THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

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MAIN EXAMINATION

SEPTEMBER – DECEMBER 2019 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

REGULAR PROGRAMME

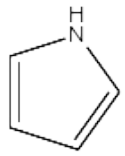
CHEM 410: CHEMISTRY OF HETEROCYCLIC COMPOUNDS

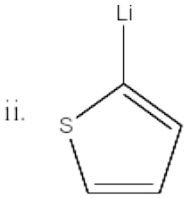
Date: DECEMBER 2019	**Duration: 2 Hours**
INSTRUCTIONS: Answer Question ONE and any other Two Questions	

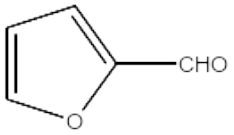
Q1. a) i) Arrange the following compounds in order of increasing aromatic character;
Pyrrole, benzene, Furan, thiophene. **(4 Marks)**

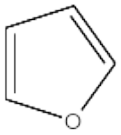
ii) Explain the increase in the aromatic character in (a)(i) above **(5 Marks)**

b) Give the products of the following reactions: **(6 Marks)**

i.  + KOH ⟶

ii.  i). CO_2 ⟶ ii). H_2O/H^+

ii.  + KOH ⟶

iv.  $+SO_3$ —pyridine→

v.  $+ NH_3$ +  —Red hot tube→

c) Explain each of following:

i). Pyrrole is less basic compared to pyridine.

ii). Electrophilic substitution in furan occurs preferably at C2 and not C3.

iii). Pyridine behaves as a deactivated benzene ring system.

iv). Pyrrole behaves like phenol in its reactions.

v). Pyridine -1-oxide is more reactive than pyridine towards nucleophiles.

(10 Marks)

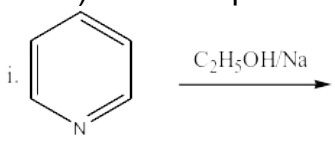
d) Arrange the following in increasing order of basicity;
Pyridine, Piperidine, Pyrrole, Methylamine and briefly explain why?

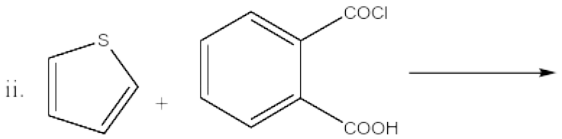
(5 Marks)

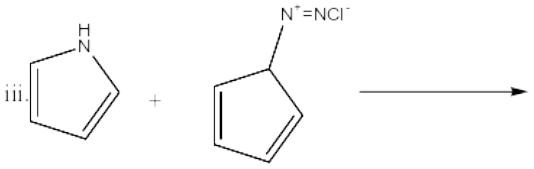
Q2. a) Explain how pyridine is synthesized by means of Skraup's synthesis, highlighting the reactions involved at every step.

(10 Marks)

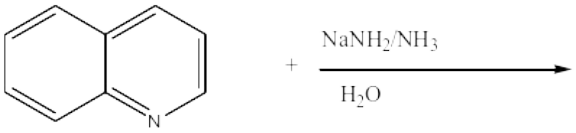
b) Complete the following reactions; **(10 Marks)**

i. 

ii. 

iii. 

iv. 

v. 

Q3. a) How is pyridine isolated from coal tar?

(5 Marks)

b) Explain why pyridine does not undergo Friedel – Crafts reactions?

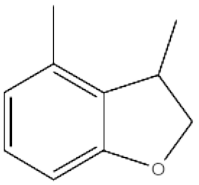
(5 Marks)

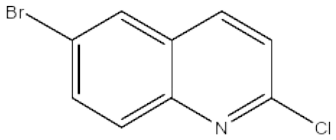
c) Which of the following heterocyclic compounds are not aromatic and why?

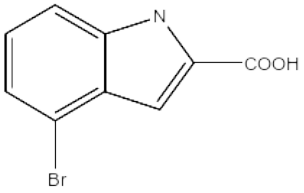
i). Pyridine
ii). Furan
iii). Piperidine
iv). Pyrrole
v). Tetrahydrofuran

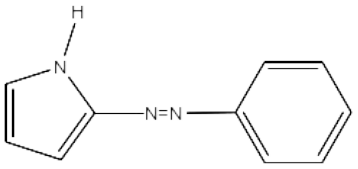
(5 Marks)

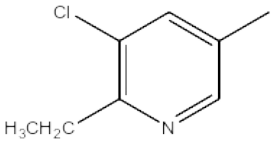
d) Give the names of the following benzene fused heterocyclic compounds;

i. 

ii. 

iii. 

iv. 



(5 Marks)

Q4. a) Give the following industrial synthesis;

i). Thiophene from butane

ii). Furan from corncobs

iii). Pyrrole from ethyne and methanal

(10 Marks)

b) Why is pyridine more basic than aniline?

(4 Marks)

c) In terms of relative stability of the intermediate, discuss the orientation of electrophilic substitution with benzo-fused five membered ring heterocycles such as indole. **(6 marks)**

Q5. a) Discuss the orientation of electrophilic substitution on pyridine in terms of the relative stability of the intermediate.

(6 Marks)

b) Give the expected product of the monochlorination of quinoline and explain the orientation.

(4 Marks)

c) Give the structure of the product from the reaction of pyridine and AlCl3 and explain why pyridine does not participate in Friedel-Craft's reactions.

(6 Marks)

d) What product is formed when quinoline is reduced catalytically with two equivalents of hydrogen? **(4 marks)**

END