- S notation (one asymmetric carbon atom). (K1,K2,K3& K4)

2.4 Racemisation and resolution. (K1,K2,K3& K4)

2.5 Geometrical isomerism of maleic and fumaric acids, E-Z notation. (K1,K2,K3& K4)

2.6 Tautomerism – keto-enol tautomerism. (K1,K2,K3& K4)

Unit III: (12 hours)

3.1 Ionic equilibria- strong and weak electrolytes, common ion effect. (K1,K2,K3& K4)

3.2 Definition of pH, pKa, pKb and pKw. Buffer solution.(K1,K2,K3& K4)

3.3 Electrochemical cells – construction, definition of emf, standard electrode potentials.(K1,K2,K3& K4)

3.4 Types of cells- primary and secondary.(K1,K2,K3& K4)

3.5 Principle of Standard hydrogen electrode and calomel electrode. (K1,K2,K3& K4)

3.6 Principle of Electrophoresis, electro-dialysis and electro-osmosis.(K1,K2,K3& K4)

Unit IV: (12 hours)

4.1 Photochemistry-Laws of light absorption- Lamberts law and Lamberts-Beer's law. (K1,K2,K3& K4)

4.2 Grotthus – Draper's law and Stark – Einstein's law of photochemical equivalence.(K1,K2,K3& K4)

4.3 Quantum yield (Definition) (K1,K2,K3& K4)

4.4 Photochemical reactions, kinetics of hydrogen and chlorine reaction. (K1,K2,K3& K4)

4.5 Jablonski diagram. (K1,K2,K3& K4)

4.6 Fluorescence, phosphorescence, photosensitization and chemiluminescence (definition, examples and applications).(K1,K2,K3& K4)

Unit V: (12 hours)

5.1 Medicinal chemistry - definition and one example each for analgesics, antipyretics antiseptics, tranquilizers, sedatives and hypnotics. (K1,K2,K3& K4)

5.2 Local anesthetics and general anesthetics. (K1,K2,K3& K4)

5.3 Antibiotics – structure and uses of Penicillin, Streptomycin and Chloramphenicol. (K1,K2,K3& K4)

5.4 Causes and treatment of diabetes. (K1,K2,K3& K4)

5.5 Causes and treatment of cancer.(K1,K2,K3& K4)

5.6 Causes and treatment of AIDS.(K1,K2,K3& K4)

References:

1. R.D.Madan, Modern Inorganic Chemistry,S.Chand and Co., Reprint 2004.
2. B.R Puri, L. R Sharma and Kalia K. C., Principles of Inorganic Chemistry,Shoban Lal, Nagin Chand and Co., 29th Edition, 2004.
3. B.S.Bahl and ArunBahl,Advanced Organic Chemistry, Sultan Chand and Co. Ltd., Reprint 2007.
4. K.S.Tewari, A Textbook of Organic Chemistry, Vikas Publishing House Pvt. Ltd., Reprint 2001.
5. B. R. Puri, L. R Sharma and M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co., January 2019.
6. V.Veeraiyan and A.N.S. Vasudevan, Textbook of Allied Chemistry, High Mount Publishing House, 2003.
7. Jayashree Ghosh, A Textbook of Pharmaceutical Chemistry, S.Chand and Company Ltd., Reprint 2005.

Open Educational Resources (OER)

1. https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Map%3A_Organic_Chemistry_(McMurry)/22%3A_Carbonyl_Alpha-Substitution_Reactions/22.03%3A_Keto-Enol_Tautomerism
2. https://www.askiitians.com/revision-notes/chemistry/coordination-compounds/
3. http://www.ecs.umass.edu/cee/reckhow/courses/Etreat/slides/597tl01p.pdf - Electrochemistry basics.

SEMESTER II

UACHC20–ALLIED CHEMISTRY II

Year: I SEM: II	Course Code UACHC20	Title of the Course Allied Chemistry Practicals	Course Type Practicals	Course Category Allied	H/W 2	Credits 2	Marks 100

Course Outcomes:

The Learners will be able to

1. Acquire skills in acid-base titrations.
2. Acquire skill in Permanganometry
3. Acquire skill in determining hardness of water
4. Analyse the elements presents in organic compounds.
5. Analyse the functional groupspresents in organic compounds

CO	PSO					
	1	2	3	4	5	6
CO1	H	M	H	H	H	H
CO2	H	M	H	H	H	H
CO3	H	M	H	H	H	H
CO4	H	M	H	H	H	H
CO5	H	M	H	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H

CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

I Volumetric Analysis:

1. Estimation of sodium hydroxide using standard sodium carbonate.
2. Estimation of Hydrochloric acid using standard oxalic acid.
3. Estimation of borax using standard sodium carbonate.
4. Estimation of ferrous sulphate using standard Mohr's salt.
5. Estimation of Oxalic acid using standard ferrous sulphate.
6. *Estimation of temporary and permanent hardness of water.

II Organic Analysis:

Reactions of aldehyde (aromatic), *ketone (aliphatic and aromatic), carbohydrate, carboxylic acid (mono and dicarboxylic), phenol, aromatic primary amine, amide and diamide.
Systematic analysis of organic compounds containing one functional group and characterization by confirmatory tests or derivatives.

References:

1. A R Kulandaivelu, R Veeraswamy & V Venkateswaran - Allied Practical Chemistry, 1/eS. Chand Publishers, ISBN – 9788121920575, 2001.
2. Alwin David - Allied Chemistry laboratory manual – I, ISBN: 978-93-5311-785-6**,** 2018.