B.Sc. Chemistry

Syllabus

(With effect from 2021)

DEPARTMENT OF CHEMISTRY
The Gandhigram Rural Institute – Deemed to be University
Gandhigram – 624 302 Tamil Nadu

TEMPLATE FOR UG PROGRAMME

S.NO	CATEGORY	NO. OF CREDITS
1.	Part-I Language : Tamil/Hindi/Malayalam/French (3 courses)	09
2.	Part-II Language: English (3 courses)	09 — 018
3.	Part-III Core Courses i) Major Course : Maximum 65 credits (Theory & Practical) ii) Allied Courses : (4 courses) iii) Electives : a) Discipline Centric (2 courses) b) Generic (2 courses) iv) Modular Course: (2 Courses) v) Project	65 - 065 16 06 06 — 036 04 04
4.	Part-IV i) Environmental Studies ii) Skill Development Course: a) Computer Course (1 courses) b) Skill Based Elective (1 course) c) Communication and Soft skills (1 course) iii) Language —111: Core Hindi/Tamil/Malayalam (2 courses)	04 03 02 — 015 02 04
5.	Part-V i) Gandhian Studies (I course) ii) Extension Education (1 course) iii) NSS/Sports/Fine Arts iv) Yoga v) Shanti Sena vi) VPP vii) Human Values and Professional Ethics	02 02 01 — 010 01 o1 02 01
	Total	120-144

Semester-wise Credit Distribution for B. Sc. Chemistry-2021

Course code	Title of the Course	Credits	Hours		Max. Marks		
			Theory	Practical	CFA	ESE	Total
FIRST SEMESTER							
21TAMU0101/ 21HIDU0101/ 21MALU0101/ 21FREU0101	Tamil / Hindi / Malayalam / French	3	3	-	40	60	100
21ENGU01X1	English	3	3	-	40	60	100
21CHEU0101	Basics of Chemistry - I	3	3	-	40	60	100
21CHEU0102	Practical I: Inorganic qualitative analysis	1	-	3	60	40	100
21MATU01A1	Allied Maths – I	4	4	-	40	60	100
21EVSU0101	Environmental studies	3+1	3	2	40	60	100
21NSSU0001 / 21FATU0001 / 21SPOU0001	NSS / Fine Arts / Sports	1	1	-	50	-	50
21YOGU0001	Yoga	1	1	-	50	-	50
Total		**20**	**18**	**5**			
SECOND SEMESTER							
21TAMU0202/ 21HIDU0202/ 21MALU0202/ 21FREU0202	Tamil / Hindi / Malayalam / French	3	3	-	40	60	100
21ENGU02X2	English	3	3	-	40	60	100
21CHEU0203	Basics of Chemistry - II	3	3	-	40	60	100
21CHEU0204	Practical II: Volumetric Analysis	1	-	3	60	40	100
21MATU02A2	Allied Maths – II	4	4	-	40	60	100
21CTAU0001 / 21CHIU0001	Core Tamil / Core Hindi / Core Malayalam	2	2	-	50	-	50
21ENGU00C1	Communication and Soft Skills	2	2	-	50	-	50
21GTPU0001	Gandhi's Life, Thought and Work	2	2	-	50	-	50
21EXNU0001	Extension Education	2	2	-	50	-	50
Total		**22**	**21**	**3**			
THIRD SEMESTER							
21TAMU0303/ 21HIDU0303/ 21MALU0303/ 21FREU0303	Tamil / Hindi / Malayalam / French	3	3	-	40	60	100
21ENGU03X3	English	3	3	-	40	60	100
21CHEU0305	Inorganic Chemistry- I	4	4	-	40	60	100
21CHEU0306	Practical III: Applied Chemistry	1	-	3	60	40	100
21PHYU03A1	Allied Physics-I	3	3	-	40	60	100
21PHYUO3A1	Allied Physics Practical – I	1	-	3	60	40	100
21CTAU0002 / 21CHIU0002	Core Tamil / Core Hindi / Core Malayalam	2	2	-	50	-	50
21SHSU0001	Shanthi Sena	1	2	-	-	-	-

21CSAU03A1	Computer Fundamentals and office automation	3	2	1	50	-	50
21EXNU03V1	VPP	2	-	-	50	-	50
Total		**23**	**19**	**7**			
Value added course offered -21CHEU3VA1 - Organic Surface Coatings							
FOURTH SEMESTER							
21CHEU0407	Organic Chemistry-I	3	3	-	40	60	100
21CHEU0408	Inorganic Chemistry-II	3	3	-	40	60	100
21CHEU0409	Physical Chemistry-I	3	3	-	40	60	100
21CHEU0410	Practical IV: Inorganic Quantitative Analysis	2	-	5	60	40	100
21PHYU04A2	Allied Physics-II	3	3	-	40	60	100
21PHYU04A3	Allied Physics Practical-II	1	-	3	60	40	100
21CHEU04DX	Discipline Centric Elective	3	3	-	40	60	100
21CHEU04GX	Generic Elective	3	3	-	40	60	100
*	Human Values and Professional Ethics (to be taken by GTPS)	1	-	-	50	-	50
Total		**22**	**18**	**8**			
Value added course offered -21CHEU4VA2 -Small Scale Industries & Waste Management							
FIFTH SEMESTER							
21CHEU0511	Inorganic Chemistry – III	4	4	-	40	60	100
21CHEU0512	Organic Chemistry - II	4	4	-	40	60	100
21CHEU0513	Physical Chemistry - II	4	4	-	40	60	100
21CHEU0514	Practical – V :Organic Qualitative Analysis	2	-	5	60	40	100
21CHEU05DX	Discipline Centric Elective	3	3	-	40	60	100
21CHEU05SX	Skill based Elective	2	2	-	50	-	50
21CHEU05GX	Generic Elective	3	3	-	40	60	100
Total		**22**	**20**	**5**			
Value added course offered -21CHEU5VA3 –Forensic Science							
SIXTH SEMESTER							
21CHEU0615	Organic chemistry –III	4	4	-	40	60	100
21CHEU0616	Physical Chemistry- III	4	4	-	40	60	100
21CHEU0617	Analytical Chemistry	4	4	-	40	60	100
21CHEU0618	Practical – VI: Physical Chemistry Practical	2	-	5	60	40	100
21CHEU06MX	Modular Course-I	2	2	-	50	-	50
21CHEU06MY	Modular Course-II	2	2	-	50	-	50
21CHEU0619	Project	4	-	8	40	40+20*	100
Total		**22**	**16**	**13**			
Value added course offered -21CHEU6VA4 –Development of Pharmaceutics and their uses							
Grand Total		**131**	**112**	**41**			

* 40 for external evaluation and 20 for concurrent Viva-Voce evaluation.

LIST OF DISCIPLINE CENTRIC ELECTIVE COURSES OFFERED

Course Code	Course Title	Credits
21CHEU04D1	Environmental Chemistry	3
21CHEU04D2	Industrial Chemistry	3
21CHEU04D3	Polymer Chemistry	3
21CHEU05D1	Chemistry of Natural Products	3
21CHEU05D2	Elements of Spectroscopy	3
21CHEU05D3	Green chemistry	3

LIST OF GENERIC ELECTIVE COURSES OFFERED

Course Code	Course Title	Credits
21CHEU04G1	Polymer Science	3
21CHEU04G2	Organic Chemistry for Home Science	3
21CHEU04G3	Chemistry in the Service of Mankind	3
21CHEU04G4	Food adulteration and analysis	3
21CHEU05G1	Pollution and its Control Measures	3
21CHEU05G2	Chemistry of Food	3
21CHEU05G3	Chemical Composition of Household Materials	3

SKILL BASED ELECTIVE COURSES OFFERED

Course Code	Course Title	Credits
21CHEU05S1	Clinical Chemistry	2
21CHEU05S2	Pharmaceutical Chemistry	2
21CHEU05S3	Analysis of adulteration in food	2

MODULAR COURSES OFFERED (Any two)

Course Code	Course Title	Credits
21CHEU06M1	Cosmetic Chemistry	2
21CHEU06M2	Nanoscience and its Applications	2
21CHEU06M3	Agricultural Chemistry	2
21CHEU06M4	Water Quality Analysis	2

VALUE ADDED COURSES OFFERED

Course Code	Course Title	Credits
21CHEU3VA1	Organic Surface Coatings	2
21CHEU4VA2	Small Scale Industries & Waste management	2
21CHEU5VA3	Forensic Science	2
21CHEU6VA4	Development of Pharmaceutics and their uses	2

B.Sc. CHEMISTRY

I SEMESTER

21CHEU0101 BASICS OF CHEMISTRY – I (3 Credits)

Objectives: The objective of the course is to develop an understanding of atomic structure, chemical bonding, periodic properties of elements. The course also aims to give an understanding on types of organic reactions and conformations as well as reactivity of alkanes.

Course outcome: After successful completion of the course, students will be able to

- *Describe atomic structure, orbital concepts, chemical bonding and their properties in inorganic molecules*
- *Explain the periodic properties of elements*
- *Predict the stability of reactive intermediates and explain the reaction mechanism*
- *Describe the conformations and properties of alkanes and cycloalkanes*

Unit I - Atomic Structure

Rutherford atomic model – Bohr theory of hydrogen atom – Sommerfeld theory - Particle and wave character of electrons – de Broglie's equation – Davisson- Germer experiment - Heisenberg's uncertainty principle Compton effect – Schrödinger wave equation – Eigen values and Eigen functions – quantum numbers – Pauli's exclusion principle –Orbits and Orbitals.

Unit II - Chemical Bonding

Types of bonds – ionic, covalent, coordinate and metallic bonds - condition for the bond formation - concept of hybridization – hybridization involving s-, p- and d-orbital – properties of ionic, covalent and coordinate compounds – valence bond theory –VSEPR theory. Molecular orbital theory – molecular orbital configurations of simple homo nuclear and hetero nuclear diatomic molecules – comparison between VBT and MOT – basic concept of resonance.

Unit III – Periodic Properties and Solutions

Periodic Properties: Periodicity of properties – Shielding effect – factors affecting magnitude of shielding - Effective Nuclear charge –Slater's rule – applications of effective nuclear charge – atomic volume – atomic radii, and ionic radii – factors affecting atomic and ionic radii - Ionization Energy – factors affecting ionization energy - Electronegativity – factors affecting electronegativity - Electron Affinity – factors affecting electron affinity – Diagonal relationship.

Solutions: Various units of expressing concentrations of solutions – solutions of liquid in liquids – ideal and non-ideal solutions – Raoult's law – solutions of gases in liquid.

Unit IV – Reactive intermediates and types of organic reactions

Homolytic and heterolytic bond fissions – Types of reagents - electrophiles and nucleophiles - Reactive intermediates: carbocations, carbanions, free radicals, carbene, nitrene and benzyne intermediates - definition and examples for inductive, mesomeric, hyper conjugation and steric effect. Types of organic reactions: addition, elimination, substitution, rearrangement, oxidation, reduction, polymerization.

Unit V - Alkanes

Nomenclature of alkanes - conformations of ethane, propane and butane. Nomenclature of cycloalkanes - Relative stabilities of cycloalkanes - ring strain; Baeyer's strain theory; heats of combustion; orbital structure of angle strain; conformations - cyclohexane; conformations of mono and disubstituted cyclohexanes.

Reactions of alkanes and cycloalkanes: Free radical reactions - Stability and ease of formation of free radicals; Halogenation of alkanes: mechanism; orientation; relative reactivities of alkanes towards halogenation; transition state; orientation and stability; reactivity and selectivity; non-rearrangement of free radicals

References:

1. Principles of Physical Chemistry, B. R. Puri, L.R. Sharma and M. S. Pathania, Vishal Publishing Co., 47th Ed., 2016.
2. Modern Inorganic Chemistry, R. D. Madhan and Sathya Prakash, 4th Ed., 1996.
3. A New Concise Inorganic Chemistry, J. D. Lee, Oxford Publishers, 5th Ed., 2014.
4. Organic Chemistry, R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee., Pearson Publishers, New Delhi, 7th Ed., 2011.
5. Organic Chemistry, Maitland Jones Jr, Steven A. Fleming, W. W. Norton & Company, London, 4th edition, 2010.
6. Organic Chemistry, T. W. Graham Solomons, Craig B. Fryhle. John Wiley & Sons, Inc., 10th edition, 2011.

PRACTICAL – I

21CHEU0102 INORGANIC QUALITATIVE ANALYSIS (1 Credit)

Objectives: The practical course is designed to develop skill in semi-micro inorganic analysis.

Course outcome: After successful completion of the course, students will be able to:

- *Analyze inorganic salts qualitatively and systematically eliminate interfering radicals.*
- *Identify elements in a given inorganic mixture by semi-micro qualitative analysis.*

Semi-micro qualitative analysis of inorganic mixtures containing two of the following cations and one of the interfering acid radicals and a simple acid radical.

Cations: Pb, Bi, Cu, Sn, Fe, Al, Cr, Ni, Co, Zn, Mn, Ca, Ba, Sr, Mg and NH_4^+.

Anions: Acetate, oxalate, tartarate, borate, chromate, chloride, iodide, bromide, nitrate, carbonate, sulphide, sulphate and phosphate.

References:

1. Practical Chemistry by A.O. Thomas, Scientific Book Centre, Cannanore, 2003.
2. Basic Principles of Practical Chemistry, V. Venkateswaran, R. Veeraswamy, A. R. Kulandaivelu, Sultan Chand & Sons, New Delhi, 2nd Ed., 2004.

II SEMESTER

21CHEU0203 BASICS OF CHEMISTRY – II (3 Credits)

Objectives: The objective of the course is to understand the basics of organic reactions, to know the chemistry of benzenes and arenes, to know the basic principles of metallurgy, to understand the chemistry of s-block elements, to know solid state and concept of conductor.

Course outcome: After successful completion of the course, students will be able to

- *Describe the chemistry of unsaturated organic molecules like alkenes and alkynes*
- *Predict the product of the electrophilic aromatic substitution and nuclear substitution reactions.*
- *Describe various metallurgical processes*
- *Justify the general and anomalous properties of s- block elements*
- *Describe the types of solids, symmetry elements, unit cell, powder-X-ray diffraction method and the concept of conductors.*

Unit I- Alkenes

Isomerism in alkenes: *cis- / trans-* and E/Z nomenclature - Preparation of alkenes: dehydrohalogenation, dehydration, dehalogenation and reduction of acetylene. Reactions of alkenes: regiochemistry of the addition reactions - Markovnikov's rule, peroxide effect; addition reactions of alkenes - hydrogenation, halogenation, oxymercuration, hydroboration, epoxidation, cyclopropanation, hydrohalogenation, addition of H_2O, hypohalous acid, hydroxylation with H_2O_2 and allylic substitution. Dipolar addition reactions: ozonolysis, oxidation with alkaline $KMnO_4$, oxidation with OsO_4.

Dienes: stability of isolated and conjugated double bonds - 1,2 and 1,4-addition: thermodynamic and kinetic control of addition reactions - Diels-Alder reaction.

Alkynes: Methods of preparation; addition reactions – addition reactions of alkynes - hydrogenation, halogenation, oxymercuration, hydroboration, acidity of alkynes.

Unit II - Benzene and Arenes

Aromaticity- Huckel's rule- nomenclature of benzene derivatives-structure of benzene – Electrophilic aromatic substitution reactions -mechanism of halogenation, sulphonation, and nitration - Friedel-Crafts alkylation - Friedel-Crafts acylation, theory of orientation – classification of substituent groups – effect of substituent groups. Birch reduction of aromatic compounds.

Benzyl group and its reactivity: Substitution reactions, radical reactions, oxidation at the benzylic position. Alkenyl benzenes - addition to conjugated alkenyl benzenes – orientation.

Unit III - Process of Metallurgy

Definition for minerals and ores - ore dressing – gravity separation - froth flotation-magnetic separation - chemical separation- calcination and roasting. Extraction of metal-chemical reduction-auto reduction-electrolytic reduction-metal displacement. Refining methods distillation - fractional crystallization - van Arkel method - electrolytic refining - vapour phase refining-ion exchange method-muffle furnace.

Unit IV - s-block Elements

General characteristics - anomalous behaviour of lithium and beryllium - diagonal relationships of lithium with magnesium and beryllium with aluminium. Preparation, properties and uses of lithium hydride, sodium peroxide, potassium iodide, calcium-carbide, super phosphate of lime, plaster of paris and lithopone.

Unit V - Solid State

Differences between crystalline and amorphous solids -symmetry in crystal systems - law of interfacial angles -law of rational indices - Miller indices - space lattice and unit cell-Bravis lattices-Bragg's equation - powder method. Packing in crystals - types of crystals - structure of sodium chloride - concept of conductor, semiconductor and superconductor- band theory.

References:

1. A New Concise Inorganic Chemistry, J. D. Lee, Oxford Publishers, 5th Ed., 2014.
2. Text book of Inorganic Chemistry, P. L. Soni, Sultan Chand & Sons, New Delhi, 20th Edn., 2000.
3. Organic Chemistry, R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee., Pearson Publishers, New Delhi, 7th Ed., 2011.
4. Organic Chemistry, Maitland Jones Jr, Steven A. Fleming, W. W. Norton & Company, London, 4th edition, 2010.
5. Organic Chemistry, T. W. Graham Solomons, Craig B. Fryhle. John Wiley & Sons, Inc., 10th edition, 2011.
6. Principles of Physical Chemistry, B.R. Puri, L.R. Sharma and M.S. Pathania, Vishal Publishing Co., 47th Edn., 2016.
7. Selected Topics in Inorganic Chemistry, Malik, Tuli, Madan, S. Chand & Co., New Delhi, 2010.

PRACTICAL – II

21CHEU0204 VOLUMETRIC ANALYSIS (1 Credit)

Objectives: The practical course is designed to understand basics and gain knowledge on laboratory reagents and their uses in volumetric analysis.

Course outcome: After successful completion of the course, students will be able to

- Prepare standard solutions
- Understand the concepts of volumetric analysis
- Carry out quantitative estimation of inorganic substances

1. Preparation of standard solutions.
2. Acidimetry-alkalimetry.
3. Permanganometry.
4. Redox titrations involving dichrometry.
5. Complexometric titrations.
6. Iodometry.
7. Iodimetry.
8. Precipitation titration.
9. Estimation of ferric iron by reduction method.

References:

1. Basic Principles of Practical Chemistry, V. Venkateswaran, R. Veeraswamy, A. R. Kulandaivelu, Sultan Chand & Sons, New Delhi, 2nd Edn.,2012.
2. Practical Chemistry by A.O. Thomas, Scientific Book Centre, Cannanore, 2003.

III SEMESTER

21CHEU0305 INORGANIC CHEMISTRY– I (4 Credits)

Objectives: The objective of the course is to understand the chemistry of p-block elements, to know the chemistry of halogens and inert gases and to understand radioactivity, transmutation, nuclear reactions and the applications of isotopes.

Course outcome: After successful completion of the course, the students willable to

- *Describe general characteristics, preparation of derivatives and structure of p-block elements, inter halogen compounds and inert gases.*
- *Explain the chemistry of radioactivity, types of nuclear reactions and application of isotopes in chemistry, agriculture and in medicine.*

Unit I - p-block Elements I

General characteristics of elements - diagonal relationship of boron with silicon. Preparation, properties and structure of orthoboric acid, borax and diborane-Borax bead test. Classification of carbides. Preparation, structure and uses of silicones-classification and structure of silicates. Relative strengths of boron trihalides as Lewis acids.

Unit II -p-block Elements II

Preparation, properties and structure of nitrogen dioxide, sulphur dioxide, phosphorous pentoxide, selenium oxide, orthophosphoric acid, arsenious oxide and ozone. Nomenclature and structure of oxyacids of phosphorus and sulphur.

Unit III - Halogens and Inert Gases

General characteristics, comparison of oxidizing action of halogens. Acid strengths of hydrogen halides- Nomenclature and structure of oxy acids of halogens. Preparation, properties and structure of interhalogen compounds. Inert gas-position in the periodic table-electronic configuration and reactivity- chemistry of xenon hexafluoride, xenon oxyfluoride and xenon trioxide.

Unit IV - Nuclear Chemistry – I

Composition of nucleus- nuclear stability- *n/p* ratio magic numbers- nuclear binding energy- mass defect - Radioactivity- types of radioactivity- types of radioactive rays -nuclear shell model - groups displacement law - decay constant – half-life period - radioactive equilibrium- transmutation- artificial transmutation- applications of artificial transmutation-radioactive series.

Unit V - Nuclear Chemistry – II

Nuclear reactions types: fission and fusion reactions-principle and working of nuclear reactors. Isotopes: Separation of isotopes- identification of isotopes- isotopes of hydrogen- isotope effect- application of isotopes in chemistry, agriculture and medicine - carbon dating - nuclear isomerism.

References:

1. A New Concise Inorganic Chemistry, J. D. Lee, Oxford Publishers, 5th Ed., 2014.
2. Text book of Inorganic Chemistry, P.L. Soni, Sultan Chand & Sons, New Delhi, 20thEdn., 2000.
3. Basic Inorganic Chemistry, F. A. Cotton, G. Wilkinson and P.L. Gaus John Wiley & Sons Inc F. Third Edition, 1995.

21CHEU0302 PRACTICAL III: APPLIED CHEMISTRY (1 Credit)

Objectives: The objective of the practical course is to enhance knowledge in basic principles of titrimetry, to develop skill in titrimetric analysis, to gain practical knowledge in oil analysis and to develop skill in identification of water quality parameters.

Course outcome: After successful completion of the course, students will be able to

- *Estimate certain organic compounds by titrimetry*
- *Analyze free fatty acids*
- *Calculate saponification value and iodine value*
- *Estimate water quality parameters*

1. Estimation of Phenol.
2. Estimation of Glucose (Fehling's method).
3. Estimation of Glucose (Bertrand's method).
4. Determination of iodine value of oil.
5. Determination of saponification value.
6. Determination of free fatty acid.
7. Estimation of total solids in H_2O.
8. Estimation of chloride in H_2O.
9. Estimation of fluoride in H_2O.
10. Alloy analysis.

Reference:

1. Basic Principles of Practical Chemistry, V. Venkateswaran, R. Veeraswamy, A. R. Kulandaivelu, Sultan Chand & Sons, New Delhi, 2nd Edn., 2004.

IV SEMESTER

21CHEU0407 ORGANIC CHEMISTRY – I (3 Credits)

Objectives: The objective of the course is to understand the chemistry of organic molecules based on the spatial orientation of constituent atoms or groups, to understand the chemistry of organo-halogen compounds, to know the chemistry of alcohols, ethers and epoxides, to understand the chemistry of carbonyl compounds and to understand the chemistry of polynuclear aromatic compounds and active methylene compounds.

Course outcomes: After successful completion of the course, the students will able to

- *Describe commonly used terms in stereochemistry*
- *Predict the configuration of a chiral organic molecule*
- *Demonstrate the detailed mechanism and stereochemistry of S_N1, S_N2,*
- *E1 and E2 reactions, electrophilic substitution and nucleophilic displacement reactions*
- *Describe the methods of preparation of alcholos, aldehydes and*
- *Ketones*
- *Demonstrate the reactions of aldehydes, ketones and polynuclear aromatic compounds*

Unit I – Stereochemistry

Optical isomerism- Optical activity, specific rotation, definition of optical isomerism – elements of symmetry, chirality, optical isomerism of compounds containing asymmetric carbon atoms – lactic and tartaric acids – enantiomers and diastereoisomers – racemic mixtures –Walden inversion – asymmetric synthesis – absolute configuration by R/S – notation, optical activity of compounds without asymmetric carbon atoms – allenes, spiranes and biphenyl compounds.

Unit II – Alkyl and Aryl Halides

Detailed study on mechanism and stereochemistry of S_N1, S_N2, E1 and E2 reactions. Electrophilic aromatic substitution in aryl halides– nucleophilic displacement.

Unit III – Alcohols and Ethers

Preparation – Oxymercuration and demercuration – Hydroboration and Oxidation – orientation, stereochemistry and mechanism of hydroboration – Grignard synthesis of alcohols. Glycols: periodic acid oxidation. Ethers: Williamson's synthesis – preparation of substituted ethers. Epoxides: Preparation – acid and base catalyzed cleavage of epoxides.

Unit IV – Aldehydes and ketones

Nomenclature, preparation, reaction of – nucleophilic addition reaction, reductions, Cannizarro reaction – acidity of α-hydrogen-reactions involving carbanions, base promoted and acid catalysed halogenations of ketones – aldol condensation, crossed aldol condensation, Claisen condensation, Perkin condensation and Knoevenagal reaction.

Unit V - Polynuclear Aromatic Compounds and Active Methylene Compounds

Naphthalene – anthracene, phenanthrene – reduction and substitutin reactions – Haworth's synthesis – Aromatization, orientation in polynuclear compounds. Synthetic uses of acetoacetic ester – decarboxylation of keto acids, Keto-enol tautomerism. Preparation and synthetic uses of malonic ester.

References:

1. Organic Chemistry R.T. Morrison and R.N. Boyd., Prentice Hall of India Pvt. Ltd., New Delhi, 7th Edn., 2011.
2. Organic Chemistry, I.L. Finar, ELBS, Vol 1. 6th Edn., 2002.

21CHEU0408 INORGANIC CHEMISTRY - II (3 Credits)

Objectives: The objective of the course is to understand the basic concepts of acids and bases, classification of solvents and their reactions, to learn the general characteristics of d- and f- block elements, to realize the chemistry of metal carbonyls and to gain knowledge of the functions of metal ions in biological systems.

Course outcomes: After successful completion of the course, the students will able to

- *Describe basic concepts of acids and bases*
- *Classify solvents and demonstrate reactions in non-aqueous solvents*
- *Predict the properties of d- and f-block elements*
- *Demonstrate the preparation and properties of few d- and f- block elements*
- *Classify and demonstrate the methods of preparation of organometallic compounds*
- *Describe the role of metals in biological systems such as enzymes and demonstrate the metal toxicity.*

Unit I - Acids and Bases

Lewis concept – Classification of Lewis acids – Lux-Flood concept – Hard-Soft acid base concept and its applications. Non- aqueous solvents- Classification of solvents- Neutralization reaction and solvolysis in liquid ammonia- Metal- ammonia solutions. Neutralisation, solvolysis and redox reactions in liquid sulphur dioxide.

Unit II - d-Block elements

General characteristics- electronic configuration, metallic character, ionization energy, variable valency, reducing property, colour, magnetic property, non-stoichiometric compounds, catalytic properties and tendency to form complexes. Preparation, properties and uses of potassium dichromate, potassium permanganate and manganese dioxide. Anomalous behaviour of mercury. Stability of oxidation states using standard electrode potential. Latimer diagram for dichromate and permanganate ions.

Unit III - f- Block elements

General characteristics- electronic configuration- oxidation states- colour and magnetic properties. Lanthanide and actinide contraction and their consequences. Separation methods- fractional crystallization, oxidation- reduction, ion-exchange method and chromatographic separation. Comparison between d-and f-block elements- uses of lanthanide compounds.

Unit IV - Organometallic Compounds

Metal carbonyls- definition and classification- General methods of preparation- effective atomic number rule - structure and bonding of mononuclear carbonyls of nickel, iron and chromium, binuclear carbonyls of iron, cobalt and manganese and trinuclear carbonyls of iron and osmium. Tetra nuclear carbonyls of iridium. Zeigler-Natta catalyst.

Unit V - Bio Inorganic Chemistry

Metals in biology-bulk and trace metals-biological role of myoglobin and hemoglobin- Metalloenzymes- carboxypeptidase - sodium and potassium ion pump- Biological functions and toxicity of chromium, manganese, cobalt, nickel, copper, arsenic, iodine and mercury.

References:

1. A New Concise Inorganic Chemistry, J. D. Lee, Oxford Publishers, 5^{th} Ed., 2014.
2. Text book of Inorganic Chemistry, P.L. Soni, Sultan Chand & Sons, New Delhi, 20^{th} Edn., 2000.
3. Selected topics in Inorganic Chemistry, W. U. Malik, G. D. Tuli and R. D. Madan, S. Chand & Co. Ltd., New Delhi, 2012.

21CHEU03A1 ALLIED CHEMISTRY–I (3 Credits)

Objectives: The objective of the course is to understand the structure and bonding of molecules, to have knowledge in crystal structures and their symmetry, to know basics of solutions and their properties, and to understand the concept of thermodynamics.

Course outcome: After successful completion of the course, students will be able to

- *Describe basic concepts in chemical bonding*
- *Assign the structure of simple chemical molecules*
- *Interpret the types of crystal and symmetries present in molecules.*
- *Describe the terms used in dilute solutions*
- *Describe the basics of nuclear chemistry and functions of nuclear reactors*
- *Describe the laws of thermodynamics*

Unit I - Chemical Bonding

Introduction-Ionic bond- characteristics of ionic compounds-covalent bond-characterristics of covalent compounds- coordinate bond -characteristics of coordinate complexes- inert pair effect; Fajan's rule-Octet rule - basic concepts of hydrogen bond.-types of hydrogen bonding-sigma and pi -bonds. Concept of hybridization, structures of $BeCl_2$, BF_3, CH_4, PCl_5, and SF_6 – VSEPR Theory.

Unit II - Solid State

Types of solids, symmetry of crystals, Miller Indices, unit cell, space lattice, Bragg's equation, classification of crystals on the basis of bonds, ionic crystals, molecular crystals, covalent crystals and metallic crystals. Structure of CsCl and NaCl, liquid crystals-applications.

Unit III - Dilute Solutions

Ways of expressing concentrations of solutions, Henry's law, solutions of solids in liquids, solubility and equilibrium concept. Colligative properties, definition, measurement of lowering of vapour pressure, elevation of boiling point, depression of freezing point and osmotic pressure, Raoult's law-derivation.

Unit IV - Nuclear Chemistry and Radioactivity

Types and properties of radiations, the group displacement law, rate of radioactive decay-types of radioactive decay- half-life period, nuclear fission and fusion reactions, artificial radioactivity, mass defect- n-p ratio and nuclear reactor.

Unit V – Thermodynamics

Thermodynamics terms-system-surroundings-intensive and extensive properties-state of a system-thermodynamic processes-reversible and irreversible processes-internal energy-first law of thermodynamics-enthalpy of a system-spontaneous process-entropy-entropy change for an ideal gas-Gibb's Helmholtz equations-free energy and work functions.

References:

1. Atkins' Physical Chemistry, *Peter Atkins, Julio de Paula, and James Keeler,* Oxford University Press, UK 11th Ed., 2017.
2. Text book of Inorganic Chemistry, *P.L. Soni*, Sultan Chand & Sons, New Delhi, 20th Ed.,2000.
3. Essentials of Physical Chemistry, *B. S. Bahl, G. D. Tuli and Arun Bahl*, S. Chand & Company Ltd, New Delhi, 12th Ed.,2011.
4. Principles of Physical Chemistry, *B.R. Puri, L.R. Sharma and M.S. Pathania*, Vishal Publishing Co., 47th Edn.,2016.
5. Selected Topics in Inorganic Chemistry, *Malik, Tuli, Madan,* S. Chand & Co., New Delhi,2010.

21CHEU03A2 ALLIED CHEMISTRY PRACTICAL–I (1 Credit)

INORGANIC QUALITATIVE ANALYSIS

Objectives: The practical course is designed to develop skills in identification of elements by semi-micro inorganic qualitative analysis.

Course outcome: After successful completion of the course, students will be able to

- *Analyze inorganic salts qualitatively and identify cations and anions present in a given unknown mixture of alts.*
- *Semi-micro qualitative analysis of inorganic salts containing the following cations and anions.*

  Cations: Pb, Cu, Al, Fe, Zn, Ca, Ba, Mg and ammonium.

  Anions : Oxalate, Borate, Carbonate, Fluoride, sulphate and Phosphate.

References:

1. Practical Chemistry by *A.O. Thomas*, Scientific Book Centre, Cannanore, 2003.
2. Basic Principles of Practical Chemistry, *V. Venkateswaran, R. Veeraswamy, A. R. Kulandaivelu*, Sultan Chand & Sons, New Delhi, 2nd Ed.,2004.
3. Vogel's Qualitative Inorganic Analysis, *G. Svehla*, 7th Ed., Dorling Kindersley, India, 4th Ed., 2009.

IV SEMESTER

21CHEU0409 PHYSICAL CHEMISTRY–I (4 Credits)

Objectives: The objective of the course is to understand basic principles, applications of thermodynamics, to understand basics of surface chemistry and surface phenomena, to impart the knowledge of basic interactions between molecules and to gain familiarity of the forces existing in molecular systems.

Course outcomes: After successful completion of the course, the students will able to

- *Solve problems in thermodynamics and describe the concepts of thermochemistry*
- *Interpret the concepts and theories of surface chemistry and colloids*
- *Analyze the surface using BET theory*
- *Describe the interactions between molecules.*

Unit I - Thermodynamics-I

Terminology – System and surrounding -types of systems - state variables - thermodynamic equilibrium - extensive and intensive properties - types of processes - first law of thermodynamics – statement - internal energy – enthalpy - heat capacity - relation between Cp and Cv - expansion of ideal gas – work done in isothermal expansion - Joule-Thomson effect and Joule-Thomson coefficient- inversion temperature.

Unit II - Thermodynamics – II

Spontaneous, non-spontaneous and cyclic process – reversible and irreversible processes. Carnot cycle – the second law of thermodynamics – efficiency of heat engine – Carnot's theorem – concept of entropy – entropy changes in reversible and irreversible processes - entropy changes in isothermal expansion of ideal gas-entropy of mixing of gases – physical significance of entropy– Gibbs–Helmholtz free energies and equations – partial molar properties – chemical potential - Clausius–Clapeyron equation.

Unit III –Thermochemistry and Chemical Equilibrium

Heat changes in chemical reactions - enthalpy of formation - enthalpy of composition – enthalpy of solution - enthalpy of dilution - enthalpy of neutralization - relation between enthalpy of a reaction at constant volume and at constant pressure - Kirchhoff equation. Law of mass action – equilibrium constant K, Kp and Kc, relation between K_p and K_c – Le-Chatelior principle and its application to $N_2+3H_2 \rightarrow 2NH_3$ system.

Unit IV–Colloids and Colligative Properties

Colloids: Types of colloidal systems – lyophilic and lyophobic sols – kinetic – optical and electrical properties of colloids – protective colloids – emulsions – gels- application of colloids.

Colligative properties – definition – measurement of lowering of vapour pressure – elevation of boiling point – depression of freezing point – osmotic pressure – reverse osmosis.

Unit V- Surface Chemistry and Electric Properties of Molecules

Surface Chemistry: Physisorption – chemisorption – Fruendlich and Langmuir adsorption isotherms – BET theory multilayer adsorption – BET equation (derivation not required) – determination of surface using BET theory - applications of adsorption.

Electric Properties of Molecules: Electric dipole - dipole moment– induced dipole moment polarization- polarizabilities – Clausius - Mossoutti equation -relative permittivity – refractive index.

References:

1. Principles of Physical Chemistry, B.R. Puri, L.R. Sharma and M.S. Pathania, Shobanlal Nagin Chand and Co. Jalendhar 41stEdn.,2001.
2. Physical Chemistry, Peter Atkins and Julio de Paula, Oxford University Press, 9th edition, 2011.
3. Physical Chemistry, Robert. G. Mortimer Academic Press; 3rd edition (2008)
4. Essentials of Physical Chemistry, B. S. Bahl, G. D. Tuli and Arun Bahl, S. Chand &Co. Ltd, New Delhi, 12thEdn.,2011.
5. A Text Book of Physical Chemistry, A.S. Nagi and S.C. Anand, Wiley Eastern Ltd, New Delhi, 7thEdn.,2000.

21CHEU04A1 ALLIED CHEMISTRY–II (3 credits)

Objectives: The objective of the course is to understand the nature of fuels, energy sources, to understand different types of polymers and its applications, to gain knowledge of nanomaterials, to know the basics of chemical kinetics and to understand the basic concepts of acids and bases.

Course outcome: After successful completion of the course, students will be able to

- *Categorize fuels and energy sources*
- *Describe the types of polymerization methods as well as preparation and uses of few well-known polymers*
- *Describe the method of preparation and properties of amino acids*
- *Classify protein and demonstrate the primary and secondary structure of proteins.*
- *Solve the problems in chemical kinetics*
- *Differentiate strong and weak acids and bases*
- *Calculate the pH of a solution*

Unit I - Fuels and Energy Sources

Classification, calorific value, characteristics of a good fuel, comparison between solid, liquid and gaseous fuels. Petroleum - classification - origin - refining of crude oil - cracking - synthetic petrol –knocking in petrol and diesel. Gaseous fuels - water gas and producer gas.

Unit II - Polymer Chemistry

Introduction – nomenclature, types of polymerization - plastics - classification of resins -– preparation, properties and uses of PE, PVC, PVA , PVAc and Nylon -6:6, PET, PAN- bakelite. Elastomers-vulcanization-synthetic rubbers-Buna-S and Buna-N

Unit III – Nanomaterials

Introduction to nanomaterials – definition - synthesis -Top down and bottom up approaches-synthesis of carbon nanotubes, characterization-applications of nanomaterials - Electron microscopy techniques-scanning electron microscopy and transmission electron microscopy.

Unit IV – Chemical Kinetics and Catalysis

Chemical Kinetics: reaction rates - rate, order and molecularity, pseudo first order reactions, integrated rate equation for first order reaction, half-life period, determination of order of reaction, simple collision theory, Arrhenius equation (derivation omitted).

Catalysis: Types of catalysis - homogeneous, heterogeneous and enzyme catalysis.

Unit V –Acids and Bases

Acids – bases, Arrhenius, Bronsted- Lowry and Lewis concepts and relative strength of acids and base - pH scale-measurement of pH-, Henderson equation, acid base indicators-pH range of indicators- theory of indicators.

References:

1. Essentials of Physical Chemistry, *B. S. Bahl, G. D. Tuli and Arun Bahl,* S. Chand & Company Ltd, New Delhi, 12th Ed.,2011.
2. Principles of Physical Chemistry, *B.R. Puri, L.R. Sharma and M.S. Pathania*, Vishal Publishing Co., 47th Edn.,2016.
3. Engineering Chemistry, *Jain, P.C. and Monica Jain,* Dhanphatrai and Sons, New Delhi, 15th Edn., 2006.
4. Nano: The Essentials: Understanding Nanoscience and Nanotechnology, *T. Pradeep*, McGraw-Hill Professional Publishing, New Delhi, 2008.
5. Atkins' Physical Chemistry, *Peter Atkins, Julio de Paula, and James Keeler*, Oxford University Press, UK 11th Ed., 2017.
6. Industrial Chemistry, *Sharma B.K*, Goel Publishing house, Meerut, UP. 2011.
7. Introduction to Nanoscience, *J. Dutta, H.F. Tibbals and G.L. Hornyak*, CRC press, Boca Raton, 2008.

ALLIED CHEMISTRY PRACTICAL – II

21CHEU04A2 VOLUMETRICANALYSIS (1 Credits)

Objectives: The objective of the practical course is to get expertise in the preparation of standard solutions, to understand basic principles and develop skill in titrimetric analysis.

Course outcome: After successful completion of the course, students will be able to

- Prepare standard solutions
- Demonstrate the principles of titrimetry
- Analyze titrimetric data systematically and estimate the amount of inorganic substances in a given solution.

  - Preparation of standard solutions
  - Estimation of sodium hydroxide
  - Estimation of hydrochloric acid
  - Estimation of oxalic acid
  - Estimation of potassium dichromate
  - Estimation of ferrous ammonium sulphate
  - Estimation of Zinc
  - Estimation of available chlorine
  - Estimation of hardness of water

References:

1. Vogel's textbook of quantitative chemical analysis Mendham, *John.Denney, Ronald C.Barnes, John D.Thomas, M.,* 7th Ed., Prentice Hall, New York, 6th Ed., 2000.
2. Practical Chemistry by *A.O. Thomas*, Scientific Book Centre, Cannanore,2003.
3. Basic Principles of Practical Chemistry, *V. Venkateswaran, R. Veeraswamy, A. R. Kulandaivelu*, Sultan Chand & Sons, New Delhi, 2nd Ed.,2004.

21CHEU0410 Practical IV: INORGANIC QUANTITATIVE ANALYSIS (2 Credits)

Objectives: The objective of the practical course is to understand the chemistry of inorganic quantitative analysis, to acquire skills in inorganic quantitative estimation methods, to get trained in quantitative estimation methods, and to gain knowledge in the preparation of some inorganic complexes.

Course outcome: After successful completion of the course, students will be able to

- *Demonstrate the principles of inorganic quantitative estimation methods*
- *Plan and execute an experiment to prepare metal complexes and gravimetrically analyze certain metal complexes.*

1. Argentometry: Estimation of Chloride (Mohr's method)
2. Colorimetry:
   (i) Estimation of iron (III)
   (ii) Estimation of copper (II)
3. Gravimetric analysis
   (i) Estimation of lead as lead chromate
   (ii) Estimation of nickel as Ni-(DMG)
   (iii) Estimation of aluminium as aluminium oxinate
   (iv) Estimation of calcium as calcium oxalate
   (iv) Estimation of barium as barium sulphate
4. Preparation
   (i) Tetrammine copper(II) sulphate
   (ii) Tris(ethylenediamine) nickel(II) chloride
   (iii) Prussian blue
   (iii) Hexammine cobalt(III) Chloride

References:

1. Practical Chemistry by A.O. Thomas, Scientific Book Centre, Cannanore, 2003.
2. Basic Principles of Practical Chemistry V. Venkateswaran, R. Veeraswamy,A. R. Kulandaivelu, S. Chand & Sons, New Delhi, 2nd Edn., 2004.

V SEMESTER

21CHEU0511 INORGANIC CHEMISTRY – III (4 Credits)

Objectives: The objective of the course is to learn the basic concepts of coordination chemistry, to understand different theories and applications of coordination compounds, to understand the properties of coordination compounds and to gain knowledge in mechanical aspects of coordination compounds.

Course outcome: After successful completion of the course, students will be able to

- *Describe basic concepts and theories of coordination chemistry*
- *Predict the properties of coordination compounds*
- *Demonstrate the applications of coordination compounds*
- *Predict the reaction mechanisms in coordination complexes.*
- *Determine the stability constant by Job's and Bjeruum methods*

Unit I - Introduction to Coordination Chemistry

Addition compounds -Double salts- complex compounds- complex ion and coordination number- Ligands and their classification- chelates and their uses- coordination number and stereochemistry of complexes- IUPAC Nomenclature of coordination compounds. Isomerism: Structural isomerism - ionization, hydrate, ligand, linkage, coordination, position, Stereoisomerism - geometrical isomerism in square planar and octahedral complexes - optical isomerism in octahedral complexes.

Unit II - Theories of Coordination Compounds

Werner's theory- Sidwick's electronic interpretation- EAN concept- Valence Bond Theory- Postulates of VBT - Complexes with sp^3, dsp^2 and d^2sp^3 hybridizations -outer and inner orbital complexes- Limitations of VBT- Crystal Field Theory- Postulates of CFT- Crystal field splitting in octahedral, tetragonal, square planar and tetrahedral complexes- High spin and Low spin complexes.

Unit III - Theories and Applications

Factors affecting crystal field splitting, John Teller distortion- Crystal field stablisation energy- calculation and uses- Limitations of crystal field theory. Applications of copper and silver complexes in inorganic qualitative analysis. Applications of Ca-EDTA and Ni-DMG complexes in inorganic quantitative analysis.

Unit IV - Properties of Complexes

Magnetic susceptibility-origin of magnetism-Dia and Para magnetism-magnetic moments-Spin only formula-Gouy's experimental method. Color of transition metal complexes-visible spectrum of aqueous Ti (III) ion. Stability of complexes-overall and stepwise formation constants-Factors affecting stability of metal complexes with reference to the nature of metal ion and ligand -Determination of stability constant by Job's and Bjeruum's method.

Unit V - Reaction Mechanism in Complexes

Lability and inert complexes - VBT and CFT- Ligand substitution reactions in octahedral complexes-Basic concepts of dissociation, association and SN_1CB mechanism-substitution reactions in square planar complexes, trans- effect-applications of trans effect. Electron transfer reactions-Basic concepts of outer sphere and inner sphere mechanism- Factors affecting the rates of outer sphere electron transfer reactions.

References:

1. A New Concise Inorganic Chemistry, J. D. Lee, Oxford Publishers, 5^{th} Ed., 2014.
2. Principles of Inorganic Chemistry, B. R. Puri, L. R. Sharma and K. C. Kalia, Shoban Lal Nagin Chand & Co., New Delhi, 2001.
3. Text Book of Inorganic Chemistry, P. L. Soni, S. Chand & Sons, New Delhi, 1993.
4. Selected Topics in Inorganic Chemistry, Malik, Tuli, Madan, S. Chand & Co., New Delhi, 2002.

21CHEU0512 ORGANIC CHEMISTRY II (4 Credits)

Objectives: The objective of the course is to understand the chemistry of carboxylic acids and their derivatives, to understand the chemistry of amines and quaternary ammonium salts, to know the chemistry of phenols and organo nitrogen compounds, to know the chemistry of five and six membered heterocyclic compounds and to understand organic chemical reactions of heterocyclic compounds.

Course outcome: After successful completion of the course, students will be able to

- *Describe the preparation, properties and reactions of carboxylic acids, amines, phenols and certain heterocyclic compounds*
- *Demonstrate the synthetic uses of diazonium salts*
- *Predict the mechanism of certain organic rearrangements*.

Unit I - Carboxylic Acids and Their Derivatives

Structure; synthesis – oxidation, nitrile synthesis and reaction of organometallic reagent with CO_2; Acidity of carboxylic acids, effect of substituents on acidity; reactions of carboxylic acids: Formations of esters, amides, acid chlorides and anhydrides; reactions with organolithium agents and metal hydrides; decarboxylation; Hunsdiecker reaction; Hell Volhard Zelensky reaction. Functional derivatives of carboxylic acids - nucleophilic acyl substitution, nucleophilic substitution: alkyl vs. acyl. Hydrolysis of amides, acid and alkaline hydrolysis of esters, trans esterification. Dicarboxylic acids - action of heat on dicarboxylic acids. Hydroxy acids - Reformatsky reaction, action of heat on hydroxy acids.

Unit II –Amines

Preparation-Hofmann degradation- synthesis of secondary and tertiary amines -basicity of amines -basicity constant -structure and basicity, Effect of substituent on basicity -Hofmann rearrangement. Quaternary ammonium salts: Exhaustive methylation, Hoffmann elimination - conversion of amines into substituted amides-ring substitution in aromatic amines.

Unit III - Phenols and Nitrogen Compounds

Nomenclature, preparation, properties -salts of phenols, acidity of phenols, effect of substituents on acidity - Formation of esters -Fries rearrangement - Kolbes synthesis of phenolic acids, Reimer - Tiemann reaction –reaction with HCHO; phenol -formaldehyde resins. Nitro compounds: reduction of nitrobenzene in various media - Diazonium salts: preparation and preparation and reactions- Sandmeyer reactions, synthetic uses of diazonium salts.

Unit IV - Heterocyclic Compounds

Preparation and properties of Furan, pyrrole, thiophene, pyridine and quinolone - aromatic nature, electrophilic substitution, basicity of pyridine - Skraup synthesis.

Unit V - Molecular Rearrangements

Molecular rearrangements: Mechanism of the following selected rearrangements - Benzidine, Wagner-Meerwin, Beckmann, Pincol-pinacolone, Favorski and Claisen rearrangements.

References:

1. Organic Chemistry, R.T. Morrison and R.N. Boyd., Prentice Hall of India Pvt. Ltd., New Delhi, 7th Edn., 2011.
2. Organic Chemistry, Maitland Jones Jr, Steven A. Fleming, W. W. Norton & Company, London, 4th edition, 2010.
3. Organic Chemistry, T. W. Graham Solomons, Craig B. Fryhle. John Wiley & Sons, Inc., 10th edition, 2011.

21CHEU0513 PHYSICAL CHEMISTRY II (4 Credits)

Objectives: The objective of the course is to understand basic terminologies of electrochemistry, to know the theories of strong electrolytes, to be familiar with the fundamentals of different types of electrochemical cells, to understand phase rule for one and two component systems and to be familiar with the principles of rotational and vibrational spectroscopies.

Course outcome: After successful completion of the course, students will be able to

- *Describe the basics of electrochemistry*
- *Analyze and interpret phase diagram of one and two component systems*
- *Demonstrate the basics of vibrational and rotational spectroscopic techniques*

Unit I - Electrochemistry I

Faraday's law of electrolysis, specific, molar and equivalent conductance and its variation with dilution, cell constant, transport number-determination by moving boundary method, Kohlrausch's law, applications of Kohlrausch's law, conductance measurements-applications.

Unit II - Electrochemistry II

Theory of strong electrolytes, Arrhenius theory, limitations, Debye-Huckel theory of strong electrolytes, Onsager equation (no derivation), solubility product and its applications, pH scale and buffer action.

EMF of cells, reversible cells, types of reversible electrodes, single electrode potential, reference electrodes, cell reaction and e.m.f.-thermodynamic relationship, Nernst equation, electrode concentration cells, electrolyte concentration cells.

Unit III - Electrochemistry III

Applications of e.m.f. measurements, determination of transport number, solubility, pH and potentiometric titrations, Fuel cells (basic concept), principle and applications of polarography. Electrochemical theory of corrosion, corrosion due to dissimilar metal cells and concentration cells, Pilling Bedworth rule, passivity.

Unit IV – Gaseous State and Phase Rule

Gaseous State: Kinetic theory of gases- Maxwell’s distribution of molecular velocities (derivation omitted)-collision diameter- collision number, collision frequency- mean free path – real and ideal gases – van der Waal’s equation.

Phase Rule: Phase, component and degree of freedom, derivation of phase rule, one component Systems - water system, sulphur system, two component systems- Lead-Silver system, zinc-Magnesium system, formation of compounds with incongruent and congruent melting points-ferric chloride-water system, sodium sulphate-water system.

Unit V - Molecular Spectroscopy

Rotational spectra, rigid diatomic rotator, non-rigid rotator, selection rule, vibrational spectra, simple harmonic oscillator, anharmonic oscillator, selection rule, electronic spectra, Frank-Condon principle.

References:

1. Principles of Physical Chemistry, B.R. Puri, L.R. Sharma and M.S. Pathania, Shoban Lal Nagin Chand and Co., New Delhi, 2001.
2. Essentials of Physical Chemistry, B.S. Bahl, GD. Tuli and Arun New Delhi, 12th Edn., 2011.
3. A Text Book of Physical Chemistry, A.S. Nagi and S.C. Anand Wiley Eastern Ltd, New Delhi, 7^{th} Edn., 2000.

PRACTICAL – V

21CHEU0514 ORGANIC QUALITATIVE ANALYSIS (2 Credits)

Objectives: The objective of the practical course is to understand the principles of organic qualitative analysis and to develop skill in single stage preparation of organic compounds.

Course outcome: After successful completion of the course, students will be able to

- *Analyze mono and bifunctional organic compounds qualitatively*
- *Synthesize organic compounds and their derivatives*
- *Recrystallize and purify the products of organic reactions*
- *Determine the physical constants of the products*

1. Qualitative Analysis of organic compounds -Analysis of mono and bifunctional organic compounds. Preparation of derivatives, recrystallization, and determination of physical constants.
2. Single stage preparation of organic compounds involving acylation, oxidation, hydrolysis, nitration, esterification, condensation and bromination.

References:

1. Text Book of Practical Organic Chemistry, A.I. Vogel, ELBS, London, 5th Edn., 2010.
2. N.S. Gnanaprakasam and G. Ramamoorthy, Organic Chemistry Lab Manual, S. Viswanathan Company Pvt. Ltd., 1998.

B.Sc. CHEMISTRY (V SEMESTER)

SKILL BASED ELECTIVE (2 Credits)

(One of the four courses has to be chosen by the students)

VI Semester

21CHEU0616 ORGANIC CHEMISTRY- III (4 Credits)

Objectives: The objective of the course is to understand the chemistry of carbohydrates, to know the chemical aspects of amino acids, to understand the basic principles involved in organic photochemistry and also have an elementary idea of pericyclic reactions, to know the chemistry of selected alkaloids and terpenes, to know the synthetic utility of selected oxidizing and reducing organic reagents and also synthetic uses of selected organic name reactions**.**

Course outcome: After successful completion of the course, students will be able to

- *Describe the chemistry of carbohydrates*
- *Classify protein and demonstrate the primary and secondary structure of proteins.*
- *Draw Jablonski diagram and demonstrate the mechanism of Norrish type I and II reactions*
- *Determine the structures of selected alkaloids and terpenes*
- *Identify suitable reagents for selected organic reactions*

Unit I – Carbohydrates

Nomenclature and structure of carbohydrates; interrelationship among monosaccharides; mutarotation and its mechanism – cyclic structure -pyranose and furanose forms - determination of ring size, haworth projection formula, configuration and conformational analysis of monosaccharides- Fischer determination of the structure of D-glucose; lengthening of carbon chain in aldoses – Killiyani-Fischer synthesis of aldoses; Shortening of carbon chains in aldoses: Ruff degradation.

Reactions of carbohydrates: Epimerization in base; Reduction; oxidation; osazone formation; ether and ester formation. Interconversion of aldoses and ketoses and vice versa, interconversion of aldoses to their epimers.

Unit II -Amino Acids and Proteins

Aminoacids: classification; dipolar ions; isoelectric point; synthesis - Gabriel synthesis and Strecker synthesis; reactions of amino acids – acylation, esterification, reaction with ninhydrin.

Peptides: structure of peptides; Sangers and Edmond method, terminal residue analysis, synthesis of peptides - role of protective groups (carbobenzoxy, phthaloyloxyl) - classical method - its limitations - proteins - classification - denaturation - primary, secondary structure of proteins. Colour reactions of proteins.

Unit III - Organic Photochemistry

Principles - Jablonski diagram - absorption of electromagnetic radiation - excited state - photochemical processes - photosensitisation, photochemical reactions - photoreduction,

photooxidation, photolysis of ketones - Norrish type I and type II reactions. Pericyclic reactions - characteristics of concerted reactions - electrocyclic, cycloaddition and sigmatropic reactions. (Elementary idea only)

Unit IV - Terpenes and Alkaloids

Terpenes - general methods of determination of structure - Isoprene rule, isolation of terpenes - structure and constitution of menthol, limonene, and camphor.

Alkaloids - alkaloidal reagents - general methods of determination of structure of alkaloids - structure and synthesis of nicotine, piperine and atropine.

Unit V - Reagents and Reactions

Reagents and catalysts: NBS, $NaBH_4$, $LiAlH_4$, LiH and Grubbs catalyst

Reactions: Wittig olefination; Vilsmeyer formylation; Mannich reaction; Staudinger reaction, Swern oxidation.

References:

1. Organic Chemistry R.T. Morrison and R.N. Boyd., Prentice Hall of India Pvt. Ltd., New Delhi, 7 th Edn., 2011.
2. Organic Chemistry, I.L. Finar, ELBS, Vol. I, 6th Edn., 2002.
3. Organic Chemistry, Maitland Jones Jr, Steven A. Fleming, W. W. Norton & Company, London, 4th edition, 2010.
4. Organic Chemistry, T. W. Graham Solomons, Craig B. Fryhle. John Wiley & Sons, Inc., 10th edition, 2011.

21CHEU0617 PHYSICAL CHEMISTRY - III (4 Credits)

Objectives: The objective of the course is to understand the basic terminologies of chemical kinetics, to understand the theories of reaction rates and catalysis, to understand the basics and concepts of photochemistry, to have an introduction of group theory and to become familiar with the fundamentals of quantum chemistry.

Course outcome: After successful completion of the course, students

- *Determine the order of the reaction*
- *Calculate the half-life of the reaction*
- *Describe the theories of reaction rates and Lambert-Beer law of photochemistry Draw and explain Jablonski diagram*
- *Predict the symmetry elements and point groups of small molecules*
- *Demonstrate the photoelectric effect, Compton effect, Heisenberg's uncertainty principle and Schrodinger wave equation*

Unit I - Chemical Kinetics I

Introduction, order and molecularity, zero, first, second and fractional order reactions, determination of orders- pseudo unimolecular reaction, half-life of a reaction, temperature dependence of reaction rates, Arrhenius equation.

Unit II - Chemical Kinetics II

Theories of reaction rates, collision theory, absolute reaction rate theory (derivation not included), significance of the free energy of activation and entropy of activation, unimolecular reactions, Lindmann theory.

Catalysis, types of catalysis, characteristics of catalytic reactions, theories of catalysis, enzyme catalysis, Michaelis-Menton equation**.**

Unit III – Photochemistry

Introduction, Lambert-Beer law, Jablonski diagram, law of photochemical equivalence, quantum yield, experimental determination, photosensitized reactions, steady state approximation, photochemical reactions of H_2-Cl_2, H_2-Br_2 and dimerization of anthracene. Jablonski diagram ,Phosphorescence, fluorescence and chemiluminescence.

Unit IV - Group Theory and Its Applications

Mathematical group – group multiplication tables - symmetry elements-symmetry operations – point group of simple molecules (H_2, HCl, CO_2, H_2O, BF_3 and NH_3)

Unit V - Quantum Mechanics

Limitations of classical mechanics, black body radiation, photoelectric effect, Compton effect, Heisenberg's uncertainty principle, Schrodinger wave equation, eigen values and eigen functions, significance of wave function, orthogonality and normalization, postulates of quantum mechanics, particle in one dimensional box**.**

References:

1. Principles of Physical Chemistry, B.R. Puri, L.R. Sharma and M.S. Pathania, Shobanlal Nagin Chand & Co. Jalendhar 41st Edn., 2001.
2. Essentials of Physical Chemistry, B.S. Bahl, G.D. Tuli and Arun Bahl, S.Chand & Co. Ltd, New Delhi, 12th Edn., 2011.
3. A Text Book of Physical Chemistry, A.S. Nagi and S.C. Anand, Wiley Eastern Ltd., New Delhi, 7th Edn., 2000.
4. Introductory Quantum Chemistry, A.K. Chandra, Tata McGraw-Hill Publishing Company, 4th Edn.,1994.

21CHEU0618 ANALYTICAL CHEMISTRY (4 Credits)

Objectives: The objective of the course is to understand laboratory safety measures, error analysis and the theory of complexometric titration, to emphasize the basic principles of different electroanalytical techniques, To learn the basic principles, instrumentation and applications of spectrochemical, thermal and radiochemical techniques, and to know the basic principles and applications of separation techniques.

Course outcome: After successful completion of the course, students will be able to

- Handle toxic and poisonous chemicals safely
- Provide first-aid in case of small laboratory accidents
- Communicate scientific data and conclusions with accuracy and minimum error
- Describe the principles, applications and instrumentation of potentiometric and conductometric titrations
- Describe the principles, applications and instrumentation of UV-Vis spectrophotometry and IR Spectrophotometer
- Identify the thermal method to be used for a particular study
- Describe methods to separate compounds such as TLC, column chromatography and solvent extraction

Unit I - Laboratory practices, error analysis and titrimetric method

Storage and handling of corrosive, toxic and poisonous chemicals-simple first aid procedure for acid and alkali in eye, acid and alkali burns, heat burns and cut by glasses.

Accuracy, precision, classification of errors, minimization of errors, standard deviation, coefficient of variance and significant figures.

Complexometric titrations, principle and experimentation. Metal ion indicators and its applications.

Unit II – Electroanalytical Techniques

Amperometry-different types of titrations-applications-advantages over conventional volumetric method–Electrogravimetry theory-primary requirements-electrodeposition by constant potential and current-applications. Coulometry-types of coulometers-primary and secondary coulometric titrations-Coulometry by constant potential-applications-Constant current coulometry-application to acid base, redox and complexometry-estimation of unstable and corrosive elements.

Unit III - Spectrochemical Techniques

UV-visible spectrophotometry, principle, Beer's law, applications-deviations from Beer's law. Photometric titrations-instrumentation, monochromators and detectors-single and double beam spectrophotometer.

Instrumentation of IR spectrophotometer-sample handling techniques in IR, applications, Theory and applications of atomic absorption spectroscopy and flame emission spectroscopy-advantages-differences between AAS and FES-merits and demerits.

Unit IV - Thermal and Radiochemical Techniques

Types of thermal techniques-Principles of thermogravimetry-factors affecting the thermogram-thermograms of calcium oxalate and copper sulphate pentahydrate-applications. Principle of differential thermal analysis-interpretation of DTA curve-factors affecting the DTA curves-applications. Differential scanning calorimetry-principle and applications. Theromogram of copper sulfate pentahydrate.

Radiometric titrations-types-complex formation and precipitate formation- activation analysis- absolute and comparative methods and applications.

Unit V - Separation Techniques

Principles - applications of column chromatography- paper chromatography-thin layer chromatography and applications of chromatography. Principle and experimental procedure of ion-exchange methods and types of resins-industrial applications. Brief idea of solvent extraction techniques,-factors favouring extraction. Gas chromatography-principle and applications.

References:

1. H.W. Willard, L.I. Merrit, J.A. Dean and P.A. Settle, Instrumental Methods of Analysis, CBS Publishers, 7^{th} Edn., 1996.
2. B.K. Sharma, Instrumental Methods of Analysis, Goel Publishers, 1993.
3. Vogel's Text Book of Quantitative Chemical Analysis, ELBS, 1996.
4. N.K. Acharya, Text Book on Intellectual Property rights, Asia Law Hose, 2001.

21CHEU0619 PRACTICAL-IV: PHYSICAL CHEMISTRY (2 Credits)

Objectives: The objective of the practical course is to learn the applications of colligative properties, to carry out experiments based on phase rule, to acquire skills based on chemical Kinetics experiments and to understand electrochemistry through experiments.

Course outcome: After successful completion of the course, students will be able to

- *Determine molecular weight by Rast's Macro method and transition temperature measurement method*
- *Construct phase diagram of a simple eutectic system*
- *Determine critical solution temperature of phenol-water system*
- *Determine distribution coefficient of Iodine between water and organic solvent*
- *Determine rate constant of acid catalysed hydrolysis of an ester*
- *Determine the pKa of a weak acid*
- *Determine the viscosity of mixture of liquids by using Ostwald Viscometer.*

1. Determination of Molecular Weight by Rast's Macro method.
2. Determination of Molecular Weight by Transition Temperature measurement method.
3. Construction of phase diagram of a simple eutectic system.
4. Determination of Critical Solution Temperature of Phenol-Water system. (Determination of concentration of a salt solution through miscibility temperature measurement) .
5. Determination of distribution coefficient of Iodine between water and organic solvent.
6. Determination of rate constant of acid catalysed hydrolysis of an ester.
7. Conductometric titration of strong acid vs. strong base.
8. Determination of pKa of a weak acid.
9. Determination of degree of dissociation through conductance measurement.
10. pH-metric titration between a strong acid and a strong base.
11. Potentiometric titration between $Fe^{2+}$and Cr^{6+}.
12. Determination of viscosity of mixture of liquids by using Ostwald Viscometer.

References:

1. Practical Chemistry by A.O. Thomas, Scientific Book Centre, Cannanore, 2003.

2. Basic Principles of Practical Chemistry, V. Venkateswaran, R. Veeraswamy, A. R. Kulandaivelu, Sultan Chand & Sons, New Delhi, 2nd Edn., 2004.

B.Sc. CHEMISTRY (VI SEMESTER)

PROJECT (4 Credits)

DISCIPLINE CENTRIC ELECTIVE COURSES

21CHEU04D1 ENVIRONMENTAL CHEMISTRY (3 Credits)

Objectives: The objective of the course is to give an overview of water, air, soil, radioactive and noise pollution including methods for prevention, control measures and management of the pollution, to understand how chemistry can help in understanding contemporary environmental issues, and possible solutions to environmental problems and to develop an understanding of chemicals and their effects on the environment.

Course outcome: After successful completion of the course, students will be able to

- *Assess various types of pollution including the cause, consequence and cure*
- *Describe ozone layer depletion and its impact on global environment*
- *Communicate the impact of air, water, soil pollutants and greenhouse Gases to generate awareness*

Unit I - Water Pollution

Hydrosphere - Hydrological cycle - water quality parameters - significance of these parameters over the quality of water – Types of water pollutants - organic, inorganic, toxic metal (Cr, Ar, Hg, Pb), sediments, plant nutrients, oil spills, disease causing agents, radioactive wastes and thermal pollution - experimental determination of DO, BOD, COD and TOC.

Unit II - Air Pollution

Structure of atmosphere - composition of air- primary air pollutants- oxides of carbon, nitrogen and sulphur - sources and effects. Global warming, acid rain, photochemical smog, depletion in ozone layer- particulate pollution - Inorganic, Organic and Metallic particulates - sources and effects.

Unit III - Soil Pollution and Pollution Due to Pesticides

Soil profile - Bio Indicators - Sources and effects of soil pollution. Organochlorine pesticides, insect resistance to DDT, biomagnifications of DDT, effects of organo chlorine compounds - organo phosphorus compounds and carbamates as pesticides - Alternatives to pesticides.

Unit IV - Radioactive and Noise Pollution

Radioactive pollution - types of radiation - Sources - natural sources of radiation - electromagnetic radiations and particulate radiations - Anthropogenic sources - X-rays, radioisotopes, nuclear reactors, nuclear power plants - effects of ionising and non -ionising radiations on man. Sources and effects of noise pollution.

Unit V - Pollution Control Measures

Sources, effects and treatment methods of some specific water pollutants - Fluoride, iron and chromium. Control of air pollution - source correction methods - operational changes, cleaning of gaseous effluents - adsorption on solids, catalytic conversion - control of particulate pollutants. Remedial measures for soil pollution.

References:

1. Environmental Chemistry by B.K. Sharma and H. Kaur, Goel Publishing House,1996.
2. Environmental Chemistry by A.K. De, New Age International (P) Ltd. Publishers, 2000.
3. Environmental Chemistry by Tyagi and Mehra, Anmol Publishers, 1996.

21CHEU04D2 INDUSTRIAL CHEMISTRY (3 Credits)

Objectives: The objective of the course is to enable the student to understand the concepts of fuels and energy resources, generation of energy from various types of fuels, to understand the use of chemicals in the improvement of agricultural crops, to learn the manufacturing processes of iron, steel, alloys, glass, ceramics and refractories and to understand the process of surface coatings.

Course outcome: After successful completion of the course, students will be able to

- *Categorize fuels and energy sources*
- *Describe the types of polymerization methods as well as preparation and uses of few well-known polymers*
- *Describe the composition and manufacturing process of cements and fertilizers*
- *Demonstrate the manufacturing process and applications of iron, steel, alloys, glass, ceramics and refractories*
- *Categorize the types of surface coatings*

Unit I - Fuels and Energy Resources

Petroleum - origin of petroleum, composition, refining of petroleum fractionation composition of various fractions, cracking - catalytic and thermal cracking, synthetic petrol, knocking, octane and cetane numbers, anti knocking agents, coal gas, producer gas, Methane production from biomass, alcohol as fuel.

Unit II - Cement and Fertilizers

Cement - manufacture of Portland cement - composition - setting of cement – special cements - Aluminium cement - white Portland cement - water proof cement. Fertilizers - nitrogeous fertilizers - ammonium sulphate- urea - manufacture and action -potassium fertilizers - potassium sulphate - manufacture - phosphate fertilizers – superphosphate

Unit III – Iron, Steel and Alloys

Manufacture of pig iron by blast furnace, wrought iron by puddling processes- steel by Bessemer's process – Heat treatment of steel. Alloys-purpose of making alloys – preparation of alloys by fusion method-electro deposition and reduction method – effects of carbon, silicon, phosphorus and sulphur – application of alloy steels.

Unit IV - Glass, Ceramics and Refractories

Glass, raw materials and colouring agents - chemical reaction involved in glass manufacture - some special glasses (borosilicate, alkali silicate, optical glass, soda lime glass, their properties and applications). Ceramics - various classes of ceramics, general properties, porous and non-porous wares, raw materials for ceramics, uses. Refractories - manufacture of refractories - properties and uses of common refractory bricks - silica bricks - fire clay bricks, magnesite bricks and dolomite bricks.

Unit V - Surface Coatings

Pre-treatment of the surface, metallic coating, galvanizing, tinning - Inorganic coatings, organic coatings, oil paints, water paints, special paints, varnishes, enamels and lacquers.

References:

1. Engineering Chemistry by P.C. Jain and Monica Jain, Dhanphatrai and Sons, 15th Edn., 2006.
2. Industrial Chemistry, B.K. Sharma, Goel Publishing House, 2011.
3. A Text Book of Engineering Chemistry, S.S. Dara, S. Chand &Co., New Delhi, 15th Edn., 2006.

21CHEU04D3 POLYMER CHEMISTRY (3 Credits)

Objectives: The objective of the course is to understand the importance of polymers and an exposure to polymer chemistry, to understand various polymerization techniques and characterization of polymers, to enable a student to understand polymer structure, properties, and to know the polymer processing techniques and properties of commercially available polymers.

Course outcome: After successful completion of the course, students will be able to

- *Classify polymers and describe different types of polymerizations reactions*
- *Characterize polymers based on available experimental data*
- *Describe the structure and properties of polymers*
- *Demonstrate the properties of commercially available polymers*

Unit I – Polymerization Reactions and Techniques

Introduction – degree of polymerization – functionality-classification of polymers – polymerization reactions – addition and condensation polymerization – mechanism – polymerization techniques – bulk, solution, suspension and emulsion methods.

Unit II – Polymer Characterization

Polymer Isolation-Fractionation- concept of number and weight averages – the practical significance of molecular weight– measurement of molecular weight – end group, viscosity, light scattering, osmotic pressure and ultra-centrifugation methods – testing of polymers – tensile strength, fatigue, impact strength, tear resistance, hardness and abrasion resistance.

Unit III –Properties of Polymers

Polymer structure and physical properties – the relationship between T_g and T_m – Factors affecting T_g and T_m – significance – stereo regularity. Polymer degradation – types – mechanical, thermal and photo degradation – management of polymers.

Unit IV – Polymer Processing and Additives

Plastics –thermoplastic and thermosetting plastics. Processing techniques – calendaring, compounding injection moulding, transfer moulding and extrusion moulding, spinning – melt – Dry and Wet methods. Polymer additives: Plasticizers, fillers, antioxidants, pigments and thermal stabilizers.

Unit V – Chemistry of Important Commercial Polymers

Polyethylene, teflon, polyamides, polyesters, phenolic resins, epoxy resins and polyurethane foam. Conducting polymer, biomedical polymer – contact lens, dental polymers and artificial heart.

References:

1. Polymer Science and Technology, Goel R. Fried, Prentice-Hall of India, New Delhi, 2nd Edn., 2003.
2. Polymer Science and Technology of Plastics and Rubbers by Premamoy Ghosh, Tata McGraw -Hill Publishing Company Ltd., New Delhi, 2009.
3. Polymer Science by V.R. Gowariker, N.V. Viswanathan and Sadadeve Sreedhar, New Age International (P) Ltd. Publishers, 2003.
4. "Text Book of Polymer Science" by Fred W. Billmeyer, J.R. John Wiley Publishers, 3rd Edn., 2003.

21CHEU05D1 CHEMISTRY OF NATURAL PRODUCTS (3 Credits)

Objectives: The objective of the course is to give an introduction to chemistry of natural products like carbohydrates, steroids, terpenoids, alkaloids, amino acids and proteins and to give an introduction to synthesis of some important heterocyclic compounds.

Course outcome: After successful completion of the course, students will be able to

- *Describe the chemistry of carbohydrates, steroids, terpenoids and alkaloids*
- *Determine the structures of selected alkaloids and terpenes*
- *Classify protein and demonstrate the primary and secondary structure of proteins.*
- *Describe the synthesis of selected heterocycles*

Unit I – Carbohydrates

Classification -chemistry of monosaccharides (glucose & fructose) - elementary idea of chemistry of disaccharides (sucrose & lactose) - chemistry of polysaccharides, starch and cellulose - glycogen, insulin - industrial applications of starch &cellulose - elementary idea of glucosamine.

Unit II - Steroids and Terpenoids

Steroids - colour reactions-elementary idea - sex hormones - bile acids. Terpenoids - classification - isoprene rules – general methods of extraction - chemistry of α -pinene and camphor (synthesis not included).

Unit III – Alkaloids

Definition-classification - colour reactions - general methods of extraction - chemistry of piperine and nicotine.

Unit IV - Amino Acids and Proteins

Classification of amino acids - essential and non- essential amino acids - optical activity of amino acids - synthesis of α-aminoacids - properties of amino acids- peptides -terminal residue analysis. Proteins - classification - colour reactions – properties and structure - industrial importance of proteins.

Unit V – Heterocycles

Synthesis and reactivity of pyrrole, pyridine, indole, pyrazole, imidazole, carbazole, quinoline and isoquinoline.

References:

1. Advanced Organic Chemistry, B.S. Bahl and Arun Bahl, S.Chand & Co. Ltd., New Delhi, 2002.
2. Organic Chemistry, I.L.Finar, Vol. II, Stereochemistry and the Chemistry of Natural Products, 5th Edn., Pearson Education, 2003.

21CHEU05D2 ELEMENTS OF SPECTROSCOPY (3 Credits)

Objectives: The objective of the course is to impart the knowledge of UV-vis spectroscopy, to familiarize with the electronic excitateions, to impart knowledge of infrared spectroscopy, to gain expertise of assigning experimental values to the different vibrations, to understand the basics of NMR spectroscopy and solving simple organic molecules NMR spectra, to impart basic knowledge of mass spectrometry and to gain the knowledge of magnetism and its interaction with external field and concept in electron spin resonance.

Course outcome: After successful completion of the course, students will be able to

- *Demonstrate principles of UV-Vis spectroscopy*
- *Interpret IR spectra and describe the instrumentation of IR spectrophotometer*
- *Demonstrate principles of NMR spectroscopy and interpret NMR spectra of simple molecules*
- *Interpret mass spectra and describe the instrumentation of Mass spectrometer*
- *Analyze the interaction of odd electrons with nuclei and interpret the ESR spectra*

Unit I – Electronic Spectroscopy

UV -Vis Spectroscopy: Electronic excitation levels – selection rules-Bathochromic, hypsochromic, hyperchromic and hypochromic shifts-solvent effects-Woodward rule for calculation of the λ_{max} for dienes and unsaturated carbonyl compounds – simple applications.

Unit II - Vibrational Spectroscopy

Infrared Spectroscopy: Principle – selection rules - fundamental absorptions and overtones-applications of IR spectroscopy to compounds – amino compounds – hydroxyl compounds – effect of inter and intermolecular hydrogen bonding on IR spectra.

Unit III - NMR Spectroscopy

Introduction – basic principles of ^{1}H NMR - equivalent and non-equivalent protons - number of signals – position of signals – chemical shift – peak area and proton coupling. Splitting of signals – spin-spin coupling– coupling constant – NMR spectra of simple organic compounds. Basics of ^{13}C NMR spectroscopy.

Unit IV - Electron Spin Resonance Spectroscopy

Basic principles of ESR-Magnetic moment of an unpaired electron – energy level diagram of electron – hyperfine splitting – ESR spectrum of hydrogen atom and methyl radical.

Unit V - Mass Spectrometry

Introduction – instrumentation – mass spectrum – molecular ion peak – molecular formula calculation – mass spectrum of simple molecules (cyclohexene, ethyl benzene and methyl propyl ketone).

References:

1. Organic Spectroscopy, William Kemp, 3rd Edn., Palgrave Publications, New York, 2008.
2. Spectroscopy of Organic Compounds, P. S. Kalsi, New Age International Publishers, 6th Edn., 2009.
3. Applications of Absorption Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall of India Pvt. Ltd., New Delhi,1991.
4. SpectrometricIdentificationofOrganicCompounds,RobertM.SilversteinandFrancis X. Webster, 6th Edn., John Wiley and Sons, 2003.
5. Principles of Physical Chemistry, B.R. Puri, L.R. Sharma and M.S. Pathania, Shobanlal Nagin Chand & Co. Jalendhar 41st Edn.,2001.
6. Introduction to Spectroscopy**,** by Donald Pavia, Gary Lampman, George Kriz and James Vyvyan, Brooks/Cole publication; 5th edition, 2014.

21CHEU05D3 GREEN CHEMISTRY (3 Credits)

Objective: The objective of the course is to develop an understanding of basic principles of green chemistry, atom economic reactions and green catalysis. The course also will give an understanding greener solvents and technologies.

Course outcome: At the end of the course, students will be able to:

- *Describe the basic principles of green chemistry.*
- *Explain about atom economic reactions and safety.*
- *Describe about the green catalysis and environmentally benign solvents*
- *Assess the greener technologies.*

Unit I-Principles and concepts of green chemistry

Introduction-Basic principles-green chemistry-atom economy-rearrangement reaction-addition reactions-atom uneconomic reactions-substitution reaction-Wittig reaction-reducing toxicity.

Unit-II-Waste-Problems and prevention

Waste minimizing techniques-sources of waste from chemical industry-Onsite waste treatment-Physical treatment-chemical treatment - degradation of waste - Polymer recycling - reactions (without byproducts).

Unit-III-Green catalysis

Introduction-Comparison of catalysts-heterogeneous catalysis-zeolites-homogeneous catalyst-transition metal catalysts-greener lewis acids-phase transfer catalysis-oxidation (H_2O_2)-biocatalysis – photocatalysis – biocatalysis - photocatalysis

Unit-IV-Environmentally Benign Solvents

Introduction-organic solvents-volatile solvents-solvent free system-supercritical fluid-water –water mediated reactions-ionic liquids mediated reactions.

Unit V-Greener Technologies

Introduction-comparison of greener technology and other technology - Photochemical reactions - microwave medited reactions – sonochemistry - electrochemical synthesis.

References:

1. Green Chemistry-An Introductory Text; Mike Lancaster, RSC Publishers, 2011.
2. V. K. Ahulwalia & M.R. Kidwai: New Trends in Green Chemistry, Annamalaya Publishers, 2005.

GENERIC ELECTIVES OFFERED

21CHEU04G1 POLYMER SCIENCE (3 Credits)

Objectives: The objective of the course is to impart knowledge about the importance of polymers, to understand various polymerization techniques and characterization of polymers, to enable a student to understand polymer structure, properties and to know the polymer processing techniques and properties commercially available polymers.

Course outcome: After successful completion of the course, students will be able to

- *Classify polymers and describe different types of polymerizations reactions*
- *Characterize polymers based on available experimental data*
- *Describe the structure and properties of polymers*
- *Demonstrate the properties of commercially available polymers*
- *Describe the types of polymer processing methods*

Unit I – Basics

Basic concepts: Monomers, repeat units, degree of polymerization - Linear, branched and network polymers. Classification of polymers. Polymerization: condensation, addition, radical chain-ionic and co-ordination and co-polymerization.

Unit II - Polymer Characterization

Average molecular weight concept. Number, weight and viscosity-average molecular weights. The practical significance of molecular weight. Measurement of molecular weights. viscosity, and light scattering methods.

Unit III - Structure and Properties

Configurations of polymer chain. Morphology of crystalline polymers, strain-induced morphology. Polymer structure and physical properties-chain flexibility and other steric factors. Branching and cross linking.

Unit IV - Polymer Processing

Compounding of plastics- Processing techniques: Calendering, die casting, rotational casting, film casting, injection moulding, blow moulding, extrusion moulding, thermo forming, foaming, reinforcing and fibre spinning.

Unit V - Properties of Commercial Polymers

Fire retarding polymers and electrically conducting polymers. Biomedical polymers-contact lens, dental polymers, artificial heart, kidney, skin and blood cells.

References:

1. Textbook of Polymer Science, F.W. Billmeyer, Johny Eastern Ltd., 1992.
2. Polymer Science, V.R. Gowariker, N.V. Viswanthan and J. Sreedhar. Wiley-Eastern, 1988.

21CHEU04G2 ORGANIC CHEMISTRY FOR HOME SCIENCE (3 Credits)

Objectives: The objective of the course is to develop an understanding of food components such as carbohydrates, aminoacids, proteins, to obtain preliminary knowledge on dyes, leathers, fibers, to provide comprehensive introduction to sulpha drugs, antibiotics, fuels and to know synthesis and applications of polymers.

Course outcome: After successful completion of the course, students will be able to

- *Describe the chemistry of carbohydrates*
- *Determine the structures of selected alkaloids and terpenes*
- *Classify protein and demonstrate the primary and secondary structure of proteins*
- *Classify dyes and describe the synthesis of most popular dyes*
- *Demonstrate the tanning process*
- *Describe the mode of action of sulpha drugs and antibiotics*
- *Classify fuels and energy sources*
- *Classify polymers and describe different types of polymerizations reactions*
- *Demonstrate the properties of commercially available polymers*

Unit I - Carbohydrates

Introduction – classification-preparation and properties of glucose and fructose structure of glucose (configuration-not expected) mutarotation- interconversion of aldose and ketose. Increasing and decreasing the length of the carbon chain in sugars – polysaccharides-preliminary study of starch and cellulose. Industrial applications of starch and cellulose.

Unit II -Amino Acids and Proteins

Classification-preparation and properties of amino acids, isoelectronic point-tests for amino acids-polypeptides, peptide linkage, proteins – classification-denaturation of proteins, colour reactions, biological significance of proteins, structure of proteins, primary structure of proteins, end group analysis, preliminary study of secondary structure, introduction to DNA and RNA.

Unit III - Dyes, Leather and Fibers

Introduction-structural features of a dye-classification of dyes, preparation of methyl orange, fluoresce in, malachite green, alizarin and uses (both textile and non-textile). Leather: Basic principles in tanning and dyeing of leather, types of tanning (chrome and vegetable tanning) Fibers: Synthetic fibers derived from cellulose, nylon and terylene.

Unit IV - Sulpha Drugs, Antibiotics and Fuels

Introduction to sulpha drugs - sulphanilamide, sulphameracine, sulphaguanidine - preparation, mode of action of sulpha drugs. Antibiotics: very brief study of chloramphenicol, penicillin and tetracycline-their uses (detailed chemistry not required).

Fuels: Classification, characteristics of a good fuel. Composition and uses of LPG, producer gas, water gas, method of production of gobar gas. Petroleum – knocking-use of tetraethyl lead diesel-octane and cetane number. Synthetic petrol, Bergius process.

Unit V – Polymers

Different types of polymerization-addition, condensation, ionic and free radical polymerization-mechanisms, synthesis and applications of the following polymers-PVC, polyester, polythene, Teflon, and polystyrene – rubber-natural rubber, vulcanization of rubber-synthetic rubber-neoprene.

Reference:

1. Bahl and Arun Bahl, Text book of Advanced Organic Chemistry, S. Chand & Co., New Delhi, 1991.

21CHEU04G3 CHEMISTRY IN THE SERVICE OF MANKIND (3 Credits)

Objectives: The objective of the course is to provide comprehensive overview of fuels and energy sources, to familiarize with polymers, polymerization techniques and fertilizers, to provide an overview of vitamins and drugs, to understand the types of surface coatings, to have the knowledge about small and large scale industrial processes

Course outcome: After successful completion of the course, students will be able to

- *Classify fuels and energy source*
- *Describe the chemistry of some important polymers and fertilizers*
- *Categorize vitamins and drugs*
- *Categorize the types of surface coatings methods*
- *Describe small and large scale industrial processes*

Unit I - Fuels and Energy Resources

Types of fuels - liquid fuels - petroleum products – gaseous fuel - coal gas, producer gas and bio gas - Rocket fuels - solid and liquid propellants - nuclear fuels - difference between nuclear and chemical fuels. Renewable sources of energy - solar energy, wind energy and tidal energy.

Unit II - Polymers and Fertilizers

Chemistry of some important polymers - synthetic fibres -nylons, polyester - synthetic rubber - polyurethane rubber – reclaimed rubber - sponge, foam rubber, thermocole - polymerization techniques- bulk, solution, suspension, emulsion polymerization. Plant nutrients - need and requirements - natural and artificial fertilizer - urea, triple super phosphate, muriate of potash – complex fertilizers.

Unit III – Vitamins and Drugs

Vitamins - Water soluble vitamins - Vitamin B and C - fat soluble vitamins - A, D, E & K - sources - physiological functions and deficiency symptoms. Drugs - some important drugs – antibacterials – sulphonamide - antipyretics - aspirin - antimalarials - paludrine - antibiotics - penicillin.

Unit IV - Surface Coatings

Pretreatment of the surface metallic coating, galvanizing, tinning, inorganic coatings, organic coatings, oil paints, water paints, special paints, enamels and lacquers.

Unit V - Industrial Processes

Small scale units - manufacture of candles, safety matches, soap and naphthalene balls, shoe polish, cum paste, writing/fountain pen ink, Chalk crayons, plaster of paris and silicon carbide crucibles. Large scale units - manufacture of pulp and paper, sugar, glass, ceramics and cement.

References:

1. Industrial Chemistry by B.K. Sharma, Goel Publishing House, 12th Edn., 2001.
2. Engineering Chemistry by P.C. Jain and Monica Jain, Dhanphatrai and Sons, 15th Edn., 2006.
3. Chemical Process Industries by Shrive, George and T Austin, McGraw Hill Book Co., 1984.

21CHEU04G4 FOOD ADULTERATION AND ANALYSIS (3 Credits)

Objectives: The objective of the course is to learn about the food laws and general composition and quality criteria of the food products, to know the importance of toxicology and also the analysis of common adulterants.

Course outcome: After successful completion of the course, student will be able to

- *Describe the food laws*
- *Discuss the general composition and quality of food*
- *Determine the toxins and adulterants of food*
- *Describe the food additives*

UNIT –I Food Laws and regulations

Food Laws and regulations (Mandatory) - Food Safety and Standards Act, 2006 (FSSA), Edible Oils Packaging (Regulation) Order, 1998, Environment (Protection) Act, 1986, Fruit Products Order, 1955 (FPO), Meat Food Products Order, 1973 (MFPO), Milk and Milk Product Order, 1992 (MMPO), Solvent Extracted Oil, De-oiled Meal-Introduction to various food laws (Voluntary) - Agmark Standards (AGMARK), Codex Alimentarius Standards, BIS Standards and Specifications, Consumer Protection Act, 1986-Codex standards for Cereals & Pulses-Codex standards for Fruits and Vegetables-Role of voluntary agencies and legal aspects of consumer protection

UNIT – II Dairy Products

General Composition and quality –Dairy products -Oil and Fats-Spices and condiments -Food Grains-Flours-Canned Foods-Fruit and Vegetables products-Meat and poultry-Sugar-Beverages-Alcoholic and Non Alcoholic drinks

UNIT– III Toxicity in food

Importance of food toxicology -naturally occurring toxins in various foods -microbial and parasitic-food poisoning and food infections or food borne illness-mycotoxins – aflatoxin-bacterial toxin-residual chemical contaminants-pesticides-heavy metals, hormones in food.

UNIT – IV Food Additives

Comparison of adulterants and additives–food additives-antioxidants-Natural oxidants-synthetic oxidants-colour-stabilizer-surface active agents-artificial sweetener-flavor enhancers-Intentional adulterants-Incidental adulterants.

UNIT – V Food Analysis

Analysis of adulterants- morphological and anatomical characterization-physical techniques-chemical/biochemical techniques-electrophoresis and immunology based techniques-molecular techniques-PCR and sequencing based techniques.

References:

1. Dr. Jagmohan Negi. Edition. 2004. Food & Beverage Laws - Food Safety and Hygiene. Media : Hard Back. ISBN : 9788182040007.
2. A. Sood. 1999. Toxicology. Published by Sarup & Sons, New Delhi.
3. R.K. Trivedy. 2001. Aquatic pollution and toxicology. 1st ed. Jaipur : ABD Publishers : Distribution, Oxford Book Co.
4. S.B. Vohora, V.R. Agrawal. Toxicology and Environmental Health. 2000. Asiatech Publishers Inc.
5. The Food Safety and Standards act, 2006 along with Rules & Regulations 2011, Commercial Law Publishers (India) Pvt. Ltd.
6. Patricia and Curtis A, An operational Text Book, Guide to Food Laws and Regulations.
7. Takayuki Shibamoto, Leonard Bjeldanes, Introduction to food toxicology 1st edition Published by Science Elsevier.

21CHEU05G1 POLLUTION AND ITS CONTROL MEASURES (3 Credits)

Objectives: To provide comprehensive introduction to air pollution, water pollution, noise and nuclear pollution and their control measures.

Course outcome: After successful completion of the course, students will be able to

- *Classify pollution*
- *Communicate and create awareness about pollution and their control measures*
- *Analyze air and water quality parameters*

Unit I – Air Pollution

Major regions of the atmosphere – composition of air – specific air pollutants and their effects – CO, CO_2, SO_2, SO_3, NO and NO_2 – ozone depletion – acid rain – photochemical smog.

Unit II – Water pollution

Criteria for potable water – major water pollutants – organic, inorganic, heavy metals – (As, Cr, Fe, Pb, Cd, Hg) oil spills – sources – effects.

Unit III – Soil and Pesticide Pollution

Sources, effects of various oil pollutants – pesticides – classification. Toxicity of DDT, BHC, malathion, parathion, carbamates. Alternative sources for pesticides.

Unit IV – Noise and Nuclear Pollution

Noise pollution – sources and effects – nuclear pollution – genetic and somatic effects – nuclear disasters and major accidents.

Unit V – Analysis and control methods

Sampling of air and water pollutants – analysis of DO, BOD, COD and TOC in water – Analysis of CO by GC, NO by chemiluminescence and CO_2 by spectrometry. Treatment of water for domestic and industrial purpose – primary, secondary and tertiary treatment methods.

References:

1. Environmental Chemistry, A. K. De, 5th Edn., New Age International Publisher, 2005.
2. Environmental Chemistry, B. K. Sharma, 11th Edn., Krishna Prakashan media Limited, 2007.

21CHEU05G2 CHEMISTRY OF FOOD (3 credits)

Objective: To provide comprehensive introduction to chemistry of food and to understand functional properties of carbohydrates, proteins, aminoacids and lipids, to understand the chemical changes in food components during processing and storage, to understand the importance and sources of fats and oils in foods, to understand the sources, chemical structures and effect of processing and storage of vitamins, to provide comprehensive introduction of food additives, pigments, flavoring agents and preservatives.

Course outcome: After successful completion of the course, students will be able to

- *Describe chemical and functional properties as well as the importance of carbohydrates, proteins, aminoacids and lipids*
- *Demonstrate the effect of processing and storage of food components and vitamins*
- *Describe food additives, pigments, flavouring agents and preservatives.*

Unit I - Introduction to Food Chemistry and Carbohydrates

Introduction to Food Chemistry-Water activity and its influence on food quality and stability-Various methods for removal of water from foods – concentration and dehydration. Carbohydrates-Chemical reactions and functional properties of sugars and polypeptides in foods-chemistry and structure of homosachharides and heterosachharides.

Unit II - Proteins, aminoacid and lipids

Protein and amino acids: structure, classifications, sources, denaturation and functional properties of proteins-Maillard browning. Lipids: Various types of lipids – Simple, conjugated, phospholipids and their occurrence in foods, physical and chemical properties, effects of processing on functional properties.

Unit III - Fats and Oils

Importance of fats and oils in foods - Sources of fats and oils-Extraction of fats and oils – rendering, pressing, solvent extraction-Poly-unsaturated Fatty Acids- hydrogenation and rancidity; Saponification number, iodine value, Reichert-Meissl number, Polenske value-Lipids of biological importance like cholesterol and phospholipids.

Unit IV - Minerals and Vitamins

Sources and structures of minerals & vitamins - Effect of processing and storage of vitamins-Pro vitamins A & D; Vitamins as antioxidants.

Unit V - Food additives, Pigments, Flavouring Agents and Preservatives

Food additives – Antioxidants - Colouring agents and emulsifiers - Flavour and flavour enhancers - Flour improvers-Humectants and anticaking agents - Leavening agents - pH control agents – Preservatives - stabilizers and other additives.

References:

1. Essentials of Food & Nutrition by Swaminathan, Vol. 1 & 2.
2. Hand Book of Analysis of fruits & vegetables by S. Ranganna. Food Science (5^{th} Edn.,), Potter & Hotchkiss, CBS Publishers & Distributors.

21CHEU05G3 CHEMICAL COMPOSITION OF HOUSEHOLD MATERIALS (3 Credits)

Objective: The objective of the course is to provide basic knowledge about the polymers, to understand the chemistry of various fibers, to obtain knowledge on dyes and dyeing, to develop an understanding of pigments and to know the method of disposing the solid waste.

Course outcome: After successful completion of the course, students will be able to

- *Classify polymers and describe different types of polymerization reactions*
- *Classify fibers and describe the synthesis of important fibers*
- *Describe the structure and synthesis of most popular dyes*
- *Classify the pigments based on structure*
- *Describe the methods of solid waste management*

Unit I - Polymeric materials

Basic concepts: monomers, polymers, degree of polymerization, functionality-Linear, branched and network polymers. Classification of polymers based on polymer structure - tacticity. Polymerization: addition, condensation, radical, chain-ionic and co-polymerization. Uses of polymeric materials in home appliances.

Unit II - Production and Properties of Fibers

Definition-general classification-natural fibers - properties and importance-cellulose fibers – cotton – jute - protein fibers - wool-silk. Preparation, properties and uses of synthetic fibers – Rayon – Polyamides – Polyester – Spandex – Kevlar – Acrylic - Terylene.

Unit III - Dyes

Definition and properties of dyes-requisites of a dye- classification of dyes based on mode of application – structure, properties and uses of acidic dyes: picric acid and methanol yellow-basic dyes: methylene blue and rhodamine-B - Dyeing - basic operations in the dyeing process-dyeing of cotton and wool blends and nylons - Food colorants.

Unit IV- Optical brighteners and pigments

Introduction- optical brighteners- properties- difference between dyes and pigments-classification based on chemical structure- organic pigments-requirements of organic pigments-uses-types of pigment. Pigments and dyes for interior decoration.

Unit V - Solid waste disposal Management

Introduction-incineration-pyrolysis- thermal incineration- secured land fill-leachability studies and management of leachates- Bacterial compositing - vermi composting-Bioremediation-types: phytoremediation - eco friendly technologies: plasma gasification.

References:

1. Polymer Science, V.R. Gowariker, N.V. Viswanathan and J. Sreedhar. Wiley-Eastern, 1988. Corbman, P.B., 1985, Textiles- Fiber to Fabric (6^{th} Edition).
2. An Introduction to Synthetic drugs and dyes, Rao, Chawathe and Shah. Himalaya publishing house.,1995.
3. Synthetic Dyes, Gurdeep R. Chatwal, Himalaya Publishing house.
4. Modern Techniques of Textile Dyeing, Bleaching and Finishing, S.M. Arora, Small Industry Research Institute (1982-83).

SKILL-BASED ELECTIVE

21CHEU05S1 CLINICAL CHEMISTRY (2 Credits)

Objectives: To understand the basics of human organ functions and to impart knowledge on clinical biochemistry and laboratory practices.

Course outcome: After successful completion of the course, students will be able to

- *Describe the basic anatomy of human body*
- *Interpret laboratory results of blood and urine samples*
- *Measure total cholesterol, serum LDL and blood glucose level*

Unit I - Basics of Human Metabolism

Basics of Human Organ Functions - Plasma proteins in disease - Liver function and disease - Carbohydrate metabolism and its disorders - Disorders of detoxification and excretory mechanisms – renal function, Acid base disorders, Electrolyte and water Balance.

Unit II - Laboratory Techniques

Introduction to Clinical Laboratories - Laboratory Work Flow cycle - Phlebotomy equipments - Identification of Blood Collection Tubes &Preparation of Blood Plasma and Serum, detection of anemia-estimation of haemoglobin(Hb concentration) - Preparation of Blood Film -Blood staining, Liver Function Tests - Measurement of Serum ALT &AST, Measurement of Serum Bilirubin (Total, direct &indirect).

Unit III - Renal Function

Renal Function Tests, Measurement of Serum BUN -Renal Function Tests - Measurement of Serum Creatinine Clearance -lipid Profile, - Routine Urine Analysis & Identification of Normal Physical and Chemical Urine Constituents.

Unit IV - Urine Analysis

Microscopic examination of Urine, Quantitative Determination of Urine Protein Proteinuria & Micro albuminuria Quantitative Determination of Urine Uric Acid Quantitative Determination of Urine Creatinine. Diagnostic test for sugar in urine-Benedict's test.

Unit V - Blood Analysis

Measurement of sugar(glucose) in serum -o-toluidine method-Measurement of Serum Total cholesterol, Measurement of Serum LDL-C, Measurement of Serum HDL-C,- Measurement of Serum TG, Diabetic Profile Tests Measurement of Blood Glucose.

References:

1. Practical Clinical Biochemistry: Methods and Interpretations, R. Chawla, 3rd Edn., Jaypee Brothers Medical Publishers, New Delhi, 2003.
2. Fundamentals of Practical Clinical Biochemistry, B. Mohanty and S. Basu, B. I. publishers, New Delhi, 2006.

21CHEU05S3 PHARMACEUTICAL CHEMISTRY (2 Credits)

Objectives: To understand the basic concepts and strategies in drug design and synthesis, to provide preliminary introduction to anticancer drugs and their synthesis and recent developments in cancer therapy, to provide preliminary introduction to cardiovascular diseases, cardiovascular drugs and their synthesis, to provide preliminary knowledge on anti-infective drugs, antibiotics and their synthesis.

Course outcome: After successful completion of the course, students will be able to

- *Demonstrate the strategies involved in drug design and synthesis of drugs*
- *Classify drugs, describe structure and its uses*

Unit I - Drug Terminology and Classification

Drug action, Terminologies used – Pharmacy, Pharmacology, Pharmacognosy- Pharmacophore- Pharmacodynamics- Antimetabolites – Chemotherapy – Pharmacopoeia. Classification of Drugs – Biological and Chemical classification – Roots of drug administration, Mechanism of drug action, Metabolism of drugs- Biotransformation, Absorption of drugs , Factors affecting the absorption.

Unit II – Analgesics, antiseptics and disinfectants

Analgesics - Definition, Classification, Action of analgesics, Aspirin, Paracetamol, Narcotic analgesics. Antiseptics and Disinfectants - Definition and Distinction, Uses of Phenols, Dyes, Chloroamine, Formaldehyde and Cationic surface active agents.

Unit III- Anesthetics

Anesthetics - Definition and Classification, Uses of Volatile anesthetics - Ether, Chloroform, Halothanes, Trichloroethylene, Ferguson Principle. Gaseous anesthetic - Cyclopropane, Nitrous Oxide. Non-Volatile anesthetics – Thiopental sodium. Local anesthetics – Classification, Structure and uses of Procaine, Cocaine and Amethocaine.

Unit IV- Diabetics

Diabetics and Hypoglycemic drugs – Oral hypoglycemic agents, Sedatives and Hyponotics – Barbiturates.

Unit V – Diagnostic agents

Diagnostic agents – Radio Opaques, Preservatives, anti-oxidants, Sweetening agents, Emulsifying agents, Oniment bases, Colouring agents.

References:

1. Jayashree Ghosh, A Text book of Pharmaceutical Chemistry, S. Chand & Co., New Delhi, 2009.
2. Ashutosh kar, Medicinal Chemistry, New Age International Publisher, New Delhi, 3rd Edn., 2006.

21CHEU05S4 ANALYSIS OF ADULTERATION IN FOOD (3 Credits)

Objectives: The objective of the course is to emphasize the importance of food and adulterants, to give an overview of analysis of various types of adulterants in milk, milk products, spices, sweeteners and edible oils and also to impart the knowledge about the adulteration effects on human.

Course outcome: After successful completion of the course, students will be able to

- *Describe the common adulterants in food*
- *Analyze the adulterated food by certain chemical and analytical methods*
- *Describe the ill effects of adulterated food*

Unit I - Introduction

Food sources- types-constituents of food. Definition-adulteration and adulterant-adulterated food -common adulterants found in food – causes of food adulteration- types of contamination: physical, chemical, microbiological and metallic- common ill effects on human.

Unit II - Milk and Dairy products

Definition, Composition, Chemical and functional properties of milk components: physicochemical properties of milk protein- adulterant in milk: water-urea-sodium chloride-detergent-starch- adulterated ghee: mashed potatoes and Vanaspati - adulterated curd: cane sugar, washing powder- simple chemical method of detecting adulterated milk- Qualitative method for detecting the adulterant in milk and milk products: Spectrophotometric method

Unit III Adulterated spices

Adulterant in spices-adulterated turmeric powder: Metanil yellow and yellow clay-adulterated red chilly powder: water soluble coal tar colour and Rhodamine-B- adulterated coriander power: dung powder and common salt.-simple test to identify the adulterant in spices-instrumental analysis of adulterated spices using spectrophotometer.

Unit IV - Adulterated sweeteners and edible oils

Common adulterant in sweeteners-sugar: chalk powder and washing soda-jaggery: chalk powder-honey: sugar solution –Adulterated edible oils-sunflower oil and gingellyoil: argemone oil, mineral oil and rancidity- manual test for adulterated food- analysis of adulterants using High Performance Thin Layer Chromatograpy (HPTLC) and Thin Layer Chromatography (TLC).

Unit V - Effects of adulteration

Types of effects-health hazards-intentional adulterants: sand, stones, talc, chalk powder, sugar and sweeteners, mineral oil, kesari dal, foreign seeds, leaves, water and excess moisture, argemone seeds, rancid oil. Health hazard due to metal contaminants: arsenic, lead, mercury, tin, copper, aluminium and cadmium. Health hazard due to packaging, bacterial and fungal contamination.

References:

1. Milk and Milk Products by Eckles, Combs; and Macy, Tata McGraw Hill.
2. Seema Yadav , Food Chemistry, Anmol publishing (P) Ltd, New Delhi.
3. S.P. Heenan, S.M. Van Ruth, in Instrumental Assessment of Food Sensory Quality, **2013**
4. Bector B.S., Ram.M and Singhal, Methods of test for dairy industry and rapid examination of milk, O.P (**1998**)
5. Manual methods of analysis for adulterants and contaminants in foods ICMR (**1990**)

MODULAR COURSES

21CHEU06M1 COSMETIC CHEMISTRY (2 Credits)

Objectives: To create awareness among the undergraduate students about the role of chemistry in day-to-day life, to know more about the cosmetics and other chemicals that they use, to obtain adequate knowledge and scientific information regarding basic principles of cosmetic chemistry.

Course outcome: After successful completion of the course, students will be able

- *Choose cosmetics upon checking harmless chemical ingredients from various products available in the market*
- *Judiciously use cosmetics and other related chemicals.*

Unit I - Hair Care Products

Shampoos – principal constituents – thickeners and foam stabilizers – perfumes – preservatives – conditioning agents – antidandruff shampoos. Hair cream – composition – hair dyes – types – constituents – dye removals

Unit II - Skin Care Product

Skin cleansers – classifications – cold cream – cleansy milk – moisturizers – hand and body lotions – sun screen lotions – constituents

Unit III - Colour Cosmetics

Lipstick – constitutions – manufacturing method – lip glosses – nail polish – formulation – manufacture – face powder – constitution.

Unit IV - Dental Product

Oral care product – product categories – toothpaste – toothpowder – oral rinses – mouth washes

Unit V - Bath Preparation

Bath powders – soap and detergents – constituents – manufacture.

References:

1. Modern Technology of Cosmetics, Asia Pacific Business Press Inc., New Delhi, 2004.
2. Cosmetic Science, Dr. Satya Prakash Singh, Dr. Vijay Nigam, Thakur Publication Private Limited., 2021.

21CHEU06M2 NANOSCIENCE AND ITS APPLICATIONS (2 Credits)

Objectives: To introduce some of the fundamentals and current state-of-the-art in nanotechnology, to get familiarized with the synthesis, characterization and applications of nanomaterials.

Course outcome: After successful completion of the course, students will be able to

- *Recognize state of the art developments in the field of nanotechnology*
- *Describe useful properties of nanotubes, quantum dots and nanoparticles.*

Unit I - Introduction to Nanoscience

Definition of terms-nanoscale, nanomaterials, nanoscience, nanotechnology-scale of materials-natural and manmade-nanoscience practiced during ancient and modern periods-contributors to the field of nanoscience.

Unit II - Synthesis of Nanomaterials

Top down and bottom up approaches-synthesis of carbon nanotubes, quantum dots, gold and silver nanoparticles.

Unit III - Characterization of Nanomaterials

Electron microscopy techniques-scanning electron microscopy, transmission electron microscopy, atomic force microscopy.

Unit IV - Application of Nanomaterials

Solar cells - smart materials-molecular electronics-biosensors - drug delivery and therapy-detection of cancerous cells.

Unit V - Nanotechnology in Nature

The science behind the nanotechnology in lotus effect - self cleaning property of lotus-gecko foot- climbing ability of geckos-water strider - antiwetting property of water striders-spider silk-mechanical properties of the spider silk.

References:

1. T. Pradeep, Nano: The Essentials: Understanding Nanoscience and Nanotechnology, McGraw-Hill Professional Publishing, 2008.
2. J. Dutta, H.F. Tibbals and G.L. Hornyak, Introduction to Nanoscience, CRC press, Boca Raton, 2008.

21CHEU06M3 AGRICULTURAL CHEMISTRY (2 Credits)

Objectives: The objective of the course is to know the importance of agricultural chemistry and an exposure to analyze and find a suitable method to cultivate and to promote agricultural methods.

Course outcome: After successful completion of the course, students will be able to

- *Describe the basics of soil*
- *Classify and explain plant nutrients and fertiliizers*
- *Predict the mechanism of pesticides and herbicides*
- *Describe the structure and functions of plant growth regulators*

Unit I - Chemistry of soil

Composition of soil - Organic and Inorganic constituents. - Chemical aspects of soil - acid, alkali and saline soil. Nitrogen fixation in soils - biological nitrogen fixation.

Unit II - Plant Nutrients and Fertilizers

Plant nutrients - Sources and roles of macro and micro nutrients in plant growth - Nutritional deficiency in plants - symptoms, corrective measures - Fertilizers - classification of NPK fertilizers - natural and synthetic.

Unit III – Pesticides

Definition – Classification – organic and inorganic pesticides and its mechanism of action – Safe handling of pesticides, Fungicides - definition – classification – mechanism of action – sulfur, copper and mercury compounds.

Unit IV – Herbicides

Definition – classification – mechanism of action – Arsenic and boron compounds – urea compounds, nitro compounds and chloro compounds.

Unit V - Plant Growth Regulators

Definition - Classification - Structure and functions of - Abscisic acid - Auxins - Cytokinins - Ethylene - Gibberellins.

References:

1. Tisdale, S.L., Nelson, W.L. and Beaton, J. D. Soil Fertility and Fertilizers, Macmillian Publishing Company, New York, 1990.
2. Hesse, P.R. A Textbook of Soil Chemical Analysis, John Murray, New York, 1971.
3. Buchel, K.H. Chemistry of Pesticides, John Wiley & Sons, New York, 1983.
4. Sree Ramula, U. S. Chemistry of Insecticides and Fungicides, Oxford and IBH Publishing Co., New Delhi, 1979.

21CHEU06M4 WATER QUALITY ANALYSIS (2 Credits)

Objectives: The objective of the course is to give an in-depth understanding of water quality parameters, ground water and surface water pollution and its control measures. In addition, the students will also learn the water treatment methods, sewage and industrial effluent treatment methods and water resources management.

Course outcome: At the end of the course students will be able to:

- *Analyze water samples*
- *Evaluate pollutants and their effect on environment and on human health*
- *Suggest water treatment methods for domestic and industrial purposes*
- *Describe the methods of sewage and industrial effluent treatment and water resource management*

Unit I - Water quality parameters and their determination

Physical, chemical and biological standards significance of these contaminants over the quality and their determinations - Electrical conductivity - turbidity - pH, total solids, TDS - alkalinity - hardness - chlorides - DO - BOD- COD - TOC - nitrate – sulphate, fluoride.

Unit II - Ground water and surface water pollution and control measures

Pollution-pollutants-sources Surface water and ground water pollution - Harmful effects-pollution of major rivers - protecting ground water from pollution - ground water pollution due to Fluoride, Iron, Chromium and Arsenic - sources, ill effects and treatment methods.

Unit III - Water treatment methods

Treatment for community supply - screening, sedimentation, coagulation, filtration - removal of micro organisms - chlorination, adding bleaching powder, UV irradiation and ozonation.

Unit IV - Sewage and industrial effluent treatment

Sewage - characteristics - purpose of sewage treatment - methods of sewage treatment - primary - secondary and tertiary - Role of algae in sewage treatment. Types of industrial wastes - treatment of effluents with organic and inorganic impurities.

Unit V - Water Management

Water resources management - rain water harvesting methods - percolation ponds - check dams - roof top collection methods - water management in sugar, paper and textile industries.

References:

1. Chemical and Biological Methods for Water Pollution Studies, R.K. Trivedy and P.K. Goel, Environmental Publications, 1986.
2. Engineering Chemistry, P.c. Jain and Monica Jain, Dhanpat Rai and Sons, 1993.
3. Environmental Chemistry, B.K. Sharma, Goel Publishing House,
4. Water Quality and Defluoridation Techniques, Rajiv Gandhi National Drinking Water Mission Publication, 1994.

Value Added Courses

21CHEU3VA1 ORGANIC SURFACE COATINGS (2 Credits)

Objectives :

- *To learn the need for an organic surface coatings*
- *To understand the mechanism of action of paints, varnishes and lacquers.*
- *To understand the constituents of paints, varnishes and lacquers.*
- *To familiarizes the methods of analysis of paints, varnishes and lacquers.*

Outcomes

At the end of the course, the student will be able to

1. Explain the concept of corrosion.
2. Identify the types of corrosion.
3. Suggest the methods of corrosion prevention.
4. Develop paints, varnishes and lacquers.
5. Analyse the surface coating fundamentals

Unit - 1

Corrosion – Types of corrosion – Dry corrosion – Wet corrosion – Galvanic corrosion – Oxygen concentration cell (Differential aeration) – Galvanic series – Factors influencing corrosion.

Unit - 2

Protective measures – Sacrificial anode – Cathodic protection – Prevention of corrosion by the choice of materials and by the choice of design features – Organic corrosion inhibitors.

Unit - 3

Organic protective coatings – Paints- mechanism of action – constituents – pigments – vehicles used – fillers – alkyd paints – oil paints.

Unit – 4

Varnishes and Lacquers – constitutuents – advantages – varnishes from biomaterial waste.

Unit - 5

Evaluation of service performance of paints – Drying time – Gloss time – Resistance towards water, alkali and acid medium – wear resistance – Tensile strength – Impedance.

References :

1. B. K. Sharma, Industrial chemistry, Krishna Prakashan Media, 1991.
2. G. P. A. Turner, Introduction to paint chemistry, Chapman and Hall Ltd, 1967.

21CHEU4VA2 SMALL SCALE INDUSTRIES AND WASTE MANAGEMENT

(2 Credits)

Objectives: The objective of the course is to understand industrial processes and to set up small scale industries for income generation. This Course helps to learn the principles of different processes, machinery involved and the management of waste generated.

Specific learning outcomes:

- *Understand the principles and machinery involved in industrial processes*
- *Learning different industrial processes*
- *Handle industrial wastes generated*

Unit I - Industrial Processes I

Safety matches – composition – equipment - process – Agar battis – materials – process – Naphthalene balls – process – Wax candles - manufacturing process – shoe polish – nail polish – processes

Unit II - Industrial Processes II

Writing Ink – types - process – Gum paste – process – Chalk crayons – process – plaster of paris – manufacture – silicon carbide crucibles – terracotta products

Unit III - Industrial Processes III

Soaps – raw materials – cold and hot processes – Detergent powder – manufacturing – perfume making – process - liquid soap making – hand sanitizer – Floor cleaner – process

Unit IV - Industrial Processes IV

Herbal shampoo – cleaning lotion – herbal products – aloe vera gel – Dish washer – processes – soft drinks – carbonated drinks - manufacture

Unit V - Industrial waste management

Types of industrial waste – characterization – principles of treatment – solid waste – effluents from industries – purification methods of toxic gases – disposal of industrial waste

References:

1. B. K. Sharma, Industrial Chemistry, Goel Publisher, 17th edition, 2014

2. Vivek Madhukar Dandekar, Hand book of small scale industry, Mangalam Publications, 2016

E – Resources:

https://www.99businessideas.com/chemical-business-ideas/

21CHEU5VA3 FORENSIC SCIENCE (2 Credits)

Objectives: To understand the basics of Forensic Science, to impart awareness to the students on crime investigations and cyber crimes.

Course outcome: After successful completion of the course, students will be able to

- *Demonstrate the basic concepts and terminologies of forensic science*
- *Analyze and interpret forensic samples*

Unit I - Introduction

History and introduction to forensic science- crime-types of crimes - The crime scene-physical evidence-definition- types of physical evidences- identification and comparison of physical evidences-Method of analysis in forensic science- spectrometry-microscopy.

Unit II - Traces at Crime Scene

Fiber- collection of fiber evidence-comparison of man-made fibres- forensic examination of paint-collection and preservation of paint evidence- collection and preservation of glass evidence-comparison of glass fragments- forensic characteristics of soil- comparison of soil specimens- density gradient tube techniques- collection and preservation of soil evidence. Firearms- types – mechanism of operation – traces at crime scene-bullet comparison- cartridge cases- Gun powder residues- serial number restoration- Tool marks- other impressions- impact of fire arms on victim's body.

Unit III - Human Specific Physical Evidences and analysis - I

Hair- collection of hair evidence-morphology of hair- identification and comparison of hair – Finger prints- classifications- methods of detecting- preserving developed finger prints-foot prints and lifting- foot wear and tire impressions. Hand writing comparison- genuine and forged writing- collection of samples- detection.

Unit IV - Human Specific Physical Evidences and Analysis – II

Blood group-forensic characterization of blood stains-paternity testing-forensic characterization of semen-collection of rape evidence-DNA analysis. Toxicology of alcohol-breathe test instruments (breath analyzer) techniques used in toxicology-heavy metal poisoning-CO-poisoning-classification of drugs-drug identification-collection and preservation of drug evidence-snake poisioning.

Unit V - Cyber Crimes

The emergence of internet or cyber crime - common types of cyber crimes - Hacking, steeling of data, damage to personal data-abusing of personal data. Forensic investigation of cyber crime - Recovery and protection of computer crime evidences.

References:

1. An Introduction to Forensic Science, Prentice Hall, .Saferstein, Richard, Criminalistics Fifth edition.
2. Introduction to Forensic Science and Criminalistics, Robert E Gaenssien Dr.,Howard Harris, Henry C Lee, 2007.

21CHEU6VA4 DEVELOPMENT OF PHARMACEUTICS AND THEIR USES (2 credits)

Objectives: To understand the basics of Pharmaceutic science, to impart awareness to the students on pharmaceutical chemistry and their uses.

Course outcome: After successful completion of the course, students will be able to

- *Demonstrate the basic concepts and terminologies pharmaceutics*
- *Importance of drugs and their action*

Unit-I Basic concepts

Drug - definition- requirements of an ideal drug- history of drug development-nomenclature of drugs-classification of drugs based on sources.

Unit-II Chemical structure and therapeutic actions

Terminologies-pharmacology, pharmacy, pharmaceutics, toxicology, chemotherapy, pharmaco dynamics, pharmaco-kinetics.

Unit-III Need for Drugs

Deficiency, disorder and diseases - Disease causing organisms – bacteria- types, fungi, virus and their activities - differences between them.

Unit- IV Common diseases

Causes of common diseases – Classification of diseases and their treatment-Specific diseases caused by various organisms-Immunity, Vaccination-Adverse drug reactions, types and minimisation.

Unit-V Mechanism of drug action

Mechanism of drug action and metabolism of drugs-Absorption of drugs and assay of drugs.

References:

1. F. S. K. Barar, Essential of Pharmacotherapeutics, New Delhi: S. Chand & Company, 2000.
2. S. N. Pandeya and J. R. Dimmock, An Introduction to Drug Design, New Delhi: New Age International, 1997.
3. G. Patrick, Medical Chemistry, New Delhi: Viva Books, 2002. 4. Richard B. Silverman. The organic Chemistry of drug design and drug action, 2nd ed., Academic Press, 2004.