KIBABII UNIVERSITY

2021/2022 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER

MAIN EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN RENEWABLE ENERGY AND BIOFUELS TECHNOLOGY

COURSE CODE: REN: 322

COURSE TITLE: HEAT AND MASS TRANSFER

DATE: 02/09/2022 **TIME:** 9:00aM-11:00aM

INSTRUCTIONS TO CANDIDATES

Answer question ONE and any other two questions

This paper consists of 4 printed pages. Please Turn over

QUESTION ONE

a. State the law of the conservation of energy and mass (2mks)

b. Define the following terms as used in mass and heat transfer (5mks)

   i. Heat

   ii. Specific heat

   iii. Sensible heat

   iv. Latent heat of fusion.

   v. Latent heat of vaporization

c. Differentiate between saturated liquid and saturated vapour (4mks)

d. List THREE heat transfer modes (3mks)

e. If a cup of hot coffee and an ice cream were left on the table in this room what would happen to them? Why? (3mks)

f. Explain why the freezer compartment is placed at the top of the fridge? 2mks

g. What is meant by counter flow and concurrent flow heat exchangers? 2mks

h. The thermal conductivity of copper is 390W/mk. Calculate the rate of heat transfer through copper wire with area 4.0cm^2 and the length of 0.5m. The temperature difference between both ends of the wire is 30 degrees centigrade. (4mks)

i. Why does metal feel colder than wood, if they are both at the same temperature? (2mks)

j. An object of area 0.25m^2 and convective heat transfer coefficient of 100W/m^2 K is 40 degrees Celsius. The object is placed in air which is at 50 degrees Celsius. Calculate the convective heat transfer rate? (3mks)

QUESTION TWO

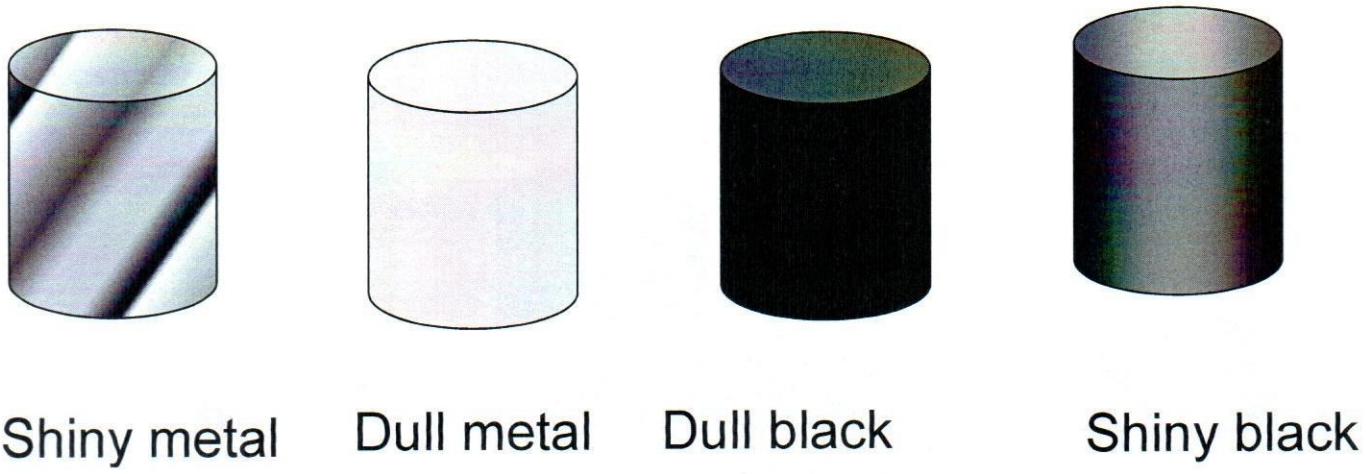
a. With a well labelled diagram, explain how a thermos flask minimizes the heat losses. (8mks)

b. A textile dryer is found to consume 4 m3/hr of natural gas with a calorific value of 800 kJ/mole. If the throughput of the dryer is 60 kg of wet cloth per hour, drying it from 55%

moisture to 10% moisture, estimate the overall thermal efficiency of the dryer taking into account the latent heat of evaporation only (12mks)

QUESTION THREE

a. Four containers were filled with warm water. Which container would have the warmest water after ten minutes? (4mks)



b. Use a section of saturated steam table below to answer the questions that follows.

Temp	Vapour pressure (kPa)	Enthalpy (kJ/kg)	
		Liquid Hc	Sat vapour Hv
100	101.35	419.04	2676.1
105	120.82	a.	b
110	143.27	461.30	2691.5

i. Calculate latent heat of vaporization of water at 100 degrees Celsius and atmospheric pressure (2mks)

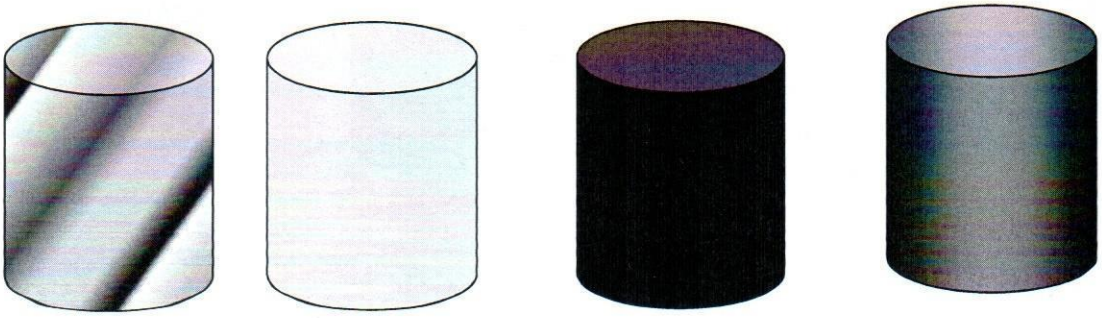
ii. Using interpolation method, find the values of a & b (6mks)

iii. Using the given enthalpies, determine the quality of steam "X" (8mks)

QUESTION FOUR

a. What do you understand by superheated steam (2mks)

b. Four containers were placed equidistant from a heater. Which container would have the warmest water after ten minutes? (4mks)



Shiny metal Dull metal Dull black Shiny black

c. Differentiate between direct and indirect contact heat exchangers. (4mks)

d. Consider a counter flow heat exchanger used to cool oil from 70 degrees Celsius to 40 degrees Celsius using water available at 30 degrees Celsius. The outlet temperature of the water is 36 degrees Celsius and the flow rate of oil is 1kg/s. The specific heat of oil is 2.2kJ/kgK. The overall heat transfer coefficient U=200W/m^2 K.

i. Calculate the logarithmic mean temperature difference (LMTD) (3mks)

ii. Determine the heat flow rate using mass flow rate of oil (3mks)

iii. Calculate the area of the heat exchanger (4mks)