

As Per New Syllabus (CBCS Pattern and NEP 2020)

Shivaji University, Kolhapur

B.Sc. Part-II : Semester-IV

# ORGANIC CHEMISTRY

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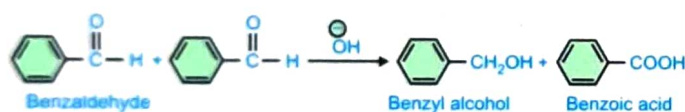
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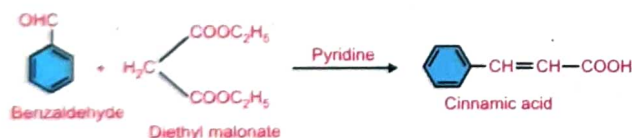
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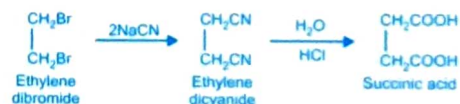
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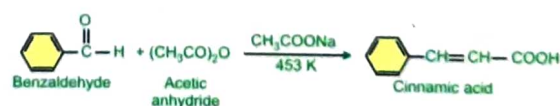
Cannizzaro's Reaction



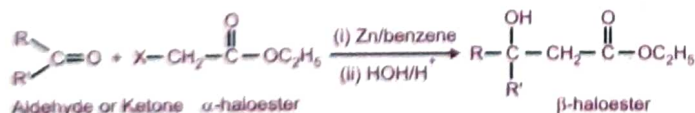
Knoevenagel Condensation



Formation of Succinic Acid



Perkin Reaction



Reformatsky Reaction

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# **ORGANIC CHEMISTRY**

**(DSC - D4 : Paper VIII)**  
**B.Sc. Part II : Semester IV**

**New Changed CBCS Syllabus of Shivaji University,  
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# PREFACE

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We have great pleasure in presenting this book to B.Sc. Part II Semester IV Organic Chemistry students of Shivaji University Kolhapur. This book has been written according to the new prescribed syllabus of CBCS pattern (as per NEP 2022) of Shivaji University, Kolhapur.

The simple language and the lecture style used by the authors make the reader to understand the subject very easily. All the topics have been dealt at sufficient length and every attempt is made to prepare a text complete in itself. The exercise at the end of each chapter includes multiple choice questions, long answer questions and short answer questions to test the understanding of the student.

Authors has no claim to the original research in preparing the book. Liberal use of the material available in the works of eminent authors has been made. The authors are thankful to these eminent authors for their valuable work.

We are thankful to Nirali Prakashan, Pune for making us a part of their team of Authors. We thank Mr. Dineshbhai Furia and Mr. Jignesh Furia for publishing this book.

We are grateful to Mr. Virdhaval Shinde (Marketing Executive, Kolhapur District) for his nice co-operation. We are very much thankful to Mr. Kiran Kamble (Proof Reading), Mrs. Anjali Muley (Graphic Design) and Mr. Malik Shaikh for a neat and error free D.T.P. of this book.

Errors might have crept in despite utmost care to avoid them and author shall be grateful if these are pointed out along with valuable suggestions for the improvement of the quality of the book.

We hope that this book will be useful for students and teachers.

**Authors**

# SYLLABUS

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## **Unit 1: Carboxylic Acids and their Derivatives [06 Hrs.]**

- 1.1 Monocarboxylic Acid: Introduction, Methods of Formation from Alcohols, Aldehydes, Ketones, Nitriles and Alkyl benzenes.
- 1.2 Halo Acids: (a) Synthesis of halo acids-Mono, Di, Tri-chloro acetic acid by HVZ reaction (b) Reactions - Substitution reaction of Monochloro acetic acid by Nucleophiles  $\text{OH}^-$ ,  $\text{I}^-$ ,  $\text{CN}^-$  and  $\text{NH}_3$
- 1.3 Hydroxy acids: Citric acid
  - (a) Methods of formation of Citric acid from glycerol.
  - (b) Chemical Reactions: Reaction of citric acid: Acetylation by acetic anhydride, reduction by HI, action of heat.
- 1.4 Dicarboxylic Acids:
  - (a) Introduction
  - (b) Methods of formation of succinic acid from ethylene dibromide, maleic acid
  - (c) Chemical Reactions: Action of heat, Action of  $\text{NaHCO}_3$ ,  $\text{C}_2\text{H}_5\text{OH}$  in the presence of acid.
  - (d) Method of formation of Phthalic acid from o-xylene and Naphthalene
  - (e) Chemical Reactions of Phthalic acid : Action of heat, reaction with sodalime, ammonia.
- 1.5 Carboxylic Acid Derivatives:
  - (a) Introduction
  - (b) Acid halide derivative: Acetyl chloride:
    - (i) Synthesis from acid, by action with  $\text{PCl}_3$  and  $\text{SOCl}_2$ .
    - (ii) Reaction with water, alcohol (Mechanism of esterification is expected) and ammonia.
  - (c) Acid anhydride derivative:
    - (i) Synthesis of acetic anhydride by dehydration of acetic acid.
    - (ii) Reactions with water, alcohol and ammonia.

## **Unit 2: Amines and Diazonium Salts**

**[05 Hrs.]**

### **2.1 Amines**

- (i) Introduction, Classification and Nomenclature
- (ii) Methods of preparation:
  - (a) From alkyl halide by amonolysis
  - (b) By reduction of nitriles or cyanides
  - (c) From unsubstituted amides (Hoffmann degradation),
  - (d) By Gabriel synthesis (from Phthalamide).

- (iii) Reactions: Carbylamine reaction, Schotten-Baumann reaction, Electrophilic substitution (Aniline) - Nitration, Bromination, Sulphonation.

## 2.2 Diazonium salt:

- (i) Introduction
- (ii) Preparation of Benzene diazonium chloride.
- (iii) Reactions of Benzene diazonium chloride.
  - (a) Replacement reaction - Sandmeyer's reaction.
  - (b) Coupling reactions: Synthesis of Congo red.

## Unit 3: Carbohydrates

[06 Hrs.]

### 3.1 Introduction

### 3.2 Classification of carbohydrates, reducing and non-reducing sugars

### 3.3 Physical properties of glucose and fructose

### 3.4 Killiani's synthesis of Glucose from D-Arabinose

### 3.5 Determination of structure of D-Glucose.

- (a) Open chain structure of D-Glucose.
- (b) Configuration of D-Glucose from D- Arabinose
- (c) Ring structure of D-Glucose.
- (d) Size of ring in D-Glucose by Methylation method.
- (e) Haworth projection for D-Glucose.

### 3.6 Cyclic structure of Fructose

### 3.7 Structures of Disachharides

- (a) Linkage between Monosachharides
- (b) Open chain and Haworth cyclic structures of Sucrose, Lactose and Maltose.

### 3.8 Structures of Polysachharides: (a) Starch, (b) Cellulose

## Unit 4: Carbonyl Compounds - Aldehydes and Ketones

[06 Hrs.]

### 4.1 Introduction, Nomenclature of aliphatic and aromatic aldehydes and ketones

### 4.2 Structure and reactivity of Carbonyl group

### 4.3 Reactions of Carbonyl Compounds - Mechanism and applications of -

- (i) Aldol condensation, (ii) Claisen and Benzoin Condensation,
- (iii) Perkin's reaction, (iv) Cannizzaro's reaction, (v) Knoevenagel condensation and (vi) Reformatsky reaction.

## Unit 5: Stereochemistry

[07 Hrs.]

- 5.1 Conformational isomerism – Introduction
- 5.2 Representation of conformations of ethane by using Saw-Horse, Fischer (dotted line wedge) and Newman's projection formulae
- 5.3 Conformations and conformational analysis of ethane and n-butane by Newman's Projection formula with the help of energy profile diagrams
- 5.4 Relative stability of cycloalkanes - Baeyer's strain theory and Theory of strainless rings.
- 5.5 Conformations and stability of cyclohexane
- 5.6 Conformations and stability of methyl cyclohexane
- 5.7 Locking of conformation in t-butyl cyclohexane

### Reference Books:

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Stereochemistry Conformation and Mechanism, 9<sup>th</sup> Edition, By P. S. Kalasi, Publisher: New Age International, 2017.
3. Stereochemistry of Carbon Compounds by Eliel.
4. Stereochemistry of Organic Compounds by D. Nasipuri.
5. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd.
7. Organic Chemistry. Volume I, II, III by S.M. Mukharjee, S.P. Singh and R.P. Kapoor. Wiley Eastern Limited (New Age International)
8. Advanced Organic Chemistry by, B.S. Bahl, Arun Bahl, S. Chand and Company, Ltd.
9. Chemistry by R. L. Madan, S. Chand and Company Ltd.

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