KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2016/2017 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER
SPECIAL/SUPPLEMENTARY EXAMINATIONS

FOR THE BACHELOR OF RENEWABLE ENERGY AND BIOFUELS TECHNOLOGY

COURSE CODE: IPT 327

COURSE TITLE: HEAT AND MASS TRANSFER

DURATION: 2 HOURS

DATE: 21ST SEPTEMBER 2017 TIME: 3 – 5PM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of **4** printed pages. Please Turn Over

QUESTION ONE (30 MARKS)

a) Differentiate between natural convection and forced convection (2 marks)

b) State Newton's law of cooling (2marks)

c) A steam main of 150mm outside diameter containing wet steam at 28 bar is insulated with an inner layer of diatomaceous earth, 40mm thick and an outer layer of 85% magnesia, 25mm thick. Calculate the heat loss per metre length of the pipe and the temperature of the outer surface of the lagging when the room temperature is 20^0 C. Neglect the thermal resistance of the pipe itself. Assume that the inside surface of the pipe is at the same temperature and take the heat transfer coefficient for the outside surface of the lagging as $17W/m^2K$.The thermal conductivities of diatomaceous earth and 85% magnesia are 0.09 and 0.06W/mK respectively. Neglect radiation. (20 marks)

d) Make a neat labelled sketch of a counter–flow recuperator together with the temperature profiles for two fluids A and B. (6 marks).

QUESTION TWO (20 MARKS)

a) A small hemispherical oven is built of an inner layer of insulting firebrick 125mm thick and an outer covering of 85% magnesia 40mm thick. The inner surface of the oven is at 800 ^{0}C and the heat transfer coefficient for the outside surface is $10W/m^2K$; the room temperature is 20 ^{0}C. Calculate the rate of heat loss through the hemisphere if the inside radius is 0.6m.Take the thermal conductivities of firebrick and 85% magnesia as 0.31 and 0.05W/mK respectively. (14 marks)

b) State four factors which govern conduction of heat in solids (4 marks)

c) Exlain how higher heat transfer is ensured in a shell – and – tube heat exchanger (2 marks)

QUESTION THREE (20 MARKS)

a) Name the three (3) types of heat exchangers. (3 marks)

b) Differentiate between parallel flow and counter-flow with respect to heat exchangers (2 marks)

c) What is the driving force that facilitates mass transfer? (3 marks)
d) Explain the application of drying as a mass transfer process in the food industry (6 marks)
e) Define the following terms:
   i) Saturation state
   ii) Dry saturated vapour (4 marks)

f)Explain what happens when a dry saturated vapour is heated at constant pressure (2 marks)

QUESTION FOUR (20 MARKS)

a) Explain the process of batch distillation (10 marks)
b) State four (4) requirement of a tower packing for gas absorption. (4 marks)
c) i) Explain the meaning of convective mass transfer (1 ½ marks)

   ii) Give an expression for determining the convective mass transfer coefficient (1 mark)

d) Briefly outline the procedure for solid – solid extraction (3 ½ marks)

QUESTION FIVE (20 MARKS)

a) State Fick's first law of steady – state diffusion (2 marks)
b) State four (4) applications of leaching (4 marks)
c) Name the factors that pose difficulties to heat transfer in heat exchangers (2 marks)
d) Briefly describe how the scrapping action is produced in scrapped surface heat exchangers (6 marks)
e) Describe the procedure for single – stage flash distillation (6 marks)

END