KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2020/2021 ACADEMIC YEAR

THIRD YEAR SECONDSEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF
B.SC RENEWABLE ENERGY AND BIOFUELS TECHNOLOGY

COURSE CODE: REN 322

COURSE TITLE: HEAT AND MASS TRANSFER

DURATION: 2 HOURS

DATE: 7/10/2021 **TIME: 8:00-10:00AM**

INSTRUCTIONS TO CANDIDATES

(i) Answer **Question 1 (Compulsory)** and any other **TWO** questions
(ii) All symbols have their usual meaning
(iii) Use steam tables provided

This paper consists of **3** printed pages. Please Turn Over

QUESTION ONE (Compulsory) - 30 MARKS

a) State Fourier's law of conduction of heat.

(5 Marks)

b) Explain the implication of the Grashof number with regard to fluid flow.

(4 Marks)

c) Give the differences between the following.

i) Radiosity

(2 Marks)

ii) Irradiation

(2 Marks)

d) What is heat transfer by convection?

(3 Marks)

e) Explain briefly the differences between the following types of heat exchangers

(i) Recuperative

(2 Marks)

(ii) Regenerative

(3 Marks)

f) Draw a well labeled diagram to show the temperature distribution in a counter-flow heat exchanger

(5 Marks)

g) Define LMTD

(4 Marks)

QUESTION TWO – 20 MARKS

a) A meat slab of 25mm thickness having a thermal conductivity of 1 W/m^0C is heated with the help of a microwave heating for roasting the meat slab. The centre temperature of the slab is maintained at 100^0C while the surrounding temperature is 30^0C. The heat transfer coefficient on the surface of the meat slab is 20 $W/m^{2\,0}C$.

Take:

$$t_{max} = t_a + q_g\left(\frac{L}{2h} + \frac{L^2}{8k}\right)$$

Determine the microwave heating capacity in W/m^3.

(10 Marks)

b) A plate which is 2cm thick and 10cm wide is used to heat a fluid at 30^0C. The heat generation inside the blade is 7×10^6 W/m^3. The thermal conductivity of the blade is 26 W/m^{0}C. The heat losses from the edge of the plate are negligible.

Determine the heat transfer coefficient that can maintain the temperature of the plate below 180^0C.

(10 Marks)

QUESTION THREE – 20 MARKS

Calculate the heat transfer coefficient for water flowing through a 25mm diameter tube at a mass flow rate of 1.8 kg/s when the mean bulk temperature is 42^0C.
For turbulent flow of a liquid, take:

$$Nu = Re^{0.8}Pr^{0.4}$$

(20 Marks)

QUESTION FOUR – 20 MARKS

In a chemical plant, a solution of density 1100 kg/m^3 and a specific heat of 4.6 kJ/kgK is to be heated from 65^0C to 100^0C; the flow of solution required is 11.8 kg/s. It is desired to use a tubular heat exchanger, the solution flowing at about 1.2 m/s in a 25mm bore iron tubes, and being heated by wet steam at 115^0C. The length of the tubes must not exceed 3.5 m. The inside and outside heat transfer coefficients are 5 and 10 kW/m^{2}K, respectively. The thermal resistance of the iron tube is negligible.

Estimate the:

a) number of tubes required

(8 Marks)

b) number of tube passes required

(12 Marks)