



# Organic Chemistry CH 401 Course



**Krishna P. Kaliappan**  
**Department of Chemistry**  
**Indian Institute of Technology-Bombay**  
**Mumbai 400 076 INDIA**

**<http://www.chem.iitb.ac.in/~kpk>**  
**[kpk@chem.iitb.ac.in](mailto:kpk@chem.iitb.ac.in)**



# Syllabus

CH-401 (2020)/Chem/IIT-B      Instructor: Dr. Kaliappan, Krishna P.

**Classification of reactions:** A brief introduction to substitution, elimination, addition, oxidation, reduction, rearrangement and pericyclic reactions.

**(2 Lectures)**

**Cycloaddition reactions:** Diels-Alder reaction; general features, dienes, dienophiles, selectivity, intramolecular and intermolecular reactions, hetero-Diels Alder reaction. 1,-3-dipolar cycloaddition reactions; general features, dipoles, dipolarophiles. [2+2] cycloaddition reactions; general features, selected examples. **(8 Lectures)**

**Molecular rearrangements:** Illustration of electron deficient and electron rich skeletal rearrangements with examples; Sigmatropic rearrangements-Claisen and related rearrangements, Cope and oxy-Cope rearrangements; 2,3-sigmatropic rearrangements and ene reaction. **(6 Lectures)**



# Syllabus

CH-401 (2020)/Chem/IIT-B

Instructor: Dr. Kaliappan, Krishna P.

**Functional group transformations:** alcohols to alkylating agents, Mitsunobu and related reactions, introduction of functional groups by nucleophilic substitution at saturated carbon, nucleophilic cleavage of C-O bonds in ethers and esters and inter-conversion of carboxylic acid derivatives. (4 Lectures)

**Oxidation:** Metal based oxidizing reagents: A review and detailed discussion of chromium, manganese, ruthenium, silver and other metal-based reagents. Non-metal based oxidizing reagents: DMSO, peroxide, peracid and oxygen based oxidation. Miscellaneous oxidizing reagents like IBX, DMP, CAN, DDQ, periodate etc. (7 Lectures)

**Reduction:** Homogeneous and heterogeneous hydrogenations; Discussion on borane based racemic and chiral reagents, aluminum, tin, silicon based reducing agents. Dissolving metal reductions. (5 Lectures)

**Selectivity and protecting groups:** Illustration of chemoselectivity, regioselectivity and stereoselectivity with examples; protecting groups for alcohols, amines, acids, ketones and aldehydes. (4 Lectures)



# Suggested Books

**Jerry March, “Advanced Organic Chemistry”, Fifth Ed., Wiley, 2007.**



# Suggested Books

Jerry March, “Advanced Organic Chemistry”, Fifth Ed., Wiley

F. A. Carey and R. J. Sundburg, “Advanced Organic Chemistry, Part B”, Fifth Ed., Plenum Press

J. Clayden, N. Greeves, S. Warren and P. Wothers, “Organic Chemistry”, First Ed., Oxford University Press

W. Carruthers, “Some Methods of Organic Synthesis”, Cambridge University Press

## Evaluation Pattern

Mid-Semester	30%
End Semester + Assignments	50%
Quiz (2 Nos)	20%

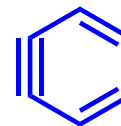
**-There will be a total of 36 (1h) lectures, and 7 tutorials**





# Functional Groups

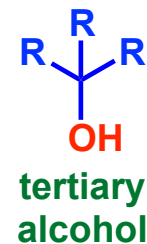
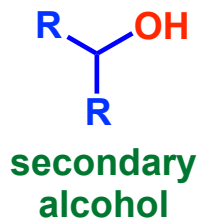
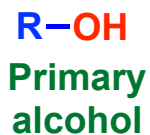
Only with carbon and hydrogen



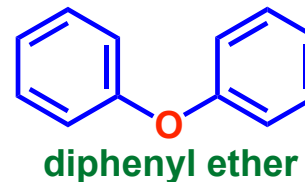
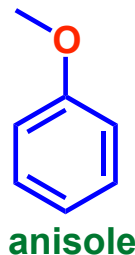
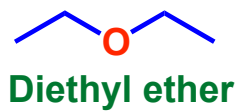
With heteroatoms

With **one** oxygen atom:

## 1. Alcohol



## 2. Ether

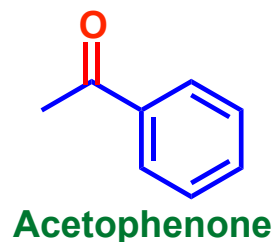




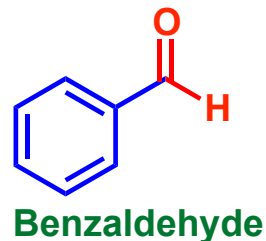
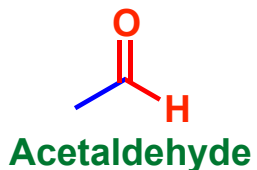
# Functional Groups

With **one** oxygen atom:

## 3. Ketone



## 4. Aldehyde



## 5. Epoxide, Cyclic ethers





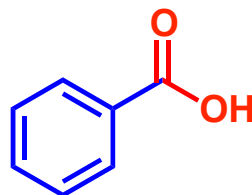
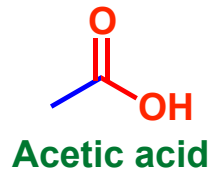


# Functional Groups

## With heteroatoms

With **two** oxygen atoms:

### 1. Acid



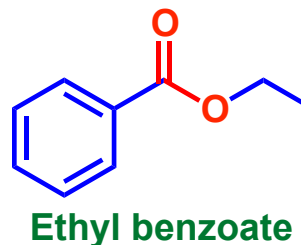
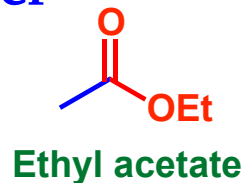
### 2. Ketal



### 3. Acetal



### 4. Ester



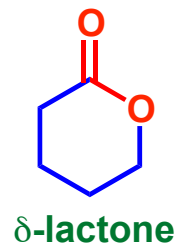
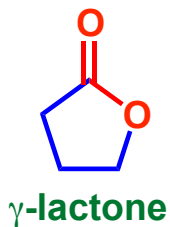


# Functional Groups

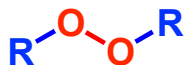
## With heteroatoms

With **two** oxygen atoms:

### 5. Lactone (Cyclic ester)

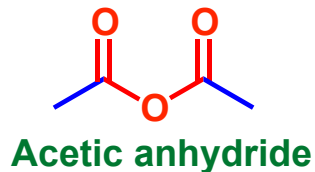


### 6. Peroxides



With **three** oxygen atoms:

### 1. Anhydrides



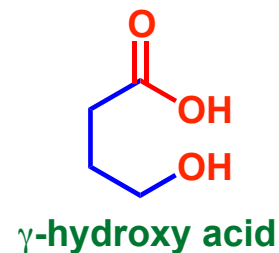
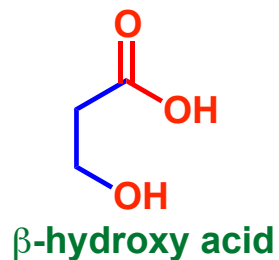
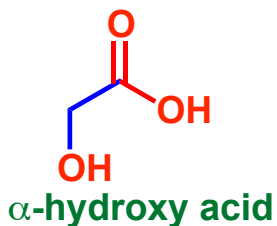


# Functional Groups

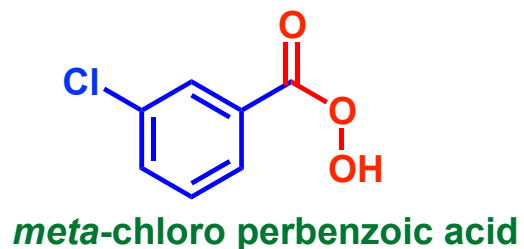
## With heteroatoms

With **three** oxygen atoms:

### 2. Hydroxy acid



### 3. Peracids



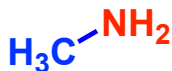


# Functional Groups

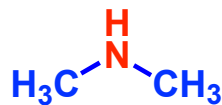
## With heteroatoms

### With **One** Nitrogen atom

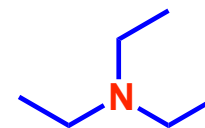
#### 1) Amines



Methyl amine  
(primary amine)

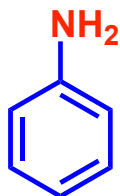


Dimethyl amine  
(secondary amine)



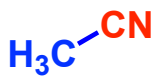
Triethyl amine  
(tertiary amine)

#### 2) Aromatic amines



Aniline

#### 3) Nitriles



Acetonitrile



# Functional Groups

## With heteroatoms

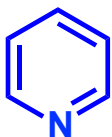
### With **One** Nitrogen atom

#### 4) Aziridines

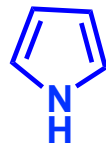


aziridine

#### 5) Hetero Aromatic amines



Pyridine

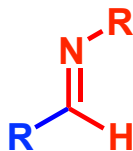


Pyrrole

#### 6) Imines



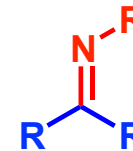
Primary aldimine



Secondary aldimine



Primary Ketimine



Secondary Ketimine

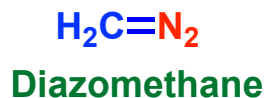


# Functional Groups

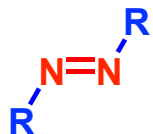
## With heteroatoms

### With **Two** Nitrogen atoms

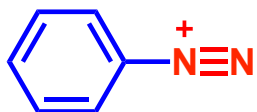
#### 1) Diazo



#### 2) Azo



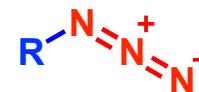
#### 3) Diazonium salts



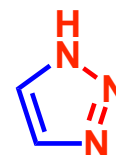
Benzenediazonium cation

### With **Three** Nitrogen atoms

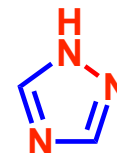
#### 1) Azides



#### 2) Triazoles



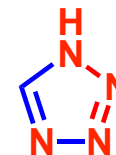
1,2,3-triazole



1,2,4-triazole

### With **Four** Nitrogen atoms

#### 1) Tetrazole



1-tetrazole

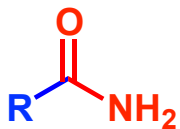


# Functional Groups

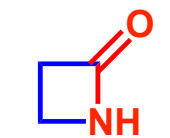
## With heteroatoms

With One Nitrogen atom and One oxygen atom

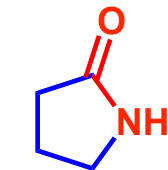
### 1) Amides



### 2) Lactams

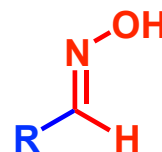


$\beta$ -lactam

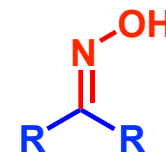


$\gamma$ -lactam

### 3) Oximes

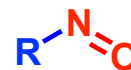


aldoxime



ketoxime

### 4) Nitroso



### 5) Nitrile oxides





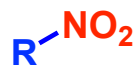


# Functional Groups

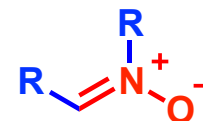
## With heteroatoms

### With One Nitrogen atom and Two oxygen atoms

#### 1) Nitro

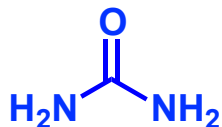


#### 2) Nitrones



### With Two Nitrogen atoms and One oxygen atom

#### 1) Urea

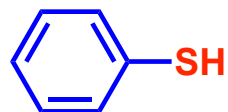




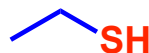
# Functional Groups

## With heteroatoms (sulfur)

### 1) Thiols

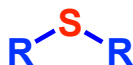


Thiophenol



Ethanethiol

### 2) Thio ethers

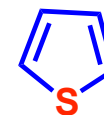
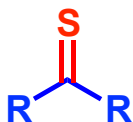


### 4) Thiirane



### 5) Heterocycles

### 3) Thio carbonyl



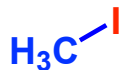
Thiophene



# Functional Groups

## With heteroatoms (halogens)

### 1) Halides

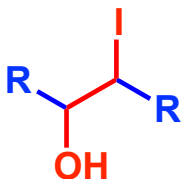


Methyl iodide



Ethyl bromide

### 2) Halohydrin

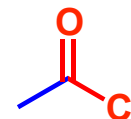


### 3) Dihalides



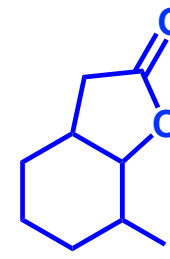
1,2-dichloroethane

### 4) Acid Chloride



Acetyl chloride

### 5) Halolactones

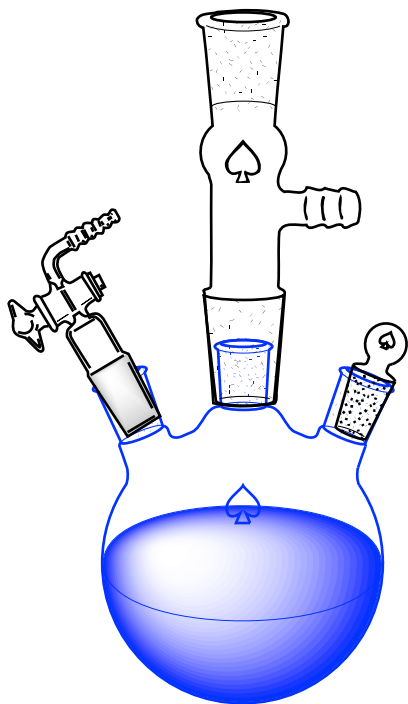




# Classification of Reactions

Organic synthesis and Music: What is common between them?

Reactions can be classified into **seven** types



1. Addition reaction
2. Elimination reaction
3. Substitution reaction
4. Oxidation reaction
5. Reduction reaction
6. Pericyclic reaction
7. Rearrangement reaction

