

SARVAJANIK UNIVERSITY

M.Sc. Organic Chemistry

SECOND SEMESTER

Program: M.Sc. Organic Chemistry	Type: Theory
Semester: II	
Subject: DSC-III- Organic Synthesis & Mechanism	
Credit: 04(T) + 02 (P)	Total learning hours: 60
Course description: This course paper is about organic reaction mechanisms, which are extremely useful in predicting the products and improving the reaction efficiency. Rearrangement, Methods of determining mechanism, Oxidation, Reduction, Chirality and Aromaticity.	
Student learning outcome: At the end of the course students will be able to learn...about <ul style="list-style-type: none">• Rearrangement reaction to electron deficient carbon, nitrogen, oxygen and electron rich carbon atom.• Name reaction, its mechanism and application.• Aromaticity in benzenoid and non-benzenoid compounds.• Kinetic and non-kinetic methods used for determination of reaction mechanism.• Chirality in an organic compound,• Draw stereoisomers in the 3-dimensional conventions & determining absolute configuration.• Oxidation and reduction with different reagents.	

Unit 1 Rearrangement

(08Hours)

- 1.1 Rearrangement to electron deficient carbon: Pinacol-pinacolone, Wagner -Meerwein, Benzilic acid, Wolf (Arndt-Eisterts synthesis) Rupe and Demjanov
- 1.2 Rearrangement to electron deficient Nitrogen: Hofmann, Curtius, Schimdt, Lossen and Beckmann
- 1.3 Rearrangement to electron deficient Oxygen: Baeyer Villiger
- 1.4 Rearrangement to electron rich carbon: Favorskii, Witting, Neber, Steven's and Sommelet Houser
- 1.5 Aromatic rearrangements: Fries, Claisen and Benzidine free radical

Unit 2 Methods of Determining Mechanisms and Isotope Effects

(08Hours)

- 2.1 Introduction
- 2.2 Methods of determining mechanism
 - 2.2.1 Determination of the products formed
 - 2.2.2 Study of intermediate formed
 - 2.2.3 Study of catalyst
 - 2.2.4 Stereochemical Evidence
 - 2.2.5 Kinetic Evidence
 - 2.2.6 Isotope Labelling
- 2.3 Isotopic Effects

Unit 3 Reactions, Mechanism and Applications of the Name Reactions: (10 Hours)

- 3.1 Baeyer-villiger oxidation
- 3.2 Dakin reaction
- 3.3 Baker-venkataraman reaction
- 3.4 Reformatsky reaction
- 3.5 Robinson annulations

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- 3.6 Cannizzaro reaction
- 3.7 Dieckmann reaction,
- 3.8 Perkin Reaction,
- 3.9 Stobbe condensation
- 3.10 Bischler Napieralski reaction
- 3.11 Witting rearrangement

Unit 4 Oxidation

(08Hours)

- 4.1 Oxidation of alcohol: Chromic acid, Chromium (VI)oxide, pyridine complexes, manganese (IV)oxide and silver carbonate
- 4.2 Oxidation to carbon- carbon double bonds: diols, epoxides, enantio selective epoxidation of allylic alcohols, Synthetic reaction of epoxides and ozonolysis.
- 4.3 Oxidation of ketones; conversion into unsaturated ketones, oxidation of ketols
- 4.4 Oxidative degradation of acids, aromatic rings of phenols, Oxidation of amines
- 4.5 Oxidation with ruthenium tetroxide, Oxidation with thallium(III)nitrate,
- 4.6 Oppenauer oxidation

Unit 5 Reduction

(06Hours)

- 5.1 Catalytic hydrogenation, selectivity of reaction of functional groups,
- 5.2 Stereochemistry mechanism,
- 5.3 Homogeneous hydrogenation,
- 5.4 Reduction by dissolving metals: reduction with metal and acid reduction of carbonyl compounds
- 5.5 Reduction with Metal in liquid ammonia (Birch reduction)
- 5.6 Reductive fission of alcohols and halides
- 5.7 Reduction by hydride transfer reagents:
- 5.8 Other methods : Wolf Kishner reduction, desulphurization of thioacetals

Unit 6 Hammett Equation its Modification and Applications

(08Hours)

- 6.1 Linear free energy relationship
- 6.2 Hammett equation
- 6.3 Derivation of Hammett equation
- 6.4 Physical meaning of σ and ρ
- 6.5 Significance and modification of ρ
- 6.6 Applications of Hammett plots
- 6.7 Deviation from linearity
- 6.8 Thermodynamic implication of Hammett equation

Unit 7 Aromaticity

(06Hours)

- 7.1 Aromaticity and Huckel's rule
- 7.2 Aromaticity in benzenoid and non-benzenoid compounds
- 7.3 Annulenes, fullerenes
- 7.4 Alternant and non-alternant hydrocarbons energy level of molecular orbitals
- 7.5 Anti aromaticity, homo aromaticity, non-aromatic compounds

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Unit 8 Concept of Chirality

(06Hours)

- 8.1 Recognition of symmetry elements and chiral structures
- 8.2 Stereo isomerism, determining absolute configuration
- 8.3 Optical activity and optical purity
- 8.4 Resolution
- 8.5 Chiral crown ethers and cyclodextrins
- 8.6 Conformation of carbocycles up to cyclodecane.

References:

1. Mechanism and structure in organic chemistry, E.S. Gould, Holt, Rinehart and Winston.
2. Advanced organic chemistry, J. March.
3. Physical organic chemistry, J. Hine.
4. Advanced organic chemistry Part A-Carey F. A. and Sundberg R. J. (Plenum Press).
5. Organic Chemistry, Clayden, Greeves, Warren and Wothers [Oxford Press].
6. Designing organic synthesis, S. Warren, Willey
- 7 Some modern methods of organic synthesis, W. Carrathers, Cambridge Univ. Press
8. Modern synthetic reaction, H.O. House, W. A. Benjamin.
- 9 Advanced organic reactions, reactions, mechanisms and structure, J. March, Wiley.
10. Principles of organic synthesis, R.O.C. Norman and J. M. Coxon, Blackie Academic and Professional.
11. Advanced organic chemistry part-B, F, A. Carrey and R. J. Sundberg, Plenum
- 12 Organic reaction and their mechanisms, P. S. Kalsi, New Age International Publishers.
13. Protective groups in organic synthesis, T. W. Greene and P. G. M. Wuts, IInd Edition, John Wiley and Sons 1991.
14. Organic synthesis: the disconnection approach, Sturant Warren, John Wiley and Sons.
15. Mechanism and structure in organic chemistry, E.S. Gould, Holt, Rinehart and Winston.
- 18 Advanced organic chemistry Part A, Carey F. A. and Sundberg R. J. (Plenum Press).
19. Organic Chemistry, Clayden, Greeves, Warren and Wothers [Oxford Press].

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SECOND SEMESTER

Program: M.Sc. Organic Chemistry	Type: Theory
Semester: II	
Subject: DSC- IV-CHEMISTRY OF NATURAL PRODUCTS	
Credit: 04(T) + 02 (P)	Total learning hours: 60
Course description: <p>The course will cover the diversity of <i>natural products</i> and their roles in biological systems, the <i>chemistry</i> and biosynthesis of the <i>major</i> natural product classes and the synthesis of important natural products.</p> <p>The study-unit will expose students to the field of natural product chemistry with emphasis on different classes of natural products including carbohydrates, proteins, terpenes and lipids. During the study-unit, the discussion will focus on the occurrence, structure and chemical synthesis the natural products. The study-unit will, in addition, give an understanding of the use of natural products as starting materials in organic reactions.</p>	
Student learning outcome: <p>At the end of the course students will be able to...</p> <p>Learn the different types of alkaloids, glycosides & terpenes etc and their chemistry and medicinal importance</p> <ul style="list-style-type: none"> • Explain the importance of natural compounds as lead molecules for new drug discovery • Explain vitamins Chemistry and Physiological significance of Vitamin • Elaborate general methods of structural elucidation of compounds of natural origin. • Learn advanced methods of structural elucidation of compounds of natural origin. • Understand isolation, purification and characterization of simple chemical constituents from the natural sources 	

Unit 1 Natural Pigments & Alkaloids

(06Hrs)

- 1.1 Natural Pigments and Porphyrins Derivatives
 - 1.1.1 Porphyrins: General Structure, Synthesis and Spectral properties
 - 1.1.2 Structural determination of Haemoglobin, Chlorophyll
 - 1.1.3 Synthesis of crypto pyrrole, Phyto pyrrole, Opso pyrrole and their carboxylic acid derivatives
- 1.2 Alkaloids
 - 1.2.1 Classification and nomenclature of alkaloids
 - 1.2.2 Structure elucidation of Morphine, Reserpine and their physiological properties

Unit 2 Steroids and Sex Hormone

(06Hrs)

- 2.1 Steroids
 - 2.1.1 Sterols, Spectral properties of steroids, stereo chemistry of the steroids
 - 2.1.2 Structure determination of Cholesterols and ergosterol
 - 2.1.3 Bile acids and structure of bile acids and structural elucidation
 - 2.1.4 Synthesis of Cholanic acids (α , β)
- 2.2 Sex hormones
 - 2.2.1 Classification of hormones
 - 2.2.2 Structure and Synthesis of Androgens, Oestrogens and Gestrogen
 - 2.2.3 Biochemical role of adrenocortical hormone,
 - 2.2.4 Partial Synthesis of Cortisone

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Unit 3 Terpenoids & Carotenoids **(10Hrs)**

- 3.1 Terpenoids
 - 3.1.1 Classification, nomenclature, occurrence, isolation
 - 3.1.2 General methods of structure determination
 - 3.1.3 Isoprene rule
 - 3.1.4 Structural determination of Citral, Zingiberen
- 3.2 Carotenoids
 - 3.2.1 Introduction, geometrical isomerism
 - 3.2.2 Structure determination and synthesis of β -carotene and Vit-A

Unit 4 Amino-acids, Peptides and Proteins: **(10Hrs)**

- 4.1 Amino acids
 - 4.1.1 Introduction and classification
 - 4.1.2 General synthetic methods
 - 4.1.3 Chemical and enzymatic hydrolysis of proteins to peptides, amino acid
- 4.2 Peptides
 - 4.2.1 Introduction
 - 4.2.2 General principle of polypeptide synthesis
 - 4.2.3 Synthesis of peptides on solid support
- 4.3 Protein
 - 4.3.1 Introduction, characteristics, classification
 - 4.3.2 Secondary structure of proteins, forces responsible for holding of secondary structures, α -helix, β -sheets
 - 4.3.3 Tertiary structure of protein-folding and domain structure
 - 4.3.4 Quaternary structure
 - 4.3.5 Chemistry of oxytocin

Unit 5 Vitamins **(10 Hrs)**

- 5.1 Introduction and structure determination of:
 - 5.1.1 Vitamin-A
 - 5.1.2 Vitamins B1 & B2
 - 5.1.3 Vitamin-H
 - 5.1.4 Vitamins of K-group
- 5.2 Biological functions of vitamin B1, B2, B6, folic acid, B12, C, D1, E (α -tocopherol), K1, K2, H (β - biotin).
- 5.3 Synthesis of
 - 5.3.1 Vitamin B1 including synthesis of pyrimidine and thiazole moieties
 - 5.3.2 Vitamin B2 from 3, 4-dimethylaniline and D (-)-ribose
 - 5.3.3 Vitamin B6 from: 1) Ethoxy acetylacetone and cyano acetamide
2) Ethyl ester of N- formyl-DL-alanine (Harris synthesis)
 - 5.3.4 Vitamin E (α -tocopherol) from trimethylquinol and phytol bromide
 - 5.3.5 Vitamin K1 from 2-methyl-1, 4-naphthaquinone and phytol.

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Unit 6 Nucleic Acids **(04Hrs)**

- 6.1 Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding
- 6.2 Structure of ribonucleic acids (RNA) and deoxyribonucleic acids (DNA)
- 6.3 Double helix model of DNA
- 6.4 Chemical and enzymatic hydrolysis of nucleic acids
- 6.5 The chemical basis for heredity, and overview of replication of DNA, transcription, functions of nucleotides
- 6.6 Chemical synthesis of DNA

Unit 7 Carbohydrates **(06Hrs)**

- 7.1 Introduction to naturally occurring sugars
- 7.2 Structure elucidation of lactose and D-Glucosamines
- 7.3 Structural features and applications of inositol, starch, cellulose, Chitin and heparin

Unit 8 Enzymes and Enzyme Models: **(08Hrs)**

- 8.1 Introduction
- 8.2 Chemical and biological catalysis
- 8.3 Mechanism of enzyme action: Transition state theory
- 8.4 Catalytic power, specificity and regulation
- 8.5 Nomenclature and classification
- 8.6 Extraction and purification
- 8.7 Fischer's lock and key and Koshland's induced fit hypothesis
- 8.8 Enzyme kinetics, Michaelis-Menten and Lineweaver Burk plots
- 8.9 Reversible and irreversible inhibition
- 8.10 Enzymes in organic synthesis
- 8.11 Synthetic enzymes

References:

1. Chemistry of Natural Products by Krishnaswamy N. R., Universities Press
 2. Organic Chemistry, Natural Products -Vol. I by O.P. Agarwal, Krishna Prakashan Media (P) Ltd
 3. Organic Chemistry, Natural Products -Vol. 2: by O.P. Agarwal Krishna Prakashan Media (P) Ltd
 4. Organic Chemistry of Natural Products -Vol. I Revised 4th Edition by Chatwal Gurdeep R. Himalaya Publishing House
 5. Organic Chemistry of Natural Products Vol. 2: Revised 4th Edition by Chatwal Gurdeep R. Himalaya Publishing House
 6. Stereochemistry and the Chemistry Natural Products, 5th Edition by FINAR Pearson Education India
 7. Chemistry of Natural Products, Vol. 1 by Ashutosh Kar CBS
 8. Natural Products: Chemistry and Applications by Sujata V. Bhat, B. A. Nagasampagi, S. Meenakshi, Narosa Publishing House
 9. Chemistry of Natural Products: Amino Acids, Peptides Proteins and Enzymes by V. K. Ahluwalia, Lalita S. Kumar, Sanjiv Kumar, ANE Books
 10. Natural Products: Chemistry, Biochemistry and Pharmacology by Goutam Brahmachari
 11. Total Synthesis of Natural Products: At the Frontiers of Organic Chemistry by Springer
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M.Sc. Organic Chemistry
SECOND SEMESTER

Program: M.Sc. Organic Chemistry	Type: Theory
Semestre: II	
Subject: SEC-II- Instrumentation and Analytical Techniques	
Credit: Th (04) + Pr (02)	Total learning hours: 60
Course description: This Course Paper proposes to teach about Principle, Instrumentation and Applications of various spectroscopy and chromatographic techniques, advanced instrumentation techniques, chemical sensors and biosensors.	
Student learning outcome: At the end of the course students will be able to... Learn <ul style="list-style-type: none"> • The History, origin, laws, principles, theories, instrumental set up, its' working mechanism, various components and it's working pattern, procedure of analysis and applications in the various field of analysis about: • Visible Spectroscopy • Atomic Absorption Spectrometry • Optical Emission Spectrometry • Advanced Instrumentation Techniques • Gas Chromatography • High Performance Liquid Chromatography • Ion Exchange and Ion Exclusion Chromatography • Chemical Sensors and Biosensors 	

Unit 1 Visible Spectroscopy

(06 Hours)

- 1.1 Characteristics of electromagnetic spectrum
- 1.2 Origin of spectra and electronics transitions
- 1.3 Laws of absorption of radiation - Lambert & Beer's law and its deviation
- 1.4 The architecture of a spectrophotometer
- 1.5 Calibration curve and standard addition method - multi component analysis
- 1.6 Applications of UV-visible spectroscopy

Unit 2 Atomic Absorption Spectrometry

(08 Hours)

- 2.1 The history & principle of atomic absorption spectroscopy
- 2.2 AAS – Instrumentation
 - 2.2.1 Radiation sources: line & continuum
 - 2.2.2 Atomization techniques: FAAS & GFAAS
 - 2.2.3 Wavelength selector: monochromator
 - 2.2.4 Detectors: PMT
 - 2.2.5 Single & double beam AAS
- 2.3 Applications of atomic absorption spectrometry

Unit 3 Optical Emission Spectrometry

(08 Hours)

- 3.1 Introduction and principle
- 3.2 Atomic spectroscopic sources
- 3.3 Inductively coupled plasma - the discharge

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- 3.4 ICP-OES Instrumentation
 - 3.4.1 Nebulizers
 - 3.4.2 Spray Chambers
 - 3.4.3 Sample introduction systems
 - 3.4.4 Optics and the spectrometer
 - 3.4.5 Emission detectors
- 3.5 Applications of ICP-OES

Unit 4 Advanced Instrumentation Techniques (06 Hours)

- Principle, Instrumental set up & Applications of
- 4.1 Non dispersive IR (gas analyzer)
 - 4.2 Modern elemental analyzer
 - 4.3 Total organic carbon analyzer
 - 4.4 Mossbauer Spectroscopy
 - 4.5 Turbidimetry
 - 4.6 Naphelometry

Unit 5 Gas Chromatography (08 Hours)

- 5.1 Introduction of chromatography and principle of separation
- 5.2 Classification -GSC and GLC & its applications
- 5.3 Components of instruments: carrier gas, sample injection system, stationary and mobile phase
- 5.4 Columns - packed column and capillary column - WCOT, SCOT, PLOT
- 5.5 Detectors - FID, TCD, ECD, ASD
- 5.6 Principle and applications of GC-HS, GC-MS

Unit 6 High Performance Liquid Chromatography (08 Hours)

- 6.1 Introduction, principle and types of HPLC
- 6.2 Components of instruments: pumps high pressure, pneumatic, syringe, reciprocating, hydraulic
- 6.3 Sample injection system
- 6.4 Column
- 6.5 Detector: ultra violet light absorption, refractive index, evaporative light scattering
- 6.6 Selective applications in separation and estimations
- 6.7 Principle and applications of LC-MS

Unit 7 Ion Exchange and Ion Exclusion Chromatography (08 Hours)

- 7.1 Ion exchangers – types, characteristics and properties
- 7.2 Ion exchange equilibrium and factors affecting it
- 7.3 Instrumental set up of IEC- columns and detector

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- 7.4 Principle, procedure and applications of IEC
- 7.5 Principle, working procedure and applications of Ion Exclusion Chromatography:
 - 7.5.1 Gel Permeation Chromatography
 - 7.5.2 Ion Exclusion Technique
 - 7.5.3 Inorganic Molecular Sieves

Unit 8. Chemical Sensors and Biosensors (08 Hours)

- 8.1 Definition and classification of sensors, Signal and noise
- 8.2 Efficiency of sensors, sensitivity and limit of detection
- 8.3 Principle and applications of
 - 8.3.1 Electrochemical sensors
 - 8.3.1.1 Coulometry & Potentiometry
 - 8.3.1.2 Conductimetry & Amperometry
 - 8.3.1.3 Polarography & Voltammetry
 - 8.3.2 Solid state electrode & Mass sensitive sensors
 - 8.3.3 Optical sensors & Thermal sensors
 - 8.3.4 Biosensors & Biocatalytic biosensors

References

1. Engineering Chemistry, P.C. Jain & Monica Jain, 17th Edition, Reprint 2011, Dhanpatrai Publishing Company (P) Ltd.
2. Handbook of Analytical Instrument, R.S. Khandpur, 2nd Edition, Reprint 2009, Tata McGraw Hill Publishers.
3. Instrumental Methods of Chemical Analysis (Analytical Chemistry), H. Kaur, 8th Edition, 2012, Pragati Prakashan.
4. Basic Concepts of Analytical Chemistry, S.M. Khopkar, 3rd Edition, Reprint 2009, New Age International (P) Limited, Publishers.
5. Analytical Instrumentation Handbook, Ewing's, Edited by Jack Cazes, 3rd Edition, 2005, Marcel Dekker Publisher.
6. Instrumental Methods of Analysis, H. H. Willard, L. L. Meritt, J.A. Dean and F.A. Settle, 7th Edition, 1986, CBS Publishers.
7. Instrumental methods of analysis, B.K. Sharma, 24th Edition, 2005, Goel Publishing House.
8. Instrumental Analysis, D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, 11th Edition, Reprint 2012, Cengage Learning.
9. BIOS-Instant Notes-Analytical Chemistry, D. Kealey, P.J. Haines, 2002, Viva Books (P) Ltd.
10. Analytical Instrumentation, Bela G. Liptak, 1st Edition, 1994, 1st Indian Reprint, 2012, Chilton Book Company.

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SECOND SEMESTER

Program: M.Sc. Organic Chemistry	Type: Theory
Semester: II	
Subject: DSE-II- Forensic Chemistry & Toxicology	
Credit: 04(T) + 02 (P)	Total learning hours: 60
Course description: This course paper intends to deal about the Forensic Toxicology, the branch of science that applies the principles and knowledge of toxicology to issues and problems in the field of law. To achieve this, techniques of analytical chemistry are combined with principles of toxicology to address issues related to the toxic effects of substances on humans that are germane to judicial proceedings. Analytical chemistry deals with the techniques and methods for determining the identity and relative amounts of unknown components in a sample of matter.	
Student learning outcome: At the end of the course students will be able to learn... <ul style="list-style-type: none">• Forensic chemistry and its scope,• Examination of petroleum products, fires, explosives,• Types of forensic toxicology, analysis, extraction, isolation and clean up procedures,• Forensic examination of metallic poison and various organic-toxic compounds.	

Unit 1: Forensic Chemistry and its Scope (16 hrs)

- 1.1 Analysis of beverages:
Alcohol and Non- alcoholic, country made liquor, illicit liquor
- 1.2 Drugs of abuse: Introduction, Classification, Narcotic drugs & Psychotropic substances, drugs of abuse in sports.
- 1.3 Brief Introduction to Drugs and cosmetic act, Excise Act, NDPS Act
- 1.4 Analysis of Gold and Other metals in cheating cases.

Unit 2: Examination of Petroleum Products (14 hrs)

- 2.1 Distillation & Fractionation, various fraction and their commercial uses.
- 2.2 Standard methods of analysis of petroleum products for adulteration
- 2.3 Trap cases: purpose, examination of chemicals used in trap case
- 2.4 Cement: Composition, types and Forensic analysis, Mortar & Concrete

Unit 3: Fires (13 hrs)

- 3.1 Nature and Chemistry of fire, Classification
- 3.2 Igniters of fires, Phases of fires, Main types of fires
- 3.3 Examination of scene of fires
- 3.4 Arson: Relevant IPC sections, Motives, Analysis of Accelerants

Unit 4: Explosives (14 hrs)

- 4.1 Classification, Comparison & characterization of explosives
- 4.2 Military & Commercial explosives
- 4.3 Qualitative determination: Detection of Explosophores (anions), Detection of Black powder, Nitrocellulose and Dynamite,
- 4.4 Quantitative determination

Unit 5: Forensic Toxicology (14 hrs)

- 5.1 Introduction, concept and Significance
- 5.2 Poisons: Definition, Classification of poisons
- 5.3 Types of poisoning sign and symptoms of poisoning
- 5.4 Mode of action, factors modifying the action of poisons
- 5.5 Toxicological exhibits in fatal and survival cases
- 5.6 Preservation Treatment in cases of poisoning
- 5.7 Analysis report

Unit 6: Extraction, Isolation and Clean-up procedures (15 hrs)

- 6.1 Non-volatile organic poison

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- 6.2 Stas-otto, Dovbriey Nickolls (Ammonium sulphate) method, acid digest and Valov(Tungstate) methods, Solid phase micro extraction techniques, Solvent extraction methods
- 6.3 Volatile Poisons: Industrial solvent acid and basic Distillation
- 6.4 Toxic Cations: Dry Ashing and Wet digestion process
- 6.5 Toxic Anions: Dialysis method total alcoholic extract

Unit 7: General Study and Analysis

(13 hrs)

- 7.1 Barbiturates, methaqualone, Hydro morphine, Methadone, Meprobamate, Mescaline, Amphetamines, LDS, Heroin, Cannabinoids, Phinothiazines
- 7.2 Insecticides: Types, General methods for their analysis
- 7.3 Alkaloids: Definition, classification, Isolation and General characterization.
- 7.4 Analysis of Ethyl Alcohol in blood and urine, illicit liquor, Methanol, Acetone, Chloroform, Phenol
- 7.5 Snake venoms and Poisons, Irrespirable gases
- 7.6 Vegetable poisons, Opium, Abrus, Cyanogenetic glycosides, Dhatura, Marking nuts, Nux-vomica, Oleander and Aconite
- 7.7 Forensic Pharmacological studies:
Absorption, Distribution, Metabolism, Pathways of drug metabolism

Unit 8: Forensic Examination of Metallic Poisons

(14 hrs)

- 8.1 Absorption, Distribution, Metabolism, Pathways of metallic poison metabolism:
Arsenic, Mercury, Lead, Bismuth, Copper, Aluminium, Iron, Barium, Zinc.

References:

1. Vogel's Textbook of Quantitative Chemical Analysis, Maudham Bassett et.al; 6th Edition, 2004, Longman Essex.
 2. Organic Chemistry Vol. II, I. L. Finar, Pearson Education, Singapore.
 3. Organic Chemistry, R.T. Morrison, R.N. Boyd; 6th Edition., 2003, Prentice Hall, New Delhi.
 4. Vogel Textbook of Practical Organic Chemistry, Brean S. Furniss et. al; 1998, Addison Wesley Longman, Edinburg.
 5. Medicinal Chemistry, A. Burger, Vol. II, 1970, Wiley Interscience, NY.
 6. D. A. Skoog, D.M. West, F.J. Holler; Analytical Chemistry – An Introduction, 7th Edition, 2000, Saunders College Pub. Philadelphia, USA.
 7. Working Procedure Manual – Chemistry, Explosives and Narcotics, 2000, BPR&D Pub.
 8. Official and standardized Methods of Analysis, C.A. Watson, 1994, Royal Society of Chemistry, UK.
 9. Modi's Medical Jurisprudence & Toxicology, 1988, M. M. Trirathi Press Ltd. Allahabad.
 10. Forensic Science Hand Book, Vol I, II and III, Saferstein, R., 1982, Pretince Hall, NI.
 11. Analytical Methods in Human Toxicology, Part II, Curry, 1986.
 12. Poison Detection in Human Organs Curry, A.S., 1976.
 13. Forensic Science, Handbook, Vol. I, II & III, Saferstien, Prentice Hall Inc, USA.
 14. Encyclopedia of Forensic Sciences Vol. I, II and III, J. A. Siegel, P.J Saukko, 2000, Acad. Press.
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Laboratory Practical

1. Estimation of mixture (Acid + Amide)
2. Estimation of mixture (Acid + Ester)
3. Determination of Phenol in water sample by Spectrophotometer.
4. Determination of COD in water sample by Spectrophotometer.
5. Estimation of Sugar in natural sample by Spectrophotometer.
6. Identification of salts (cation /anion) by simple colour test and group analysis.
7. Identification of metals by simple colour test and group analysis/
spectrophotometer.
8. Identification of different vegetable poison by colour test/chromatography etc.
9. Identification of insecticides and pesticides by TLC/ colour test.
10. Separation of Amino Acids using Thin Layer Chromatography.
11. Estimation of Vitamin C by Iodometric Titration
12. Preparation of Lineweaver Burk Plot for Amylase Enzyme.
13. Qualitative Analysis of Carbohydrates.

References:

1. Standard Methods for Examination of Water & Wastewater, Andrew D. Eaton, Lenore S. Clesceri, Eugene W. Rice, Arnold Greenberg, 23rd Edition, 2017, published by APHA, AWWA, WEF.
2. Official Methods of Analysis, Dr. William Harwitz, Dr. George W Latimer, 18th Edition, 2005, published by Association of Officiating Analytical Chemists (AOAC).
3. Analytical Techniques in Agriculture, Biotechnology and Environmental Engineerin; A. Nag; 1st Edition, 2006, Prentice Hall of India.
4. Laboratory Manual in Biochemistry – J. Jayaraman, 2011, New Age Publication.
5. Analytical Chemistry, H. Kaur, 1st Edition, 2013, Pragati Prakashan.