

VEER NARMAD SOUTH GUJARAT UNIVERSITY
M.Sc. Semester-III (ORGANIC CHEMISTRY)
STRUCTURE OF THE SYLLABUS TO BE EFFECTIVE FROM JUNE 2019

Sr. No.	Course Title	L	T/C/S	Credit
1	Natural Products and Bio-molecules	4	1	4
2	Selected Topics In Organic Chemistry-I	4	1	4
3	Organic Chemistry in Industry	4	1	4
4	Medicinal Chemistry-I OR Dye and Intermediates-I	4	1	4
5	Practicals	12		8
		28	4	24

External Examination Time Duration: 03 hrs

Name of Exam	Semester	Paper No	Course group	Credit	Internal Marks	External Marks	Total Marks
M. Sc.	III	I	Core	04	30	70	100
		II	Core	04	30	70	100
		III	Core	04	30	70	100
		IV	Core	04	30	70	100
			Practical	08	60	140	200
			Total	24	180	420	600

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PAPER-I (Natural Products and Bio-molecules)

Max. Marks: 100 (External – 70 + Internal – 30)

Total Periods: 45

UNIT-I NATURAL PIGMENTS & ALKALOIDS (12 Periods)

(A) Natural Pigments & Porphyrins Derivatives

Porphyryns: General structures, Synthesis and Spectral properties. Synthesis of cryptopyrrole, Phytopyrrole, Opsopyrrole and Haemopyrrole and their carboxylic acid derivatives.

Structural elucidation of Haemoglobin and Chlorophyll (Analytical evidences only)

(B) Alkaloids

Classification of alkaloids; Structural elucidation of Morphine, Reserpine and Colchicine (Analytical evidences only)

UNIT-II STEROIDS & SEX HORMONES (11 Periods)

(A) Steroids

Introduction to Sterols: Structure determination of cholesterol and ergosterol (no synthesis), Bile acids: Introduction, Structural elucidation and Synthesis of Cholic acids (α and β both).

(B) Sex Hormones

Classification of hormones: Structure and synthesis of Androgens, Oestrogens and Gestrogens. Name and structures of Adrenocortical hormones, Partial synthesis of cortisone.

UNIT-III VITAMINS & TERPENOIDS (11 Periods)

(A) Vitamins

Structure determination, Synthesis and biochemical functions of Vitamin A, Vitamins B1 and B2, Vitamin H

(B) Terpenoids

Classification, nomenclature and isolation

Structure determination and synthesis of Farnesol, Zingiberene, Cadinene, Gibberlic acid and Abietic acid.

UNIT-IV Nucleic Acids & Enzymes (11 Periods)

(A) Nucleic Acids

Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding, Chemical and enzymatic hydrolysis of nucleic acids, Structure of nucleosides and nucleotides, DNA, RNA (Basics structures only), DNA replication, Transcription, Translation, Protein Biosynthesis.

(B) Enzymes

Classification, nomenclature and inhibition, factors affecting catalytic activity and specificity in action, regulation of enzyme activity

Reference Books Recommended:

1. Organic Chemistry, Vol. I & II (Sixth edition), I. L. Finar.
2. S.W. Pelletier, Chemistry of the Alkaloids, Van Nostrand Reinhold Co., New York (1970).
3. K.W. Bentley, The Alkaloids, Vol. I., Interscience Publishers, New York (1957).
4. Chemistry of Organic Natural Products, Vol. I & II, O. P. Agrawal.
5. Organic Chemistry of Natural Products, Vol. I & II, Chatwal.
6. Organic Chemistry (5/e) by Morrison & Boyd.
7. Chemistry of Vitamins – S. F. Dyke.
8. Natural Products Chemistry, Vol. I & II, K. Nakanishi.
9. The Molecules of Nature, J. B. Hendrickson.
10. Selected Organic Synthesis: Ian Fleming.
11. Chemistry of Natural Products, N. R. Krishnaswamy.
12. The Chemistry of Natural Products, K. W. Bentley. Vol. I – V.
13. J.W. Apsimon, Total Synthesis of Natural Products, Vol. 1-6, Wiley-Interscience Publications, New York (Vol. 1, 1973).
14. Principles of biochemistry – Donald J.Voet, Judith G.Voet, Charlotte W. Pratt (John Wiley and sons)
15. Lehninger principles of biochemistry- David L.Nelson and Michael M.Wx (Palgrave Macmillan / W.H. Freeman company New York)
16. Biochemistry – U.Satyanarayana Baro and allied P.Ltd., Kolkata

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PAPER-II (Selected Topics in Organic Chemistry-I)

Max. Marks: 100 (External – 70 + Internal – 30)

Total Periods: 45

UNIT-I NMR SPECTROSCOPY

(12 Periods)

Theory and principles of NMR spectroscopy, Theory of Fourier Transform

(i) ¹H NMR Spectroscopy

Proton resonance condition, Aspects of PMR spectra – number of signals, chemical shift, factors influencing chemical shift, deshielding, chemical shift values and correlation for protons bonded to carbons (aliphatic, olefinic, aldehydic, aromatic) and other nuclei (alcohols, phenols, enols, acids, amides and mercaptans), effect of deuteration, spin-spin coupling, (n+1) rule, factors effecting coupling constant “J”

(ii) ¹³C NMR spectroscopy

Types of ¹³C NMR Spectra: proton coupled and decoupled ¹³C spectra, chemical shift, calculations of chemical shifts of aliphatic, olefinic, alkyne, aromatic, hetero aromatic and carbonyl carbons, factors affecting chemical shifts

(iii) 2D NMR Techniques

Preliminary idea of 2D NMR,

UNIT-II ENVIRONMENTAL CHEMISTRY

(11 Periods)

(i) Water Pollution: Basic Concepts of Eutrophication, Water Quality, Water contaminants, Heavy minerals, Organic contaminants, PCBs and other Halogens materials, PAH, Pesticides, Waterborne Pathogens, Aquatic toxicology, Water Purification Methods, Sewage treatment.

(ii) Air Pollution: Air pollution sources and emissions- Particulates, Aerosols, Photochemical smog, Determination of SO_x, NO_x, CO_x and hydrocarbons, Air pollution control technologies of particulate and gaseous pollutants

(iii) Effluent treatment: Industrial pollution of sugar, distillery, drug, pulp & paper and their analysis. Effluent treatment plants of above industries.

UNIT-III HETEROCYCLIC CHEMISTRY-I

(11 Periods)

(A) Nomenclature of Heterocycles:

Hantzsch-Widman nomenclature systems for monocyclic and fused heterocycles and bridged heterocycles

(B) Five and six membered heterocycles with two hetero atoms:

Synthesis, reactivity, aromatic character and importance of following heterocyclic rings: Oxazole, Thiazole, Pyrazole, Imidazole, Pyridazine, Pyrimidine, Pyrazine

(C) Condensed five membered heterocycles:

Synthesis, reactivity, aromatic character and importance of following heterocyclic Rings: Benzoxazole, Benzthiazole, Benzopyrazole, Benzimidazole.

UNIT-IV REAGENTS FOR ORGANIC SYNTHESIS

(11Periods)

Introduction, Preparation and Industrial Applications of the following,

(1)N-Bromosuccinimide (NBS)

(2)Grubbs 1st and 2nd generation catalyst

(3)N,N-dicyclohexylcarbodiimide (DCC)

(4)Lead tetra-acetate (LTA)

(5)Baker's yeast

(6)n- butyl lithium

(7)K₃Fe(CN)₆ and DMSO

(8)Grignard Reagent

(9)Diazomethane

(10)Polyphosphoric acid

Reference Books Recommended:

1. R.M. Silverstein and F.X. Webster, Spectroscopic Identification of Organic Compounds, 6th Edition (2003) John Wiley, New York.
2. D.H. Williams and I.F. Fleming, Spectroscopic Methods in Organic Chemistry, 4th Edition(1988), Tata-McGraw Hill, New Delhi.
3. P.Y Bruice, Organic Chemistry, 2nd Edition (1998) Prentice – Hall, New Delhi.
4. Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, Springer- Verlag (1986).
5. One and Two dimensional NMR Spectroscopy – Atta-Ur-Rehman, Elsevier (1989).
6. Organic structure Analysis- Phillip Crews, Rodriguez, Jaspars, Oxford University Press (1998).
7. G.W. Vanloon, S.J. Duffer, Environmental Chemistry - A Global Perspective, Oxford University Press (2000).
8. F.W. Fifield and W.P.J. Hairens, Environmental Analytical Chemistry, 2nd Edition (2000), Black Well Science Ltd.
9. Colin Baird, Environmental Chemistry, W.H. Freeman and Company, New York (1995).
10. A.K. De, Environmental Chemistry, 4th Edition (2000), New Age International Private Ltd., New Delhi.
11. Peter O. Warner, Analysis of Air Pollutants, 1st Edition (1996), John Wiley, New York.

12. S.M. Khopkar, Environmental Pollution Analysis, 1st Edition (1993), Wiley Estern Ltd., New Delhi.
13. S.K. Banerji, Environmental Chemistry, 1st Edition (1993), Prentice-Hall of India, New Delhi.
14. An introduction to the chemistry of heterocyclic compounds-R M Acheso
15. Heterocyclic Chemistry- J A Joule and Smith
16. Heterocyclic Chemistry-II- R R Gupta, M Kumar, V Gupta, Springer (India) pvt
17. Heterocyclic Chemistry, 4th Edition by J. A. Joule & K. Mills, Published by Chapman & Hall (1995)
18. Principles of modern heterocyclic chemistry, Edited by Leo A. Paquette, Published by Pearson Benjamin Cummings (1968)
19. Heterocyclic Chemistry, 3rd Edition by Thomas L. Gilchrist, Published by Prentice Hall (1997)
20. The Structure & Reactions of Heterocyclic Compounds, Edited by Michael Henry Palmer, Published by Edward Arnold (1967)
21. Heterocyclic chemistry by V. K. Ahluwalia, Narosa publishing house.
22. Organic synthesis using transition metals-Roderick Bates (Wiley).
23. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press).
24. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg, 5th edition (2007).
25. Guidebook to organic synthesis-R K Meckie, D M Smith and R A Atken.

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PAPER-III (Organic Chemistry in Industry)

Max. Marks: 100 (External – 70 + Internal – 30)

Total Periods: 45

UNIT-I ORGANIC CHEMISTRY IN INDUSTRY

(12 Periods)

Introduction, Process Chemistry versus Research Chemistry

Pharmaceutical Industry: Drug Discovery, Drug development, Preclinical and clinical testing, Medicine, Future Problems and Opportunities

Agrochemical Industry: Classification, Biodegradable and Persistent Pesticides, Toxicity, Chemical Classification of Pesticides-Herbicides and Insecticides

UNIT-II BASIC CONCEPTS OF DYE AND DYE INTERMEDIATES

(11 Periods)

Introduction of Dyes and Pigments, Absorption of visible light, colour of wavelength absorbed, complementary colour. Relation between color and chemical Constitution, Witt's theory, Armstrong's theory, Nietzki's theory, Valence bond theory, Molecular orbital theory, Fastness Properties, Exhaustion and fixation properties. Natural Dyes, Nomenclature of Dye Intermediates, Colour Index

Classification of Dyes: Based on structure, based on mode of application to fibres, Non-Textile uses of dyes: Dyes in medicine, leather, paper, colour photography and electro photography, food, cosmetics, displays and laser dyes.

UNIT-III BASIC CONCEPT OF DRUGS

(11 Periods)

Introduction, Classifications: On the basis of their chemical structure and therapeutic action, Nomenclature: Proprietary and Non-proprietary name, Nomenclature of new drugs by WHO, Names of drugs: Generic and brand names

Theories of drug action: Occupancy theory, Rate theory and induced fit theory Biological defence, chemical defences, Furguson principle

Absorption of drugs: Routes of administration, factors that affect on absorption

Physico chemical properties: Solubility, Partition coefficients, Ionization constant, Electronic effect, Steric effect, Stereochemical consideration

UNIT-IV UNIT PROCESSES

(11 Periods)

(i) Nitration: Nitrating agents. Mechanism of aromatic nitration. Industrial chemicals derived from Benzene, Naphthalene, Anthracene using Nitration.

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

(iii) Amination: Aminating agents, Amination by reduction, Amination by Ammonolysis. Industrial chemicals derived from Benzene using Amination.

(iv) Alkylation: Alkylating agents. Industrial important alkyl compounds derived by various routes

(v)Halogenation:Halogenating agents. Industrial important halogenated compounds derived by various routs

Reference Books Recommended

1. Organic Chemistry: A Mechanism Approach; Penny Chaloner, CRC Press, Tailor and Francis; Florida.
2. Pharmaceutical Process development: Current Chemical and Engineering Challenges, J. Blacker and M. T. Williams, RSC Cambridge, UK.
3. Fine Chemicals: The Industry and Its Business, P. Pollak, 2nd Edition, Wiley.
4. The chemistry of synthetic Dyes, Vol. I to VII by Venkataraman, Academic Press, New York.
5. Chemistry of Synthetic Dyes & Pigments by Lubs.
6. Dyes and their intermediates by E. N. Abrahart.
7. Handbook of synthetic dyes and pigments, Vol. I & II by K. M. Shah.
8. Industrial Dyes by Klans Hunger, Germany by Wiley-VCH.
9. Development in the Chemistry and technology of Organic Dyes by J.Griffiths, Blackwell Sci. Pub., Oxford, London.
10. Principles of colour Technology by Fred W. Billmeyer and Max Saltzman, John Wiley & Sons.
11. Medicinal Chemistry by G. R. Chatwal.
12. A textbook of Pharmaceutical Chemistry by Jayshree Ghosh.
13. Chemical Process Industries by R. N. Shreve.
14. Riegel's Hand-Book of Industrial Chemistry, Ed. by James A. Kent.
15. Industrial Chemicals by Faith, Keyes, Clark.

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PAPER-IV (Medicinal Chemistry-I)

Max. Marks: 100 (External – 70 + Internal – 30)

Total Periods: 45

UNIT-I DRUG DESIGN, PHARMACOKINETICS AND PHARMACODYNAMICS (12 Periods)

Drugs and Drug Design Introduction, drug targets, procedure for drug design, pro-drug, concepts of lead compounds, lead modification, structure activity relationship (SAR), LD₅₀, ED₅₀, therapeutic index, Concepts of drug receptors, Elementary treatment of drug receptor interactions.

Introduction to Pharmacokinetic and Pharmacodynamic, Drug administration, Drug absorption, drug distribution, drug Metabolism (general pathway of drug metabolism: Phase-I and Phase-II), elementary treatment of enzyme stimulation, biotransformation, Drug excretion.

UNIT-II PSYCHOACTIVE DRUGS

(11 Periods)

(i) General anaesthetics:

General classification and Structural variations

(ii) Local Anaesthetics:

General classification and SAR

(iii) Sedatives and Hypnotics:

General classification, Structural variations and mode of action

Synthesis and therapeutic uses of only the following:

Thiopental (Pentothal), Amobarbital (Amytal), Diazepam, Chlorazepam, alprazolam, glutethimide, Nikethamide, Benzocaine, Procaine, Lidocaine (xylocaine), Dibucaine (Nupercaine), Phenacaine (Holocaine).

UNIT-III Antipyretic Analgesics and NSAIDs Agents

(11 Periods)

General classification of Antipyretic Analgesics, Narcotic Analgesics and Non-Steroidal Anti-Inflammatory Drugs

Structural variations in Morphine, Morphan and 4-Phenylpiperidine Analogues. Opioid Receptors (Name only), Limitations of Opioids,

Synthesis and therapeutic uses of only the following:

Meperidine (Pethidine), Ibuprofen, Meclofenamate sodium, Oxyphenbutazone, Diclofenac Sodium, Mefenamic acid,

UNIT-IV DIURETICS, ANTI-DIABETIC AGENTS AND CARDIOVASCULAR DRUGS

(11 Periods)

(A) Diuretics:

General classification. Structural variation and SAR of Thiazide Diuretics Synthesis and therapeutic uses of only the following:

Chlorothiazide, Furosemide, Ethacrynic acid, Triamterene

(B) Insulin and Oral Hypoglycemic Agents (Anti-diabetic agents or drugs affecting sugar metabolism):

General classification,

Synthesis and therapeutic uses of only the following:

Glipizide, Glybomuride Troglitazone, Chlorporpamide, Glibenclamide

(C) Cardiovascular Drugs:

General introduction of Antiarrhythmic agents and Antihypertensive drugs Structure variation in β -adrenergic blockers and Dihydropyridines, Structure – activity Relationship of ACE Inhibitors

Synthesis and therapeutic uses of only the following: Verapamil, Methyldopa, Atenolol, Lisinopril, Losartan

Reference Books Recommended

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. Principles of Medicinal Chemistry, Vol. I & II (5/e), by S. S. Kadam, K. R. Mahadik, K. G. Bothra (Nirali Prakashan).
3. Principles of Medicinal Chemistry by William O. Foye (ed.), Lea and Febiyer, Philadelphia.
4. Wilson and Gisvold's Text-book of Organic Medicinal and Pharmaceutical Chemistry (5/e, 1982) by Robert F. Doerge (J. B. Lippincott Company, Philadelphia/Toppan Co. Ltd., Tokyo).
5. Essential of Medicinal Chemistry (2/e) by Andrejus Korolkovas (A Wiley Interscience Publication, 1988, John Wiley & Sons, Canada).
6. Medicinal Chemistry by Ashutoshkar (Wiley Eastern Ltd., 1993).
7. The Pharmaceutical Basis of Therapeutics by Goodman and Gilman (The Macmillan Co.).
8. The Organic Chemistry of Drug Synthesis, Vol. I, II & III (1980), Ed. By D. Lednicer and L. A. Mitscher (John Wiley and Sons, New York).
9. Topics in Medicinal Chemistry, Vol. I & II by Rabinowitz and Myerson (Editor) (Interscience, 1968).
10. Adhunik Sanshleshit Aushodhonu Rasayanvighyan, Dr. Anamik Shah, University Granth Nirman Board, Ahmedabad.
11. Medicinal Chemistry, D. Sriram and P. Yogeewari, 1st edi., Pearson Education, 2007.
12. Handbook of pharmaceutical chemicals by Dr. A. R. Shenoy and Dr. V. R. Shenoy Multitech Publishing Co., 15-Yogesh, Hingwala Lane, Ghatkopar (East) Mumbai.
13. Fundamentals of Medicinal Chemistry by G Thomas.

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PAPER-IV (DYES AND INTERMEDIATES-I)

Max. Marks: 100 (External – 70 + Internal – 30)

Total Periods: 45

UNIT-I AZO DYES

(12 Periods)

General Introduction: Diazotization, mechanism and different methods of diazotization and laws of coupling, General introduction, classification and synthesis of Monoazo dyes, Bisazo dyes and Azoic dyes.

Synthesis of the following:

Disperse Red 13, Acid Blue 92, Mordant Black 3, Acid Black 1, Acid Blue 113, Direct Blue 15, Direct Violet 1, Direct Red 28, Naphthol AS-BR, Fast Orange GGD.

UNIT-II

(11 Periods)

(A) Fluorescent Whitening Agents

Introduction, Theory of fluorescence, Classification of FWA and synthesis of important member of each class and their uses.

(B) Types of Fibres and Basic Operations in Dyeing Process

Types of fibres: Natural, semisynthetic and synthetic, Dyeing and

Interactions: Ionic Interactions, Hydrogen bond, Van der Waal's Interactions and Covalent Interactions.

Basic Operations in Dyeing Process: Preparation of the fibres, Preparation of the dyebath, application of the dyebath and finishings, Various methods of dyeing: Direct dyeing, Vat dyeing, Mordant dyeing, Disperse dyeing and Formation of dye on the fibre, Dyeing of wool with the acid dyes, Dyeing with the reactive dyes, Fastness properties: Colour fastness, Light fastness, Sublimation fastness and Burnt gas fumes fastness.

UNIT-III

(11 Periods)

(A) Classification of Dyes according to application and chemical constitution.

(B) Evaluation of dyes

(C) Dyes for Non-Textile Application

Leather dyes, Paper dyes, Hair dyes, Food dyes, Ink dyes, Photographic dyes, Indicator dyes, Laser dyes, Liquid crystal dyes, Solar cell, biological uses of dyes.

Synthesis of the following:

Eriochrome Black T, Sunset Yellow FCF, Acridine Yellow G, Safranin B, Prontosil, Methylene Blue, Nile Blue 2B, Tartrazine

UNIT-IV

(11 Periods)

(A) Pigments

Different classes of organic and inorganic pigments and their applications with examples.

(B) Heterocyclic Dyes

Pyrazolone dyes, cyanine dyes, dyes containing azine, oxazine and thiazine ring systems, Thiazole Dyes

Synthesis of only the following:

Basic Yellow 11, Basic Orange 21, Safranin B, Rosinduline GG, Sirius Supra Blue FFRL, Brilliant Alizarin Blue 3R, Sirius Supra Yellow RT, Acid Yellow 19, Copper Phthalocyanine, Sirius Supra Light Green FFGL.

Reference Books Recommended

1. The chemistry of synthetic Dyes, Vol. I to VII by Venkataraman, Academic Press, New York.
2. Chemistry of Synthetic Dyes & Pigments by Lubs.
3. Dyes and their intermediates by E. N. Abraham.
4. Handbook of synthetic dyes and pigments, Vol. I & II by K. M. Shah.
5. Industrial Dyes by Klaus Hunger, Germany by Wiley-VCH.
6. Development in the Chemistry and technology of Organic Dyes by J. Griffiths, Blackwell Sci. Pub., Oxford, London.
7. Principles of colour Technology by Fred W. Billmeyer and Max Saltzman, John Wiley & Sons.
8. Advance in colour chemistry, series vol.-3, Modern colourants: Synthesis and structure, edited by A.T. Peters and H.S. Freeman, Blackie Academic & Professional(1995).
9. Colour chemistry: Synthesis, properties and applications of organic dyes and pigments, Heinrich Zollinger VCH, Germany(1987).
10. Organic Chemistry in Colour V., P.F. Gordon, P. Gregory, Springer-Verlag(1983).
11. Textile Auxiliaries, J.W. Batty
12. The production and applications fluorescent brightening agents, Milos Zahradnik, John Wiley & Sons (1982).
13. Chemistry of Dyes and Principles of dyeing-V.A. Shenai
14. Synthetic dyes- G.R. Chatwal
15. Critical reports on Applied chemistry, Vol-7, Developments in chemistry and Technology of organic dyes, Edited by : J. Griffiths, Blackwell

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M.Sc. - Semester - III
Organic Chemistry
(PRACTICALS)

1	Green Synthesis	4- Credit
2	Preparation (From Given Name reactions)	
3	Estimation	4- Credit
4	Viva-Voce	

1 Green Synthesis (Any four)

1. Preparation of acetanilide from aniline and acetic acid using Zn dust.
2. Base catalyzed aldol condensation using LiOH.H₂O as a Catalyst.
3. Bromination of *trans*-stilbene using sodium bromide and sodium bromated.
4. [4+2] cycloaddition reaction in aqueous medium at room temperature.
5. Benzil Benzilic acid rearrangement under solvent free condition

2 Preparation of industrially important compounds by following Name reactions (Any four)

1. Sandmeyer reaction
(p-chloro toluene from p-toluidine)
2. Fischer indole synthesis
(1,2,3,4-tetrahydrocarbazole from cyclohexanone and phenylhydrazine)
3. Riemer-Tiemann reaction (Salicylaldehyde from phenol)
4. Skraup synthesis (Quinoline from aniline)
5. Gebriel phthalimide synthesis
(Anthranilic acid from phthalic anhydride and phthalimide)
6. 2-hydroxy 1-naphthaldehyde from β - naphthol

3 Organic Estimations (Any Six)

1. Determination of Sulphonamides with Silver Nitrate solution by Volumetrically.
2. Determination of aromatic primary amines by either diazotization or indirect diazotization.
3. Estimation of Benzyl Penicillin.
4. Determination of coupling value (C.V.) of Dye intermediates.
5. Non-aqueous titration of Sodium Benzoate.
6. Estimation of Isoniazid.
7. Enzyme inhibition
8. -NO₂ and -OH group

Reference Books Recommended

1. Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Ren Aggarwal
2. Monograph on Green Chemistry Laboratory Experiments by Green Chemistry Task Force Committee, DST
3. Quantitative analysis by Arther I.Vogel
4. Quantitative analysis by V.K.Ahluwalia
5. Quantitative analysis by Mann and sanders

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Sr. No.	Course Title	L	T/C/S	Credit
1	Advance Organic Chemistry	4	1	4
2	Selected Topics In Organic Chemistry-II	4	1	4
3	Advance Organic Synthesis	4	1	4
4	Medicinal Chemistry-II OR Dye and Intermediates-II	4	1	4
5	Practicals	12		8
		28	4	24

External Examination Time Duration: 03 hrs

Name of Exam	Semester	Paper No	Course group	Credit	Internal Marks	External Marks	Total Marks
M. Sc.	IV	I	Core	04	30	70	100
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PAPER-I (Advance Organic Chemistry)

Max. Marks: 100 (External – 70 + Internal – 30)

**Total
Periods:45**

UNIT-I NAME REACTIONS

(12 Periods)

General nature, method, mechanism and synthetic applications of the following reactions;

- (1)Ugi reaction
- (2)Noyori reaction
- (3)Wittig reaction
- (4)Peterson olefination reaction
- (5)Mannich reaction
- (6)Stille reaction
- (7)Ene reaction
- (8)Staudinger reaction
- (9)Corey-Fuchs reaction
- (10)Ritter reaction
- (11)Mcmurry reaction
- (12)Michael addition

UNIT-II OXIDATION

(11 Periods)

Introduction, Oxidation with Cr(VI), Mn(VII), Mn(IV), OsO₄, Periodic acid. Peroxy acid. Oxidation of hydrocarbons-alkenes, aromatic rings, saturated C-H group (activated and unactivated), aldehyde and ketones

UNIT-III REDUCTION

(11 Periods)

Introduction, different reductive processes, hydrocarbons-alkenes, alkynes and aromatic rings, Carbonyl compounds- aldehydes, ketones, (LiAlH₄, NaBH₄ only for aldehyde and ketone) acids and their derivatives, epoxides, nitro, nitroso, azo and oxime groups, Birch reduction, Shapiro reduction.

UNIT-IV MOLECULAR REARRANGEMENTS

(11Periods)

(A)Rearrangement involving migration to electron deficient carbon:

- (i) Expansion and contraction of rings/Demajnov rearrangement
- (ii) Benzil-benzilic acid rearrangement

(B)Rearrangement involving migration to electron rich carbon:

- (i) Favorskii rearrangement
- (ii) Sommelet-Hauser rearrangement
- (iii) Neber rearrangement

(C)Rearrangement involving migration to electron deficient nitrogen:

- (i) Schmidt rearrangement
- (ii) Curtius rearrangement

(D)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, Rearrangement of N-nitrosoanilines (Fischer-Hepp rearrangement).

(E) Rearrangement involving migration from oxygen to ring:

- (i) Fries rearrangement
- (ii) Claisen rearrangement

Reference Books Recommended:

1. Organic synthesis using transition metals-Roderick Bates (Wiley)
2. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press)
3. Some modern methods of organic synthesis – W. Carruthers (Cambridge)
4. Organic synthesis – Michael B. Smith
5. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg, 5th edition (2007)
6. Guidebook to organic synthesis-R K Meckie, D M Smith and R A Atken
7. Organic synthesis- Robert E Ireland
8. Strategic Applications of named reactions in organic synthesis-Laszlo Kurti and Barbara Czako
9. Organic Synthesis, Jagdamba Singh & L.D.S. Yadav, 6th edition, Pragati Prakashan (2010).
10. Reaction Mechanism in Organic Chemistry by S. M. Mukherji and S. P. Singh (McMillan India Ltd., 1976)
11. Advance Organic Chemistry, Reaction Mechanism and Structure by Jerry March, 4th ed. John Wiley & Sons, 1992

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PAPER-II (Selected Topics in Organic Chemistry-II)

Max. Marks: 100 (External – 70 + Internal – 30)

Total Periods: 45

UNIT-I MASS SPECTROMETRY

(12 periods)

Theory and principles of mass spectroscopy; Instrumentation; low and high resolution mass spectra; Ionization techniques – Electron Impact (EI) ionization, Chemical Ionization (CI), Field Desorption (FD), Fast Atom Bombardment (FAB), Electrospray Ionization (ESI); Determination of molecular weight and molecular formula, nitrogen rule, detection of molecular ion peak, metastable ion peak; Fragmentations – rules governing the fragmentations, McLafferty rearrangement; Interpretation of mass spectra of different class of compounds – saturated and unsaturated hydrocarbons, aromatic hydrocarbons, alcohols, ethers, ketones, aldehydes, carboxylic acids, amines, amides, compounds containing halogens; To write possible fragmentation for given compound; To identify structure from mass spectral data; To identify structure from combined spectral data.

Structure elucidation by using UV, IR, NMR and Mass Spectroscopic techniques

UNIT-II STRUCTURE-REACTIVITY PRINCIPLES

(11 Periods)

Types of mechanisms, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammonds postulate, Curtian-Hammet principle, potential energy diagrams, transition state and intermediates, methods of determining mechanisms- isotope effect.

Effect of structure on reactivity- resonance and field effect, steric effect, quantitative treatment. The Hammett equation and linear free energy relationships, substituent and reaction constants, positive and negative deviation from Hammett equation, Taft equation, Solvent effect

UNIT-III HETEROCYCLIC CHEMISTRY-II

(11 Periods)

(A) Five and six membered heterocycles with more than two hetero atoms: Synthesis, reactivity, aromatic character and importance of following heterocycles: 1,2,3-triazole, 1,2,4-triazole, 1,2,4-oxadiazole, 1,3,4-oxadiazole, 1,2,5-oxadiazole

(B) Condensed six membered heterocycles:

Synthesis, reactivity, aromatic character and importance of following heterocyclic Rings: Quinoline, Isoquinoline, Cinnoline, Quinoxaline, Phthalazine, Naphthyridine, Phenoxazine

UNIT-IV SYNTHETIC AND BIO-POLYMERS

(11 Periods)

Bio-polymers: General introduction, types, properties and uses of polysaccharides – starch and cellulose

Synthetic polymers: General introduction, method of preparation, properties and uses of Polyester, poly-tetrafluoroethylene, polyamino acids, polycyanoacrylates,

polyurethanes, silicone rubbers, polyphosphazenes, divinylether - maleic anhydride cyclopolymer (DIVEMA) polymeric antioxidants,

Reference Books Recommended:

1. Spectroscopic Identification of Organic Compounds, R. M. Silverstein and F. X. Webster, 6th edition (John Wiley & Sons)
2. Introduction to Spectroscopy, D. L. Pavia, G. M. Lampman and G. S. Kriz, 3rd edition (Thomson Brooks/Cole)
3. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming, 4th edition (Mcgraw – Hill Book Company)
4. Organic Spectroscopy, William Kemp, 3rd edition (Palgrave)
5. Organic Spectroscopy – Principles and Applications, Jag Mohan, 2nd edition (Narosa Publishing House)
6. Spectroscopy of Organic Compounds, P. S. Kalsi, 5th edition (New Age International Publishers)
7. Elementary Organic Spectroscopy: Principles and Chemical applications (revised edition), Y. R. Sharma (S. Chand Publishing)
8. Organic Chemistry by Francis A. Carey (McGraw-Hill Book Co., 1987).
9. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell Uni.Press.
10. Principles of Organic Synthesis, R.O.C. Norman and J. M. Coxon, Blackie Academic and Professional.
11. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.
12. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers
13. An introduction to the chemistry of heterocyclic compounds-R M Acheso
14. Heterocyclic Chemistry- J A Joule and Smith
15. Heterocyclic Chemistry-II- R R Gupta, M Kumar, V Gupta, Springer (India) pvt
16. Heterocyclic Chemistry, 4th Edition by J. A. Joule & K. Mills, Published by Chapman & Hall (1995)
17. Principles of modern heterocyclic chemistry, Edited by Leo A. Paquette, Published by Pearson Benjamin Cummings (1968)
18. Heterocyclic Chemistry, 3rd Edition by Thomas L. Gilchrist, Published by Prentice Hall (1997)
19. The Structure & Reactions of Heterocyclic Compounds, Edited by Michael Henry Palmer, Published by Edward Arnold (1967)
20. Heterocyclic chemistry by V. K. Ahluwalia, Narosa publishing house.
21. Harry R. Allcock, Frederick W. Lampe and James E. Mark, Contemporary Polymer Chemistry, 3rd edition, Pearson Prentice Hall, 2005.
22. Organic Polymer Chemistry by K. J. Saunders.

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M.Sc. Semester-IV (ORGANIC CHEMISTRY)
SYLLABUS TO BE EFFECTIVE FROM JUNE 2019

PAPER-III (Advance Organic Synthesis)

Max. Marks: 100 (External – 70 + Internal – 30)

Total Periods: 45

UNIT-I PROTECTING GROUPS

(12 Periods)

Need of protecting groups – Protection of alcohols, Carbonyl, Carboxylic acid and amino groups, Synthetic equivalent groups and examples on transformations

UNIT-II DISCONNECTION APPROACH

(11 Periods)

Introduction to disconnection, Concept of synthon, Synthetic equivalent, Functional group interconversion

(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) Pericyclic reactions:

Disconnections based on Diels-Alder reaction and electrocyclic reaction: Its use in organic synthesis

UNIT-III RING SYNTHESIS

(11 Periods)

Introduction to ring synthesis

(i) Synthesis of saturated heterocycles: Synthesis of 3 and 4 membered rings

(ii) heterocycles in organic synthesis:

Synthesis of alkanes and cycloalkanes from thiophene, Synthesis of alkenes and cycloalkenes from pyridines,

Synthesis of Aromatic compounds from pyrilium salts, pyridazine, thiophenes and furan

UNIT-IV ORGANOMETALLIC COMPOUNDS AND THEIR APPLICATIONS (11 Periods)

(i) Carbon-metal bonds in organometallic compounds, Synthesis and applications of Organolithium, Organozinc and Lithium diorganocuprate.

(ii) Basic concept of organoboranes, Preparation of organoboranes, Stereochemistry of hydroboration, Mechanism of hydroboration – oxidation, Synthetic applications.

Reference Books Recommended:

1. Organic synthesis using transition metals-Roderick Bates (Wiley).
2. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press).
3. Some modern methods of organic synthesis – W. Carruthers (Cambridge)
4. Organic synthesis – Michael B. Smith.
5. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg, 5th edition (2007).

6. Guidebook to organic synthesis-R K Meckie, D M Smith and R A Atken.
7. Organic synthesis- Robert E Ireland.
8. Strategic Applications of named reactions in organic synthesis-Laszlo Kurti and Barbara Czako.
9. Organic Synthesis, Jagdamba Singh & L.D.S. Yadav, 6th edition, Pragati Prakashan (2010).
10. Reaction Mechanism in Organic Chemistry by S. M. Mukherji and S. P. Singh (McMillan India Ltd., 1976).
11. Advance Organic Chemistry, Reaction Mechanism and Structure by Jerry March, 4th ed. John Wiley & Sons, 1992.
12. Designing Organic Synthesis – A Programmed Introduction to the Synthon Approach, Stuart Warren, John Wiley & Sons (1994).
13. Organic Synthesis: The disconnection approach, Stuart Warren, John Wiley & Sons (1994).
14. Selected Organic Synthesis, Ian Fleming, John Wiley & Sons (1977).
15. Principles of Organic Chemistry by R.O.C. Norman (Chapman and Hall, 1986).
16. Organometallic Chemistry by P. L. Pauson (Edward Arnold, 1968).
17. Principles of Organometallic Chemistry by Coats, Green, Powell & Wade (Chapman and Hall, 1977).

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M.Sc. Semester-IV (ORGANIC CHEMISTRY)
SYLLABUS TO BE EFFECTIVE FROM JUNE 2019
PAPER-IV (Medicinal Chemistry-II)

Max. Marks: 100 (External – 70 + Internal – 30)

Total Periods: 45

UNIT-I ANTIBIOTICS

(11 Periods)

General introduction and classification of antibiotics

Broad spectrum antibiotics, Macrolide antibiotics, Amino glycoside antibiotics and Non-classifiable antibiotics

(i) β -lactam antibiotics:

Penicillins (Structural variations and SAR), Cephalosporins (Structural variations)

(ii) Non-lactam antibiotics:

Tetracyclin (Structural variations and SAR)

Structures and medicinal importance/ clinical uses/ pharmacological applications of the following:

Bacitracin, Vancomycin, Erythromycin, Lincomycin, Chloramphenicol, Nalidixic acid, Norfloxacin, Ciprofloxacin

Synthesis and therapeutic uses of only the following:

Methicillin, Ampicillin, Cephalexin, Chloramphenicol, Ciprofloxacin

UNIT-II ANTIALLERGIC AND LOCAL ANTI INFECTIVE DRUGS

(12 Periods)

(A) Antihistamines and related Antiallergic Drugs:

General introduction and mode of action, Structure variation in Aminoalkylethers, Ethylenediamines and Piperazine derivatives.

Synthesis and therapeutic uses of only the following:

Diphenhydramine (Benadryl), Antazoline, Chlorpheniramine, Primethazine

(B) Anti – mycobacterial agents:

General Introduction of Tuberculosis & Leprosy-disease, Treatment, Mode of action, adverse effect of Anti TB agents & Anti-leprotic agents

Synthesis and therapeutic uses of only the following: Ethionamide, Ethambutol, DDS (Dapsone), Pyrazinamide.

(C) Sulfonamides:

General classification, mode of action and SAR Synthesis and therapeutic uses of only the following:

Sulfamethoxine (Sufadoxine), Sulfamethoxy-Pyrazine (Sulfalene), Succinyl sulfathiazole (Sulfasuxidine)

UNIT-III Antimalerials and Antineoplastic agents

(11 Periods)

(A) Antimalarials:

Introduction, Types, Life cycle of plasmodium, drug resistance, General classification, SAR of 4- and 8-aminoquinolines and Structure variation in Sesquiterpene Lactones, mode of action

Synthesis and therapeutic uses of only the following:

Mefloquine, Chloroquine, Primaquine, Pyrimethamine (Daraprim), Quinacrine

(B) Antineoplastic Agents (Cancer Chemotherapy):

Introduction to cancer, types, Causes & Treatment of cancer, Metastasis, Drug Resistance, Targets of anticancer agents, adverse effects of cancer therapy (in brief) General classification of antineoplastic agents, Cell Cycle-Specific (CCS) and Non Cell Cycle-Specific (CCS) Agents, Mode of action,

Synthesis and therapeutic uses of only the following:

Mechlorethamine, Cyclophosphamide, Melphalan, 6-Mercaptopyrine, Trimetrexate, Cytarabine

UNIT-IV Anti-Viral and Anti-HIV agents

(11Periods)

(A) Antiviral agents:

Introduction, Types & classes of viruses, Classification of antiviral agents, mechanism of action, Antiviral Compounds for DNA Viruses & Selected RNA Virus Infections other than HIV (Influenza A and B Viruses, Hepatitis C Virus)

(B) Anti-HIV Drugs:

Introduction, HIV Infection and its Pathological Effects, HIV Structure and life cycle, Targets for Drug Design of Anti-HIV Agents, HIV drugs in clinical use, Development of Drug Resistance, the need for new Anti-HIV Drugs, Introduction of AIDS

Synthesis and therapeutic uses of only the following: Amantadine, Acyclovir, Zidovudine, Indinavir, Ritonavir

Reference Books Recommended

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. Principles of Medicinal Chemistry, Vol. I & II (5/e), by S. S. Kadam, K. R. Mahadik, K. G. Bothra (Nirali Prakashan).
3. Principles of Medicinal Chemistry by William O. Foye (ed.), Lea and Febiyer, Philadelphia.
4. Wilson and Gisvold's Text-book of Organic Medicinal and Pharmaceutical Chemistry (5/e, 1982) by Robert F. Doerge (J. B. Lippincott Company, Philadelphia/Toppan Co. Ltd., Tokyo).

5. Essential of Medicinal Chemistry (2/e) by Andrejus Korolkovas (A Wiley Interscience Publication, 1988, John Wiley & Sons, Canada).
6. Medicinal Chemistry by Ashutoshkar (Wiley Eastern Ltd., 1993).
7. The Pharmaceutical Basis of Therapeutics by Goodman and Gilman (The Macmillan Co.).
8. The Organic Chemistry of Drug Synthesis, Vol. I, II & III (1980), Ed. By D. Lednicer and L. A. Mitscher (John Wiley and Sons, New York).
9. Topics in Medicinal Chemistry, Vol. I & II by Rabinowitz and Myerson (Editor) (Interscience, 1968).
10. Adhunik Sanshleshit Aushodhonu Rasayanvighyan, Dr. Anamik Shah, University Granth Nirman Board, Ahmedabad.
11. Medicinal Chemistry, D. Sriram and P. Yogeewari, 1st edi., Pearson Education, 2007.
12. Handbook of pharmaceutical chemicals by Dr. A. R. Shenoy and Dr. V. R. Shenoy Multitech Publishing Co., 15-Yogesh, Hingwala Lane, Ghatkopar (East) Mumbai.
13. Fundamentals of Medicinal Chemistry by G Thomas.

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PAPER-IV (DYES AND INTERMEDIATES-I)

Max. Marks: 100 (External – 70 + Internal – 30)

Total Periods: 45

UNIT-I ANTHRAQUINONE DYES

(12 Periods)

Vat Dyes and Solubilized Vat dyes, Acid dyes, Mordant dyes and dyes for cellulose acetate. Synthesis of only the following:

Indanthrene Orange 7RK, Indanthrene Yellow FFRK, Indanthrene Khakhi 2G, Indanthrene Orange FFRK, Indanthrene Yellow 4GK, Indanthrene Scarlet B, Caledon Jade Green XBN, Anthracene Blue SWX, Indanthrene Brilliant Orange GR, Celliton Fast Blue FFG.

UNIT-II

(11 Periods)

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

- (i) Reactive dyes
- (ii) Triphenylmethane dyes (TPM)
- (iii) Acid dyes

Synthesis of only the following:

Procion Brilliant Blue MR, Procion Brilliant Red H-3B, Remazol Brilliant Blue R, Malachite Green, Crystal Violet, Acid Yellow 73, Acid Red 1, Acid Black 24

UNIT-III

(11 Periods)

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

- (i) Disperse dyes
- (ii) Indigoid and Thio-indigoid dyes
- (iii) Cationic dyes

Synthesis of the following:

Disperse Yellow 16, Disperse Blue 14, Celliton Fast Yellow 7G, Ciba Blue 2B, Indanthrene Brilliant Pink R, Bismarck Brown, Chrysoidine Y, Methylene Blue, Acridine Yellow G, Disperse Orange 29

UNIT-IV

(11 Periods)

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

- (A) Sulphur dyes
- (B) Ecology and toxicity of dyes with reference to textile dyes, food colours, benzidine etc.
- (C) Medicinal dyes and biological staining agents
- (D) High tech application of dyes: Liquid crystal display (LCD), Laser dyes, Photochromic dyes, Thermochromic dyes, dye sensitizer solar cells.

Reference Books Recommended

1. The chemistry of synthetic Dyes, Vol. I to VII by Venkataraman, Academic Press, New York.
2. Chemistry of Synthetic Dyes & Pigments by Lubs.
3. Dyes and their intermediates by E. N. Abraham.
4. Handbook of synthetic dyes and pigments, Vol. I & II by K. M. Shah.
5. Industrial Dyes by Klaus Hunger, Germany by Wiley-VCH.
6. Development in the Chemistry and technology of Organic Dyes by J. Griffiths, Blackwell Sci. Pub., Oxford, London.
7. Principles of colour Technology by Fred W. Billmeyer and Max Saltzman, John Wiley & Sons.
8. Advance in colour chemistry, series vol.-3, Modern colourants: Synthesis and structure, edited by A.T. Peters and H.S. Freeman, Blackie Academic & Professional(1995).
9. Colour chemistry: Synthesis, properties and applications of organic dyes and pigments, Heinrich Zollinger VCH, Germany(1987).
10. Organic Chemistry in Colour V., P.F. Gordon, P. Gregory, Springer-Verlag(1983).
11. Textile Auxiliaries, J.W. Batty
12. The production and applications fluorescent brightening agents, Milos Zahradnik, John Wiley & Sons (1982).
13. Chemistry of Dyes and Principles of dyeing-V.A. Shenai
14. Synthetic dyes- G.R. Chatwal
15. Critical reports on Applied chemistry, Vol-7, Developments in chemistry and Technology of organic dyes, Edited by : J. Griffiths, Blackwell

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M.Sc. - Semester - IV
Organic Chemistry
(PRACTICALS)

1	Spectral Exercise	4- Credit
2	Preparation of organic compounds	
3	Green Synthesis	4- Credit
4	Viva-Voce	

1 Spectral Exercise (Minimum 10 from syllabus)

Structure interpretation of organic compounds from spectra (UV, IR, NMR and Mass)

2 Preparation of industrially important compounds (Minimum 8)

1. Sulfanilamide from via p-acetamido benzene sulphonyl chloride and acetamido benzene-sulfonamide.
2. Acridone from anthranilic acid via o-chloro benzoic acid and N-phenylanthranilic acid
3. Benzocaine from p-nitro toluene via p-nitro benzoic acid and p-amino benzoic acid.
4. Eosin from phthalic acid via phthalic anhydride and fluorescein.
5. Benzanilide from benzene via Benzophenone and Benzophenoxime.
6. p-Nitro chloro benzene from acetanilide via p-nitro acetanilide and p-nitroaniline.
7. p-Chloro bromo benzene from acetanilide via p-bromo acetanilide and p-bromoaniline.
8. Anthrone from phthalic anhydride via o-benzoyl benzoic acid and anthraquinone.
9. 4-Methyl-7-hydroxy-8-acetyl coumarin from resorcinol via 4-methyl-7-hydroxycoumarin and 4-methyl-7-acetyl coumarin.
10. Preparation of Congo red dye from naphthionic acid via hydrozobenzene.
11. Preparation of o & p-hydroxyacetophenone from Aniline via phenol and phenylacetate.

3 Green Synthesis (Any Four)

1. Green approach for preparation of benzopinacolone from bezopinacol using iodine catalyst
2. Preparation of 1, 1-bis-2-naphthol under grinding at room temperature
3. Three component coupling reaction by green approach. (Synthesis of dihydropyrimidinone)
4. Green approach to Transesterification reaction (Synthesis of biodiesel)
5. Ecofriendly nitration of phenols and its derivatives using Calcium nitrate

Reference Books Recommended:

1. Vogel's Textbook of practical organic chemistry, 5th edition, B. S. Furniss, A. J. , P. W. G. Smith, A. R. Tatchell (Pearson Education).
2. Comprehensive practical organic chemistry: Preparation and Quantitative analysis, V. K. Ahluwalia, Renu Agarwal (Universities Press).
3. Monograph on Green Chemistry Laboratory Experiments by Green Chemistry Task Force Committee, DST
4. L. D. Field, S. Sternhell, J. R. Kalman - Organic Structures from Spectra-Wiley(2013)