VEER NARMAD SOUTH GUJARAT UNIVERSITY
M.Sc. (INDUSTRIAL CHEMISTRY) SEMESTER-III
TO COME IN FORCE FROM JUNE-2011 **(REVISED IN B O S Dated 18-01-2011)**

Paper-I (Chemistry in Industry-I)

Max. Marks: 70 **Total Periods: 45**

UNIT-I: Unit Processes **(15 Periods)**

Nitration: Nitrating agents. Mechanism of aromatic nitration. Industrial chemicals derived from Benzene, Naphthalene, Anthracene using nitration unit process.

Sulphonation and Sulfation: Sulphonating and Sulfating agents. Mechanism of aromatic Sulphonation. Industrial chemicals derived from Benzene, Naphthalene, Anthracene using Sulphonation unit process.

Halogenation: Halogenating agents. Industrial chemicals derived from Benzene, Naphthalene, Anthracene using Halogenation unit process.

Amination: Aminating agents, Amination by reduction, Amination by Ammonolysis. Industrial chemicals derived from Benzene, Naphthalene, Anthracene using Amination unit process.

Hydroxylation: Industrial chemicals derived from Benzene, Naphthalene, Anthracene using hydroxylation unit process.

Alkylation: Alkylating agents. Industrial chemicals derived from Benzene, Naphthalene, Anthracene using alkylation unit process.

Recommended books:

1. Unit process in Organic Synthesis by P. M. Groggins.
2. Chemical Process Industries by R. N. Shreve.
3. Riegel's Hand-Book of Industrial Chemistry, Ed. by James A. Kent.
4. Industrial Chemicals by Faith, Keyes, Clark.

Unit II: Chemical Engineering Principles, Chemical Safety and Management, Waste **(15 Periods)**

Chemical Engineering Principles: Stoichiometry, material balance, and energy balance, thermochemistry, heat flow, mechanisms, condensation and evaporation, heat exchangers, evaporators, mass transfer, principles, distillation (principles, types and concept of theoretical plates), extraction and leaching, Filtration, Crystallization, drying, industrial dryers, pumps, pipelines, industrial reactors and other vessels.

Chemical Safety and Management: A basic course in chemical laboratory safety, MSDS of chemicals, safe handling and storage of chemicals, Environment safety, care and use of safety equipment, Risk assessment, Hazard classification and management.

Waste and its disposal: Solid waste, Waste management disposal methods, Types of recycling, Hazardous waste: Management and disposal/destruction technologies, Waste separation technologies, Waste bioremediation technologies, Human resource and management

Recommended book:

Handouts from the teacher

Unit III: Green Chemistry (15 Periods)

Introduction: Twelve principles of Green chemistry, Atom economy and Waste minimization.

Green solvents and their applications: Ionic liquids, types, properties and applications, ILs as solvents, Use of ionic liquids in reactions such as Heck reaction, Knoevenagel condensation

Super critical fluids: The phase diagram of CO_2, Supercritical CO_2, its properties and applications in dry cleaning and decaffeination of coffee.

Microwave assisted synthesis: Mechanism and advantages with some examples, Biobased materials: Basic idea on Biopesticides, Biofertilizers, Biosurfactant, Biofuels, Biodegradable polymers.

Aqueous phase reaction:

1. Baeyer-Villiger Oxidation
2. Claisen-Schmidt Reaction
3. Diels-Alder reaction
4. Knoevenagel Condensation

Green approach in the synthesis of:

1. Adipic acid
2. Methyl methacrylate
3. Catechol
4. Paracetamol

Recommended books:

1. Green chemistry by V. K. Ahluwalia Narosa Pub New Delhi
2. Green Chemistry, Theory and Practice, P. T. Anastas and John C. Warner, Oxford University Press, 2000, New York, USA.
3. Green Chemistry: An Introductory Text, Mike Lancaster, Green Chemistry Network, University of York, RSC, 2002.

VEER NARMAD SOUTH GUJARAT UNIVERSITY
M.Sc. (INDUSTRIAL CHEMISTRY) SEMESTER-III
TO COME IN FORCE FROM JUNE-2011 **(REVISED IN B O S Dated 18-01-2011)**
Paper-II (Dyes)

Max. Marks: 70 **Total Periods: 45**

Unit I: Colour & Chemical Constitution and Classification of dyes (15 Periods)

Basic theories of colour: Bathochromic and hypsochromic effect – Hyper chromic and Hypo chromic effect – Witt's theory – Armstrong's theory – Nietzki's theory – Resonance theory – M.O. theory.

Fluorescent Whitening Agents: Introduction, Theory of fluorescence – Classification of FWA and synthesis of important member of each class and their uses.

Unit II: Azo and Anthraquinone Dyes (15 Periods)

Azo Dyes: General Introduction, diazotisation, mechanism and different methods of diazotization and laws of coupling, Monoazo dyes, Bisazo dyes and Azoic dyes (general introduction, classification, synthesis and evaluation of dyes).

Anthraquinone Dyes: Vat Dyes and Solubilized Vat dyes, Acid dyes, Mordant dyes and dyes for cellulose acetate.

Unit III: Sulphur, TPM and Reactive dyes (15 Periods)

General nature, classification, structural variation, synthesis and application of the following classes of dyes:

(i) ***Sulphur dyes:*** General introduction, classification and synthesis.
(ii) ***Triphenyl methane dyes:*** General introduction, classification and synthesis.
(iii) ***Reactive dyes:*** General introduction, classification and synthesis.

Recommended books:

(1) Principles of Colour Technology by Fred W. Billmeyer and Max Saltzman, John Wiley & Sons.

(2) The Chemistry of Synthetic Dyes, Vol. I to VII by Venkataraman, Academic Press, New York.

(3) Chemistry of Synthetic Dyes & Pigments by Lubs.

(4) Dyes and their intermediates by E. N. Abrahart.

(5) Technology of Textile Processing by V. A. Shehnai, Sevak Publications, Bombay.

(6) Industrial Dyes by Klans Hunger, Germany by Wiley-VCH.

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TO COME IN FORCE FROM JUNE-2011 **(REVISED IN B O S Dated 18-01-2011)**
Paper-III (Polymers)

Max. Marks: 70 **Total Periods: 45**

Unit I: General Introduction and Synthesis of Polymers (15 Periods)

Introduction, Classification of Polymers, Nomenclature of Polymers, Isomerism in Polymer Chains, History of Polymers, Industrial Scenario, Natural polymers Intermolecular Forces in Polymers ,Conformations in Polymer Chains, Polymer Waste Disposal and Remedies. Chain Growth Polymerisation (Addition Polymerisation), Mechanism of Polymerisation (Free Radical, Cationic and Anionic), Coordination Polymerisation, Ring Opening Polymerisation, Kinetics of Free Radical Addition (Chain) Polymerisation ,Thermodynamic Aspects of Polymerisation, Co-polymerisation, Step-growth Polymerisation (or Polycondensation), Phase Techniques in Polycondensation, Synthesis and Application of Some Common Industrial Polymers such as Polyolefin, Polydienes, Vinyl polymers, Acrylic polymers, Polyesters, Polyamides and polyamides, Polycarbonates, Epoxy polymers.

Unit II: Polymer Analysis and Characterization (15 Periods)

Identification: Physical Testing, Spectral Methods, Chromatographic Methods, Identification of Typical Plastic Materials, Testing Methods: Thermal and Electrical.
Chemical Characterization: Molecular Weight Distribution, Fractionation of polymers, Gel Permeation Chromatography.
Determination of Molecular Weight of Polymers: Viscosity methods, Osmotic pressure methods and Light scattering method.

Unit III: Behavior of Polymers and Polymer Technology (15 Periods)

Crystalline Behaviour: Crystalline and amorphous polymers, determination of degree of crystallinity, Crystallinity and crystallizability of polymers, Factors affecting crystallinity and properties.
Thermal Behaviour: Thermal transitions in polymers, Glass transition temperature: its determination and factors its significance.
Solution Behaviour: Dissolution of polymers, Solubility parameter, Thermodynamics of polymer dissolution.
Polymer Additives: Antioxidants, Thermal stabilizers, Fillers, UV stabilizers, Plasticizers
Polymer Processing: Moulding and Extrusion.
Recommended book
1. Principles of Polymer Science. Second Edition by P Bahadur and N.V.Sastry, Narosa Pub. House Pvt. Ltd., New Delhi.

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M.Sc. (INDUSTRIAL CHEMISTRY) SEMESTER-III
TO COME IN FORCE FROM JUNE-2011 **(REVISED IN B O S Dated 18-01-2011)**

Paper-IV (REARRANGEMENTS & SYNTHETIC APPROACH)

Max. Marks: 70 **Total Periods: 45**

UNIT-I: MOLECULAR REARRANGEMENTS (15 Periods)

(A) Rearrangement involving migration to electron deficient carbon:

(i) Acid-catalyzed rearrangement of aldehydes and ketones.

(ii) Expansion and contraction of rings/Demajnov rearrangement.

(iii) Benzil-benzilic acid rearrangement.

(B) Aromatic rearrangements:

(i) Migration around the aromatic nucleus: Jacobsen rearrangement

(ii) Migration of group from the side chain to the nucleus: Orton rearrangement, Hoffmann- Martius rearrangement, Bamberger rearrangement, Rearrangement of diazonium compounds, Rearrangement of N-nitro anilines, Rearrangement of N-nitrosoanilines (Fischer-Hepp rearrangement).

(C) Rearrangement involving migration from oxygen to ring:

(i) Fries rearrangement

(ii) Claisen rearrangement

UNIT-II: PROTECTING GROUPS & DISCONNECTION APPROACH (15 Periods)

(A) Multistep Synthesis:
Need of protecting groups – Hydroxy protective groups – Amino protective groups – Carbonyl protective groups – Carboxylic acid protective groups – Synthetic equivalent groups.

(B) Disconnection Approach:
Introduction to disconnection, Concept of synthon, Synthetic equivalent, Functional group interconversion, Concept and design of synthesis, Criteria of good disconnection, Regioselectivity and Chemoselectivity.

(i) One group disconnection:
Disconnection and synthesis of alcohols, olefins, simple ketones, acids and its derivatives.

(ii) Two groups disconnection:

Disconnections in 1, 3-dioxygenated skeletons, preparation of β-hydroxy carbonyl compounds, α, β-unsaturated carbonyl compounds, 1, 3-dicarbonyls, 1, 5-dicarbonyls and use of Mannich reaction.

(iii) Disconnection and synthesis of acyclic and cyclic hetero compounds:
Synthesis of ethers, amines, nitrogen and oxygen containing five and six membered heterocycles.

Recommended book:
Handouts from the teacher

UNIT-III: ORGANOMETALLICS AND THEIR ROLE IN ORGANIC SYNTHESIS

(15 Periods)

(i) Review on organometallic compounds, Nomenclature, Carbon-metal bonds in organometallic compounds, Synthesis and applications of Organolithium, Organozinc, Organopalladium, Organocopper and Lithium diorganocuprate.
(ii) Basic concept of organoboranes, Preparation of organoboranes, Stereochemistry of hydroboration, Mechanism of hydroboration – oxidation, Synthetic applications.

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TO COME IN FORCE FROM JUNE-2011 **(REVISED IN B O S Dated 18-01-2011)**
Practicals
Marks: 200 [External-120 + Internal-60 + Viva- 20]

I. Organic Separation:-

Separation and identification of components in mixtures containing three components. (Candidate will prepare at least **2** derivatives. Each student should carry out minimum **8** separations).

II. Organic Estimations:-

1. Determination of Sulphonamides with Silver Nitrate solution by Volumetrically.
2. Determination of aromatic primary amines by either diazotization or indirect diazotization.
3. Determination of Amino acids by formal titration.
4. Estimation of Benzyl Penicillin.
5. Determination of coupling value (C.V.) of Dye intermediates.
6. Non-aqueous titration of Sodium Benzoate.
7. Estimation of Isonazid.

III. Chromatographic Separations. (ANY FIVE)

Paper chromatographic separation of sugars, dyes, amino acids:

(At least 4 Separations)

Reference Books for Practicals:-

1. Elementry Practical Organic Chemistry Part-I Small Scale Preparations by A. I. Vogel.
2. Elementry Practical Organic Chemistry Part-II Qualitative Organic Analysis by A. I. Vogel.
3. Elementry Practical Organic Chemistry Part-III Quantitative Organic Analysis by A. I. Vogel.
4. Practical Pharmaceutical Chemistry by A. H. Bakett, Volume I & II.
5. Comprehensive Practical Organic Chemistry Qualitative Analysis by Ahluwalia & Aggarwal.
6. Organic Quantitative Analysis by Vogel's (ELBS)
7. Comprehensive Practical Organic Chemistry Preparation and Quantitative Analysis by Ahluwalia & Aggarwal.
8. Practical Physical Chemistry by J. B. Yadav.

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M.Sc. (INDUSTRIAL CHEMISTRY) SEMESTER-IV
TO COME IN FORCE FROM JUNE-2011 **(REVISED IN B O S Dated 18-01-2011)**

Paper-I (Chemistry in Industry-II)

Max. Marks: 70 **Total Periods: 45**

Unit I: Introduction to Environmental Chemistry (15 Periods)

Concept and scope, the natural cycles of environment (Hydrological, Oxygen, Nitrogen, Phosphorous and Sulphur cycles).

Air pollutants: Particulates, Aerosols, SO_x, NO_x, CO_x and Hydrocarbon emission, Photochemical smog, Global warming, Ozone layer depletion, Water pollutants, water-quality parameters and standards: physical and chemical parameters (colour, odour, taste and turbidity), Dissolved oxygen, BOD, COD, Total organic carbon, Total nitrogen, Total sulfur, Total phosphorus and Chlorine, Chemical speciation, Waste and pollutants in soil, waste classification and disposal.

Radiation pollution: classification & effects of radiation, effects of ionizing radiation on man, Effects of non ionizing radiation on life, radioactivity and Nuclear fall out, protection and control from radiation.

Recommended books:

1. Basic Concept of environmental Chemistry by Des. W. Connell
2. Environmental Chemistry, 7th Ed., By S. E. Manahan.
3. A textbook of environmental chemistry, By O. D. Tyagi and M. Mehara
4. Fundamental concept of environmental chemistry, By G. S. Sodhi.

Unit II: Agro Based Industries (15 Periods)

Paper and Pulp Industry: Manufacture of pulp mechanical and chemical pulping, manufacturing of paper, bleaching, fillers and sizing agents, colouring agents.

Oil/Fats/Wax/Soaps: Fatty acids and triglycerides, saturated and unsaturated fats, hydrogenation, polymerization, rancidity of oils, fat analysis, Butter, margarine and mayonnaise, Waxes: their types and applications, Soap and soap manufacture, Hard and soft soaps, Disadvantages of soaps over synthetic detergents

(a) ***Fermentation Industry****:* Anaerobic and aerobic fermentation production of antibiotics, amino acids (lysine, glutamic acid), alcohol, acetone, butanol, lactic acid, citric acid, vitamins and enzymes, brewing industry.
(b) ***Perfumes:*** Introduction of perfumes and perfumery chemicals, theory of olfaction and mechanism, classification of perfumes, Essential oils and their isolation, Some important terpenes and esters, Flavours, synthesis of civetone and Muskone, relation between perfumes and phermones.
(c) ***Fertilizers:*** Different types of fertilizers, their manufacture and industries in India
(d) ***Paints:*** Components of paints, pigments, thinner, binder, types of paints, water based paints, drying of paints

Recommended books:

1. Chemical Process Industries by R. N. Shreve.
2. Dryden's outlines of Chemical Technology by M. Gopal Rao and Marshall
3. Industrial Chemicals by Faith, Keyes, Clark.
4. Riegel's Hand-Book of Industrial Chemistry, Ed. by James A. Kent

Unit III : Surfactants, Explosives, Pesticides (15 Periods)

Surfactants: Classification with examples, Adsorption and micelle formation, Manufacture of anionic, cationic, zwitterionic and nonionic detergents, Applications in industries Applications as Foaming agent, Wetting agent, Dispersant, Solubilizers, Emulsifiers and Rheology modifiers, Detergent formulations, Detergent biodegradation, Biosurfactants.

Explosives: classification, characteristics, preparation of nitrocellulose-T.N.T, Picric acid, Dynamite-cordite and Gunpowder, Dynamite, HMX, PETN, Cyclonite, plastic explosives, gelatin, RDX, cordite and seismic explosives, propellants - manufacture of liquid and solid propellants - hydrazine, incendiaries and smoke screens. Industrial applications.

Pesticides: Introduction, classification, synthesis of few common pesticides of chlorinated (DDT, BHC, Chlordane, Aldrin), organophosphorus and carbamate (parathion, malathion, carbaryl) compounds family, Plant pesticides, Pesticide formulations.

Recommended books:

1. Chemical Process Industries by R. N. Shreve.
2. Dryden's outlines of Chemical Technology by M. Gopal Rao and Marshall
3. Industrial Chemicals by Faith, Keyes, Clark.
4. Riegel's Hand-Book of Industrial Chemistry, Ed. by James A. Kent

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M.Sc. (INDUSTRIAL CHEMISTRY) SEMESTER-IV
TO COME IN FORCE FROM JUNE-2011 **(REVISED IN B O S Dated 18-01-2011)**
Paper-II (Drugs)

Max. Marks: 70 **Total Periods: 45**

Unit I: Drug development and metabolism (15 Periods)

(A) ***Drug Design and development*****:**

Discovery of a drug, Discovery of Librium, Discovery of Lead Compound, Lead modification, QSAR, Drug design.

(B) ***Drug metabolism:***

Introduction, Drug Metabolism Pathways (Phase I & Phase II Transformations).

Unit II: Classification and synthesis of drugs (15 Periods)

Classification of various drugs with example:

Antibiotics, Antimalarials, Sulphonamides, Analgesics and Antipyretics, Diuretics.

Synthesis and therapeutic use of:

Verapamil, Atenolol, Pamaquine, Daraprim, Paracetamol, Novalgin, Chloramphenicol, Penicillin V, Sulphathiazole, Sulphadiazine, Melphalan, Mechlorethamine, Furosemide, Ethacrynic acid, Diazepam, Procaine, Dibucaine (Nupercaine), Chlorpheniramine, Pyrilamine, Isoniazid (INH), Ethambutol, Glibenclamide, Tolbutamide.

Unit III: Structure activity relationship and mode of action (15 Periods)

Concept of Prodrugs**,** Bioprecursor prodrugs, Carrier prodrugs, agonist and antagonist.

SAR and mode of action of following:

Antibiotics, Antimalarials, Antituberculosis, Sulphonamides, Analgesics and Antipyretics, Anticancer agents**,** Hypnotics and local anaesthetic.

Recommended books:

1. Burger's Medicinal Chemistry and Drug Discovery (5/e), 1997, Vol. 1, 2, 3, 4,5, Edited by ManFred E. Wolff (John Wiley & Sons, inc., New York).
2. Essential of Medicinal Chemistry (2/e) by Andrejus Korolkovas (A Wiley Interscience Publication, 1988, John Wiley & Sons, Canada).
3. Medicinal Chemistry by Ashutoshkar (Wiley Eastern Ltd., 1993).
4. Principles of Medicinal Chemistry, Vol. I & II (5/e), by S. S. Kadam, K. R. Mahadik, K. G. Bothra (Nirali Prakashan).
5. Medicinal Chemistry by V.K.Ahluwalia Narosa.

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TO COME IN FORCE FROM JUNE-2011 **(REVISED IN B O S Dated 18-01-2011)**
Paper-III (Petroleum)

Max. Marks: 70 **Total Periods: 45**

Unit I: Petroleum (15 Periods)

General Introduction. Definition of Petroleum & Petrochemicals. Historical development. Development of petrochemical industry in Gujarat & India. Sources of Petrochemicals: Natural Gas and Petroleum. Classification of Petrochemicals.

Chemistry of Petroleum Hydrocarbons:

Classification of Hydrocarbons

(i) Alkanes
(ii) Alkenes
(iii) Alkynes
(iv) Alicyclics
(v) Aromatics
(vi) Fused Ring Aromatics

Unit II: Petroleum Refining and Petrochemical Processes (15 Periods)

Petroleum refining and Aromatics from Petroleum: Refining processes, Aromatics from petroleum.
BTX Chemicals: Manufacturing of petrochemicals from benzene, toluene and xylene.
Industrial Manufacture of Petrochemicals: Acetone, Bisphenol-A, Ethanol amines, Ethyl alcohol, Methyl Isobutyl ketone (MIBK), Ethylene glycol, Ethylene oxide, Glycol and Polyglycol ethers.

Unit III: Petrochemicals from C_1, C_2, C_3, C_4 cuts (15 Periods)

Manufacturing of petrochemicals from C_1, C_2, C_3, C_4 cuts. Chemicals from methane, ethane, ethylene, acetylene, propane, propylene, butane and their reaction of synthesis

Recommended books:

1. Chemical Process Industries by R. N. Shreve.
2. Riegel's Hand-Book of Industrial Chemistry, Ed. by James A. Kent.
3. Industrial Chemicals by Faith, Keyes, Clark.
4. Chemicals from petroleum by Weddams.

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TO COME IN FORCE FROM JUNE-2011 **(REVISED IN B O S Dated 18-01-2011)**

Paper-IV (THEORETICAL ORGANIC CHEMISTRY)

Max. Marks: 70 **Total Periods: 45**

UNIT-I: Aromaticity (15 Periods)

Aromaticity and aromatic character, Frost circle diagram for cyclobutadiene and benzene. Concepts of aromaticity, Resonance and chemical stabilization, Aromatic character based on NMR. Criteria to check aromatic character. Huckel rule, Energy level of π molecular orbitals, Huckel molecular orbitals (HMO) method, orbital symmetry, MO of simple organic systems such as (i) ethene, (ii) allylic compounds and (iii) butadiene. Aromaticity in benzenoid and non-benzenoid compounds and charged rings, Annulenes, Antiaromaticity, Homoaromaticity.

UNIT-II: OXIDATION & REDUCTION (15 Periods)

(A) Oxidation:
Oxidation with Cr(VI), Mn(VII), Mn(IV), OsO_4, Alumininum Isopropoxide, Periodic acid Peroxidic reagents– Cleavage of ethylenic double bonds – Cleavage of glycols (with mechanism).
(B) Reduction:
Reduction of carbonyl and other functional groups:
Reduction of carbonyl group with $LiAlH_4$, $NaBH_4$ (with mechanism) – The Shapiro Reaction, mechanism and applications- The Birch reduction of aromatic rings mechanism and applications.

UNIT-III: MANUFACTURE AND USES OF PETROCHEMICALS (15 Periods)

Industrial production of the following with flow diagram: Antibiotics (Benzyl Penicillin, Tetracyclin), Citric acid, Vitamin-C, Lactic acid, Aspirin, DDT, 2, 4 –D (2, 4 – Dichloro phenoxy acetic acid), Urea, H-acid, Saccharin, 4, 4'-diaminostilbene disulphonic acid (DASDSA), 2, 4-dicyano toluene.

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Practicals
Marks: 200 [External-120 + Internal-60 + Viva- 20]

I. Organic Preparations:-

Three step preparations (at least 10)

1. Benzilic acid from benzaldehyde via benzoin and benzil.
2. Sulfanilamide from via p-acetamido benzene sulphonyl chloride and acetamido benzene-sulfonamide.
3. Anthranilic acid from phthalic acid via phthalic anhydride and phthalimide.
4. Acridone from anthranilic acid via o-chloro benzoic acid and N-phenyl anthranilic acid
5. Benzocaine from p-nitro toluene via p-nitro benzoic acid and p-amino benzoic acid.
6. Eosin from phthalic acid via phthalic anhydride and fluorescein.
7. Benzanilide from benzene via Benzophenone and Benzophenonoxime.
8. p-Nitro chloro benzene from acetanilide via p-nitro acetanilide and p-nitro aniline.
9. p-Chloro bromo benzene from acetanilide via p-bromo acetanilide and p-bromo aniline.
10. p-Chloro benzoic acid from p-nitro toluene via p-toluidine and p-chloro toluene.
11. Anthrone from phthalic anhydride via o-benzoyl benzoic acid and anthraquinone.
12. 4-Methyl-7-hydroxy-8-acetyl coumarin from resorcinol via 4-methyl-7-hydroxy coumarin and 4-methyl-7-acetyl coumarin.
13. Preparation of Paracetamol from phenol.
14. Preparation of Congo red dye from naphthionic acid via hydrozobenzene.
15. Preparation of o & p-hydroxy acetophenone from Aniline via phenol and phenyl acetate.

II. Isolations (at least 5)

1. Isolation of Caffeine from tea leaves.
2. Isolation of Casein from milk.
3. Isolation of Nicotine dipricate from tobacco.
4. Isolation of Eugenol from cinnamon leaf oil or clove.
5. Isolation of Cucumarin from turmeric.
6. Isolation of piperine from black pepper.

III. Viva-Voice examinations:-

Reference Books for Practicals:-

9. Elementry Practical Organic Chemistry Part-I Small Scale Preparations by A. I. Vogel.
10. Elementry Practical Organic Chemistry Part-II Qualitative Organic Analysis by A. I. Vogel.
11. Elementry Practical Organic Chemistry Part-III Quantitative Organic Analysis by A. I. Vogel.
12. Practical Pharmaceutical Chemistry by A. H. Bakett, Volume I & II.
13. Comprehensive Practical Organic Chemistry Qualitative Analysis by Ahluwalia & Aggarwal.
14. Organic Quantitative Analysis by Vogel's (ELBS)
15. Comprehensive Practical Organic Chemistry Preparation and Quantitative Analysis by Ahluwalia & Aggarwal.
16. Practical Physical Chemistry by J. B. Yadav.