[Time: 2.30 Hours]  
[Total Marks: 60]

Please check whether you have got the right question paper.

NB: 1. All questions are compulsory.
2. Figures to the right indicate full marks.

Q.1(A) Attempt any two of the following:
   (a) Predict the major products of the following reactions.

   i) \[ \text{Cyclopentanone} \quad \xrightarrow{\text{LDA/THF, -78°C}} \quad ? \quad \xrightarrow{\text{Br}} \quad ? \]

   ii) \[ \text{Acetophenone} \quad \xrightarrow{\text{2 NaNH}_2} \quad ? \quad \xrightarrow{\text{Br}} \quad ? \]

(b) Complete the following reaction and give its mechanism.

   i) \[ \text{PhCO} \quad + \quad \text{PhCHO} \quad \xrightarrow{\text{aq. NaOH}} \quad ? \]

   ii) \[ \text{Acetophenone} \quad + \quad \text{PhCHO} \quad \xrightarrow{\text{H}^+} \quad ? \]

(c) Complete the following reactions with suitable products.

   i) \[ \text{Cyclohexane} \quad \xrightarrow{\text{excess KH}} \quad ? \]

   ii) \[ \text{Cyclohexene} \quad \xrightarrow{\text{aq. NaOH}} \quad ? \]

   iii) \[ \text{Cyanobenzene} \quad \xrightarrow{\text{Br}} \quad ? \]

   iv) \[ \text{Acrylic acid} \quad \xrightarrow{\text{LDA/THF, -78°C}} \quad ? \quad \xrightarrow{\text{Br}} \quad ? \]

(d) Predict the products and give the mechanism of the following reaction.

\[ \text{COOEt} \quad + \quad \xrightarrow{\text{EtONa/EtOH}} ? \]

(B) Attempt any one of the following:

(a) Predict the products and name the following reactions.

   i) \[ \text{Naphthalene} \quad + \quad \text{Pyridine} \quad \xrightarrow{\text{H}^+} \quad ? \quad \xrightarrow{\text{Br}} \quad ? \]

   ii) \[ \text{Acetaldehyde} \quad + \quad \text{HCl} \quad \xrightarrow{\text{Et}_{2} \text{NH}} \quad ? \]

(b) Explain Michael addition reaction and its mechanism.
Q.2(A) Attempt any two of the following:
(a) Explain Von Richter rearrangement with its mechanism. 4
(b) What is Pummerer rearrangement? Explain its mechanism. 4
(c) Predict the product and name the following reactions.

\[ \text{H}_2\text{C}-\text{COOH} \xrightarrow{\text{HN}_3, \text{H}_2\text{SO}_4} ? \]

\[ \text{ii) } \text{X} \text{H} \xrightarrow{\text{Conc} \text{H}_2\text{SO}_4} ? \]

(d) Complete the following reaction and give the name. Write its mechanism. 4

\[ \text{O} + \text{PhCH} = \text{CO} \xrightarrow{\text{NEt}_3} ? \]

(B) Attempt any one of the following:
(a) Explain Boulton - Katritzky rearrangement with its mechanism. 4
(b) Predict the product and name the following reactions.

\[ \text{i) } \text{PhCH}_2\text{CONHOCOCH}_3 \xrightarrow{\Theta \text{H} } ? \]
\[ \xrightarrow{\text{ii) } \text{H}_2\text{O}} ? \]

Q.3(A) Attempt any two of the following:
(a) Explain the following in IR Spectroscopy:
   i) Vibrational Coupling
   ii) Study of hydrogen bonding
(b) Explain ‘donor-acceptor’ interaction in nucleophilic addition reaction on formaldehyde using FMO method. 4
(c) Which of the following compounds will show a lower \( \text{C}=\text{O} \) stretching frequency in IR spectroscopy and why?
(i) 

\[
\begin{align*}
\text{H}_3\text{CO} & \quad \text{And} \quad \text{H}_3\text{C} \\
\text{O} & \quad \text{C} - \text{CH}_3 \\
\end{align*}
\]

(ii) 

\[
\begin{align*}
\text{COCH}_3 & \quad \text{And} \quad \text{COCH}_3 \\
\end{align*}
\]

(d) ‘Dimerization of ethane takes place via photochemical pathway’. Explain on the basis of HOMO-LUMO interaction using π MOs.

(B) Attempt any one of the following:

(a) Draw the π MO diagram for the allyl anion and allyl cation. Show the interaction of their FMOs and predict the product of the reaction between the two ions.

(b) Using IR Spectroscopy how can you distinguish between

   i) Phenol and Cyclohexanol
   ii) Ethylbenzene and o-xylene

Q.4(A) Attempt any two of the following:

(a) Write the fragmentation pattern of the following molecules in Mass spectroscopy:

   i) Ethyl benzene  ii) 3-pentanone

(b) Explain the following terms in NMR spectroscopy with suitable example.

   i) Long range coupling  ii) Coupling constant

(c) An Organic Compound having M.F. C8H8O2 showed following spectral dada:

   I.R. = 2970 cm⁻¹, 1745 cm⁻¹, 1200 cm⁻¹.
   13CNMR = δ 14 (q), δ 32 (q), δ 82 (t) and δ 185 (s).

   Deduce the structure of the compound and justify your answer.

(d) Write the number of signals and splitting pattern observed in the NMR spectra of following molecules:

   i) \[
   \begin{align*}
   \text{C} & \quad \text{COOCH}_2\text{-CH}_3 \\
   \end{align*}
   \]

   ii) \[
   \begin{align*}
   \text{H}_3\text{C} & \quad \text{O} \quad \text{C} - \text{CH}_3 \\
   \end{align*}
   \]

   iii) \[
   \begin{align*}
   \text{H}_3\text{C} & \quad \text{O} \quad \text{NH}_2 \\
   \end{align*}
   \]

   iv) \[
   \begin{align*}
   \text{H}_3\text{C} & \quad \text{O} \quad \text{CH}_3 \\
   \end{align*}
   \]
(B) Attempt any one of the following:
(a) An Organic Compound having M.F. C_{10}H_{12}O showed following spectral data:
\[ \text{I.R.} = 3090 \text{ cm}^{-1}, 2970 \text{ cm}^{-1}, 1700 \text{ cm}^{-1}, 850 \text{ cm}^{-1}. \]
\[ ^1H-NMR = \delta 0.9 \ (3H, t), \delta 4.3 \ (2H, q), \delta 7.3 \ (2H, d, \text{J} = 7.5\text{Hz}), \delta 7.6 \ (2H, d, \text{J} = 7.5\text{Hz}) \text{ and } \delta 2.3 \ (3H, \text{s}). \]
\[ ^13C-NMR = \delta 15, \delta 30, \delta 35, \delta 110, \delta 120, \delta 135, \delta 140 \text{ and } \delta 210. \]
Deduce the structure of the compound and justify your answer.

(b) Explain the following in Mass spectroscopy with suitable example;
   i) McLafferty rearrangement    ii) Ortho effect

Q.5 Attempt any four of the following:
A What is Tandem alkylation? Explain with suitable example.
B Predict the products and give the mechanism of the following reaction.
\[
\begin{array}{c}
\text{Ph} \\
\text{H} \\
\text{COOH}
\end{array}
+ \begin{array}{c}
\text{Ph} \\
\text{H} \\
\text{COOH}
\end{array}
\xrightarrow{\text{Piperidine}}
\begin{array}{c}
\text{Ph} \\
\text{H} \\
\text{COOH}
\end{array}
\]
C Explain Passerini reaction with its mechanism.
D Complete the following reactions.
\[
\begin{array}{c}
\text{Ph} \\
\text{SiPh}_3
\end{array}
\xrightarrow{\text{OH}}
\begin{array}{c}
\text{Ph} \\
\text{Ph}
\end{array}
\]
\[
\begin{array}{c}
\text{Ph} \\
\text{N}
\end{array}
\xrightarrow{\text{NaOMe}}
\begin{array}{c}
\text{Ph} \\
\text{MeOH}
\end{array}
\]
E Discuss hard and soft electrophiles? Give one example of each. Comment on the relative energies of their LUMOs.
F Calculate the \( \lambda_{\text{max}} \) of the following compounds
\[
i) \begin{array}{c}
\text{Ph} \\
\text{H} \\
\text{CH}_2
\end{array}
\quad ii) \begin{array}{c}
\text{Ph} \\
\text{H} \\
\text{AcO}
\end{array}
\]
G Explain the term D2O exchange and its application in NMR spectroscopy.
H Explain the term isotopic abundance and Molecular ion peak in Mass Spectroscopy.