# MURANG'A UNIVERSITY OF TECHNOLOGY

## SCHOOL OF HUMANITIES AND SOCIAL SCIENCES

DEPARTMENT OF PHYSICAL AND BIOLOGICAL SCIENCE

UNIVERSITY ORDINARY EXAMINATION

2020/2021 ACADEMIC YEAR

**THIRD** YEAR **FIRST** SEMESTER EXAMINATION FOR, BSc. INDURSTRIAL CHEMISTRY AND ANAYTICAL CHEMISTRY

ACH 312– ORGANIC SPECTROSCOPY

DURATION: 2 HOURS

**Instructions to candidates:**

1. Answer question One and Any Other Two questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

Use spectroscopic table attached at the end of paper

Speed of light, C = 3 x $10^{3}ms^{-1}$

Avogadro's number, NA = 6.02 x $10^{23}$

Planks constant h = 6.626 x $10^{-34}JS$

Take atomic mass as follows C = 12, H =1.0, O = 16.0

## SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

## QUESTION ONE (30 MARKS)

a) Define the following terms as applied in organic spectroscopy
   i. Molecular ion (2 marks)
   ii. Spectrum (2 marks)
   iii. Coupling constant (2 marks)
   iv. Chromophore (2 marks)

b) The wavelength of sodium D line is 389.0 nm. Calculate
   i. The frequency in cycles per second (1 mark)
   ii. The wavelength in $cm^{-1}$ (1 mark)

c) Explain how the labelled fragments are formed (12 marks)

d) Distinguish between the following pairs as used in organic spectroscopy
   i. A quadrat and a doublet of doublet of doublet in $^{1}H$ NMR (2 marks)
   ii. Base peak and molecular ion peak (2 marks)
   iii. Hypochromic and Bathochromic shift (2 marks)

e) Outline selection rules in electronic transition (2 marks)

## SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION

## QUESTION TWO (20 MARKS)

a) Deduce with reasons which among the four structures (i) to (iv) give the following infrared spectrum. (4 marks)

b) The mass spectrum of h-butyl phenyl ketone, $C_6H_5CO(CH_2)_3CH_3$ show peak M/Z 162, 110, 105 and 85 show the formation of these peaks and their formulae. (4 marks)

c) Calculate the UV maxima of the following compounds. (8 marks)

d) The UV spectra for compounds 1 and 2 in ethanol were observed at 237nm and 225 nm respectively. Predict with reasons the UV spectra of these when recorded in water. (4 marks)

**QUESTION THREE (20 MARKS)**

March the following to their IR spectra place X next to those compounds that do not have a metal. (20 marks)

**QUESTION FOUR (20 MARKS)**

a) i) State the Beer-Lamberts law and explain the terms. (4 marks)

ii) An ∝-ß unsaturated ketone of relative molecular mass 110 has an absorption bond with lmax at 215nm and ε = 10,000. A solution of ketone showed absorbance A = 2.0 with 1 cm cell. Calculate concentration of ketone in g/l. (2 marks)

b) Two compounds (D and E) with the molecular formula $C_5H_{10}O$ have the following

| | $\delta$ 1$HNMR$ | $\delta$ 13$CNMR$ | | $\delta$ 1$HNMR$ | $\delta$ 13$CNMR$ |
|---|---|---|---|---|---|
| D | 2.55(septet, 1H | 212.6 | E | 2.38 (triplet, 2H | 209 |
| | 2.10 (singlet-3H | 41.5 | | 2.10 (singlet, 3H | 45.5 |
| | 1.05 (doublet, 6H | 27.2 | | 1.57 (sextet 2H | 29.5 |
| | | 17.8 | | 0.88 (triplet 3H | 17.0 |
| | | | | | 13.5 |

Both compounds have a strong absorption band in 1710-1740 $cm^{-1}$.

i. Interpret the spectra and elucidate the structure of the two compounds.
ii. Make a sketch of each $^1$H-NMR. (10 marks)

c) Calculate lmax for the following enones (4 marks)