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SET A

UNIVERSITI KALA LUMPUR

MALAYSIA FRANCE INSTITUTE

FINAL EXAMINATION

JANUARY 2014 SESSION

SUBJECT CODE	:	**FRB 30403**
SUBJECT TITLE	:	**HEAT EXCHANGER**
LEVEL	:	**BACHELOR**
TIME/DURATION	:	**9.00 am – 12.00 noon (3 hours)**
DATE	:	**03 June 2014**

INSTRUCTIONS TO CANDIDATES

1. **All documents authorized (OPEN BOOK EXAMINATION).**
2. **Please read the instructions given in the question paper CAREFULLY.**
3. **This question paper is printed on both sides of the paper.**
4. **Answer should be written in blue or black ink except for sketching, graphic and illustration.**
5. **This question paper consists only one section. Answer all questions in English.**

THERE ARE 4 PRINTED PAGES OF QUESTIONS, EXCLUDING THIS PAGE

INSTRUCTION: Answer ALL questions.

Please use the answer booklet provided.

Question 1

Answer the questions below:

a) Sketch and label schematic of a shell and tube evaporators. Explain THREE (3) methods to increase the overall heat transfer coefficient in these evaporators

(2 marks)

b) Explain the design steps of a heat exchanger using the effectiveness-NTU method. Discuss TWO (2) assumptions and ONE (1) limitations of this method.

(2 marks)

c) This question is on the evaporation of a refrigerant in a tube:

i. Describe the different modes of evaporation in this type of evaporator

(1 marks)

ii. Specify briefly the possible impact of lubricating oil on heat transfer

(1 marks)

Question 2

You are required to select a heat exchanger technology for cooling by a circuit of river water. The heat exchange is between a secondary circuit (pure water at 20 °C) and a primary circuit (river water at 5 °C)

Evaluate FIVE (5)advantages and FIVE (5) disadvantages of two technologies for this application from the selection table:

a) Plate heat exchanger with gasket

(2 marks)

b) Shell and tube heat exchanger

(2 marks)

Question 3

This question concern a dry expansion evaporator that uses R134a (average saturation temperature of 5 °C).The evaporator has 100 tubes with internal diameter of 7.3 mm and length of 2.3 m. Answer the questions below:

a) The superheated refrigerant zone in the evaporator occupy 10% of the heat transfer surface area of the evaporator. Calculate the mass of superheated refrigerant in this evaporator

(1 mark)

b) The two-phase refrigerant in the evaporator occupy 90 % of the heat transfer surface area of the evaporator. 50 % of heat transfer area has the average vapour fraction of 50% while another 40 % of heat transfer area has the average vapour fraction of 80 %. Calculate:

i. The average void fraction in these two-phase regions and the average density of the liquid and vapor mixture in these two-phase regions

(1 mark)

ii. The mass of R134a in the two-phase region and the total mass in both zones (you may assume the volume of collectors is negligible)

(1 mark)

The physical properties of R 134a are available in Table Q3:

Table Q3: Properties of R-134a

Temperature (°C)	*Quality*	*Pressure (MPa)*	*Specific volume (m^3/kg)*	*Enthalpy (kJ/kg)*	*Dynamic viscosity (Pa s)*	*Thermal Conductivity (W /m K)*
5.000	*0.0*	*0.3497*	*1/1278*	*206.8*	*254.4*	*0.08980*
5.000	*1.0*	*0.3497*	*1/17.13*	*401.5*	*10.94*	*0.01195*

Question 4

It is intended to design an evaporator (heat exchanger) for a cold room using tubes. This heat exchanger operates as an evaporator with re-circulation. The conditions of refrigerant at the inlet can be regarded as a saturated liquid and the refrigerant leaves as liquid and vapour mixture.

The choice of the designer in this exercise is limited to the choice of circuit (the connection between heat exchanger tubes which determines the number and length of refrigerant circuits in this heat exchanger).

Two scenarios (**Table Q4**) are considered, each characterized by a distinct pattern of connection and thus by a heat exchange coefficient in evaporation (refrigerant side) and a pressure drop across the evaporator (refrigerant side). The pressure drop was translated to variation in saturation temperature to facilitate the calculation.

Table Q4: Heat transfer coefficient and temperature drop at refrigerant side

	Coefficient of internal heat transfer coefficient (refrigerant side) in W/m^{2}K	**Variation in saturation temperature in Kelvin associated with the pressure drop across the evaporator for 1 meter length tube**
Scenario 1	800 W/m^2 K	0.5 K
Scenario 2	2500 W/m^2 K	2.0 K

Other information on the tubes are:
- Internal diameter of tube = 8.52 mm
- External diameter of tube = 9.52 mm
- Air side heat transfer coefficient is 23 W/m^{2}K

The temperatures of the fluids are:
- Inlet air temperature: -20 ° C
- Outlet air temperature: -25 ° C
- Outlet refrigerant temperature (saturated liquid-vapour state): -30 ° C

Answer the following questions;

a) Evaluate the overall heat transfer coefficient of the tubes in the two scenarios in Table Q4

(1 marks)

b) Calculate the log mean logarithmic temperature difference between the refrigerant and air for two scenarios in Table Q4. You need to assume that this is a counter flow heat exchanger

(1 marks)

c) Calculate the heat transfer rate for 1 meter length tube of these two scenarios

(1 marks)

d) It is proposed to add fins on the outer surface of tube. The properties of the fins are as below:

- Annular aluminium fins with external diameter = 20 mm, thickness of 1 mm and 2 mm space between fins
- Thermal conductivity of aluminium is 170 W/mK

Calculate the heat transfer rate for 1 meter length tube of these two scenarios

(4 marks)

END OF QUESTION