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CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JULY 2010 SESSION

SUBJECT CODE	:	FRD 20303
SUBJECT TITLE	:	HEAT TRANSFER & HEAT EXCHANGER
LEVEL	:	DIPLOMA
TIME / DURATION	:	9.00 am – 12.00 noon (3 HOURS)
DATE	:	21 NOVEMBER 2010

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. This question paper consists of TWO (2) sections. Section A and B. Answer all questions in Section A. For Section B, answer two (2) question only.
6. Answer all questions in English.
7. Formula is appended.

THERE ARE 7 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (Total: 60 marks)

INSTRUCTION: Answer ALL questions.

Please use the answer booklet provided.

Question 1

(a) One of the method for heat transfer is conduction.

i. What is the definition of conduction?

(2 marks)

ii. Between Copper and glass, which one has the higher thermal conductivity? Why?

(4 marks)

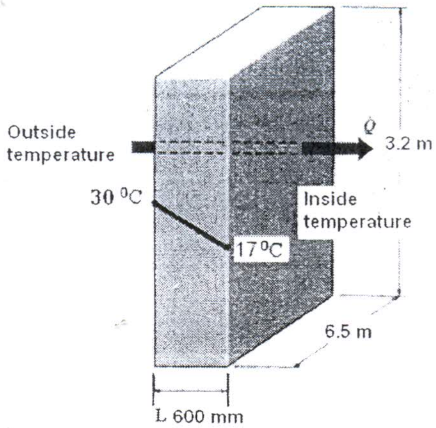

Figure Q1: Brick Wall

Referring to figure Q1, the temperatures of the outside and the inside surfaces of the basic brick wall are measured to be 30 °C and 17 °C respectively. The wall dimension is 3.2 m x 6.5 m and 600 mm thickness wall. Given the thermal conductivity is 0.7 W/m. °C. Calculate:-

(b) The rate of heat transfer through the wall by conduction in kW

(6 marks)

(c) The amount of heat transfer (kWh) where the period of the transfer is 1 day

(3 marks)

(d) The rate of heat transfer (kW) if the wall thickness increases to 900 mm.

(5 marks)

Question 2

(a) What are fundamental different between conduction and convection?

(3 marks)

(b) Heat transfer by convection involves of 2 types of convection,

i. What are the 2 types of convection?

(2 marks)

ii. Sketch a figure to show the 2 types of convection.

(4 marks)

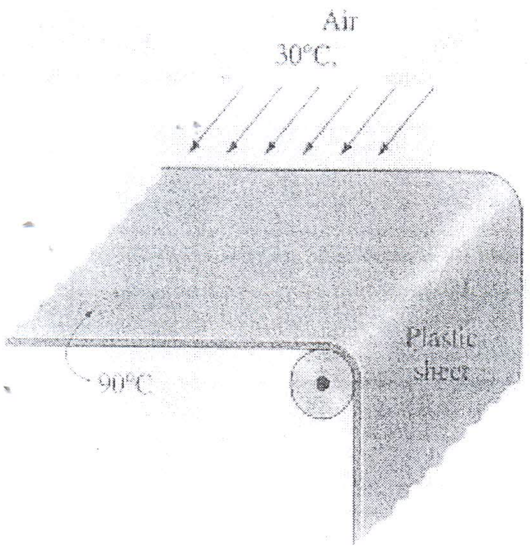

Figure Q2: Heat transfer by Convection

Referring to figure Q2, the air flow temperature blown across the plastic sheet is 30 ^{0}C and the temperature of the sheet is 90 ^{0}C. The area of the plastic sheet is 45 cm x 200 cm. Consider the convective heat transfer coefficient is 40 W/m^{2}.C. Calculate:-

(c) The rate of heat transfer at the plastic sheet by convection in kW

(6 marks)

(d) The rate of heat transfer (kW) if the heat transfer coefficient increases to 70 W/m^{2}.C and temperature of air decreases to 20 ^{0}C.

(5 marks)

QUESTION 3

(a) Write down the definition for:-

i. Grey bodies

(2 marks)

ii. Black body

(2 marks)

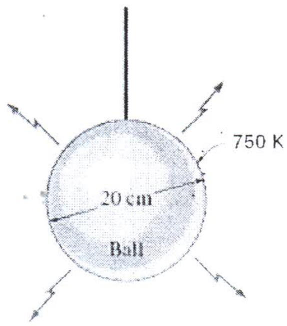

Figure Q3: Radiant ball emitted to the Surrounding

Referring to figure Q3, a radiant ball with the diameter of 20 cm is emitting radiation to the surrounding at 0 K (zero) absolute temperature. The surface of the ball is 750 K and is assumed the ball closely approximates a "**blackbody**", with the Stefan Boltzman coefficient given 5.676 x 10^{-8} W/m^2.K^4, Calculate:-

(b) The rate of radiant heat transfer emitted by the ball in kW

(7 marks)

(c) The amount of radiation (kJ) emitted by the ball in 120 minutes

(4 marks)

(d) The rate of radiant heat transfer (kW) emitted by ball if the ball is a "grey bodies" (ε is 0.75) and the diameter ball increases to 45 cm

(5 marks)

SECTION B (Total: 40 marks)

INSTRUCTION: Answer only TWO questions.
Please use the answer booklet provided.

QUESTION 4

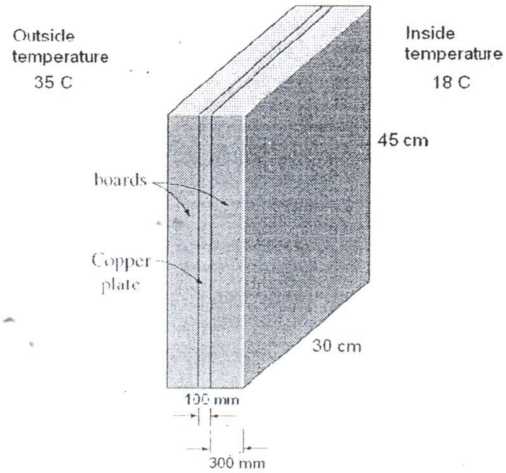

Figure Q4: Boards with copper plate resistance.

Referring to figure Q4, a double-pane board (150 cm x 100 cm) consists of two 300-mm thick layers of board separated by a 100-mm wide copper plate. The thermal conductivity of the board and copper are given to be k_{board} = 0.56 W/m·°C and k_{copper} = 375 W/m·°C. The convective heat transfer coefficient given by h_i = 10 W/m^{2}C and h_o = 25 W/m^{2}C. Calculate:-

(a) The Total Thermal resistance through the windows, in m^{2}C /W

(6 marks)

(b) The U-value coefficient, in W/m^2.C

(4 marks)

(c) The heat transmission loss through the window in W

(5 marks)

(d) The U-value coefficient (W/m^2.C) if the board thickness increases is **doubled**

(5 marks)

QUESTION 5

(a) Sketch the temperature profile across the two tubes for:-

i. Parallel Flow heat exchanger operation and,

ii. Counter Flow heat exchanger operation

(6 marks)

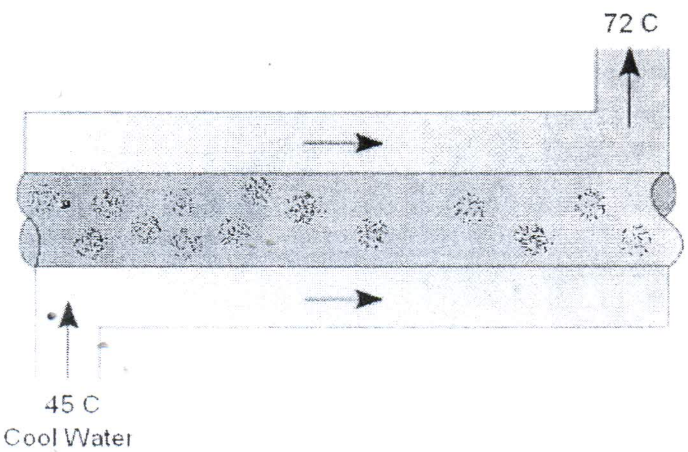

Figure Q5: Heat Exchanger

Referring to Figure Q5, a hot water (mC_p=4500 W/k) enter inner tube at 75 ^{0}C and heat exchanges with the outer tube having cool water entering at 45 ^{0}C and leaving is 72 ^{0}C. Given the cooling capacity experience by the hot water system is 96,000 W, calculate:

(b) The temperature exiting in the hot fluid in ^{0}C

(5 marks)

(c) Whether the exchanger operate <u>parallel</u> flow or <u>counter</u> flow? (Please show the temperature profile figure)

(4 marks)

(d) The Log Mean Temperature Different, ΔLMTD in ^{0}C

(5 marks)

QUESTION 6

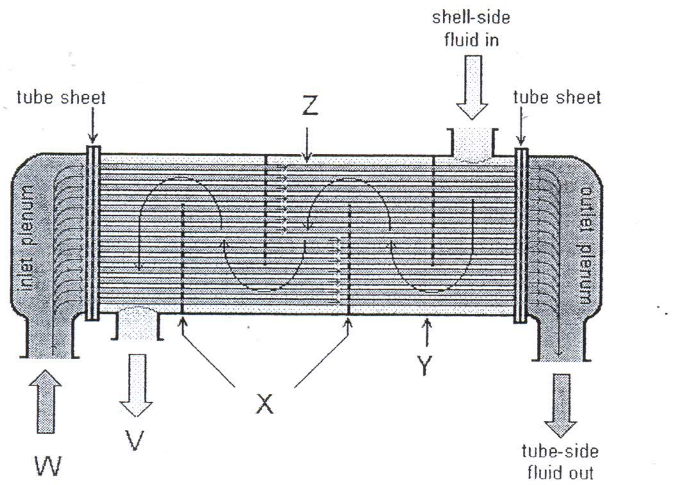

Figure Q6a: Major components of a Shell-And-Tube heat exchanger

(a) Referring to figure Q6, name the components labeled under V, W, X, Y & Z.

(5 marks)

Below is a parallel flow heat exchanger water and water in transmission surface of mild steel specification:

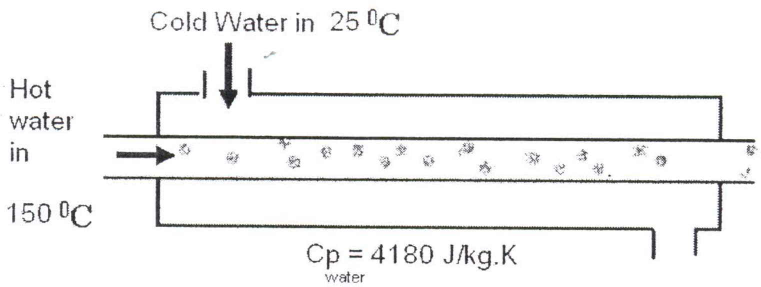

Figure Q6b: Basic Shell-And-Tube heat exchanger

Cold flow enters at 25 ^{0}C; mass flow rate, m = 2 kg/s

Hot flow enters at 150 ^{0}C; mass flow rate, m = 8 kg/s

Area, A = 45 m^2, Overall heat transfer coefficient, U: 464.4 W/m^2.K

Calculate:-

(b) The Capacitance rate of C_{max} and C_{min}?

(2 marks)

(c) Value of NTU method

(3 marks)

(d) The number of capacitance ratio, C_r?

(3 marks)

(e) Sketch in Appendix 1 (To be returned), the value of heat exchanger effectiveness?

(3 marks)

(f) The rate of heat exchanger by NTU Method, in kW

(4 marks)

END OF QUESTION

APPENDIX 1 (TO BE RETURNED)

The effectiveness of parallel and counter-flow heat exchangers from CHART

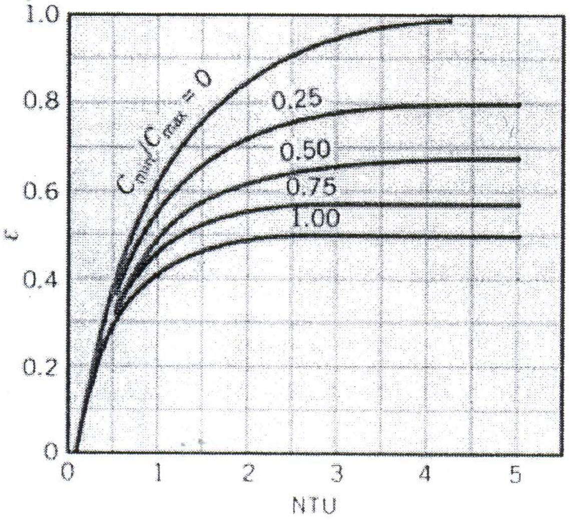

FIGURE 11.14 Effectiveness of a parallel-flow heat exchanger

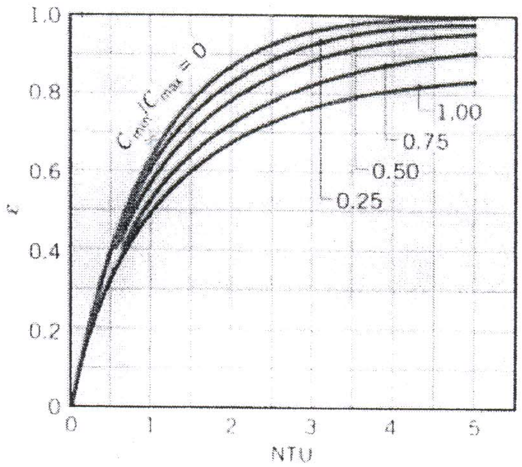

FIGURE 11.15 Effectiveness of a counterflow heat exchanger

APPENDIX 2

1. Heat Flux

$$\dot{q} \equiv \frac{\dot{Q}}{A}.$$

Where, q = heat Flux, (W/m. or BTU/hr.ft.)

Q = Heat flow rate (Watt or BTU/hr)

A = Area to the direction of heat flow (m^2 or ft^2)

2. Fourier Law's

$$\dot{Q} = kA\frac{T_1 - T_2}{L} \rightarrow k = \frac{\dot{Q}/A}{L(T_1 - T_2)}$$

Where

Q = Heat flow rate in x- direction, unit in watt, Btu/hr

k = the thermal conductivity, unit in W/m.K, BTU/hr.ft.F

A = the area normal to the direction of heat flow, in unit m^2, ft^2

dT = different temperature (T_{low} - T_{high}), unit ^0C, ^0F

dx = thickness distance in the direction of heat flow. unit m^2, ft^2

3. Log Mean Different Temperature, ΔLMTD

$$\Delta T_{lm} = \frac{(\Delta T_2 - \Delta T_1)}{\ln(\Delta T_2/\Delta T_1)} \qquad (2\text{-}2)$$

where:

ΔT_2 = the larger temperature difference between the two fluid streams at either the entrance or the exit to the heat exchanger

ΔT_1 = the smaller temperature difference between the two fluid streams at either the entrance or the exit to the heat exchanger

$$Q = U \cdot A \cdot \Delta T_{LMTD}$$

where

Q = heat transfer rate (W)

U = overall heat transfer coefficient ($W/m^2.K$) @ Correction Factor, F

A = area (m^2)

$\Delta LMTD$ = log mean temperature difference (K)

4. NEWTON Law's

$$P = \frac{dQ}{dt} = hA\,(T - T_0)$$

$P = dQ/dt$ is rate at which heat is transferred in watt / Btu/hr

h = convection heat-transfer coefficient $W/m^2.C$ / (Btu/hr-ft2-°F)

A = exposed surface area m^2 / ft^2

T = temperature of the immersed object (surface) ^0C

T_0 = temperature of the fluid sufficiently far from the surface ^0C

5. Stefan Boltzman Law's

$$\dot{Q} = \sigma A T^4$$

and

$$q = \varepsilon \sigma A \left(T_s^4 - T_\infty^4\right)$$

Where:

Q = heat transfer, Btu/hr or Kw

σ = *Stefan-Boltzman constant*

0.1714 x 10-8 Btu/hr-ft2.R^4 *and* = 5.676 x 10-8 W/m2.K^4

ε = Emissivity

A = Area surface, m^2 or ft^2

$T^4 = (T_1 - T_2)$, T_1 = Temperature of the first body, K or ^0R

T_2 = Temperature of second body, K or ^0R

6. Heat transmission, Q = A. U. (T_{out} - T_{in})

Where, A = Area of the wall surface, m^2 or ft^2
U = U-Value, W/m^2.C or BTu/(hr•°F• ft2)
T_{out} = Temperature out, °C or °F
T = Temperature in, °C or °F

7. U-Value factor

$$U = \frac{1}{\text{Total Thermal Resistance}}$$

$$U = \frac{1}{\sum R}$$

where,

$$\sum R = R_o + R + R_i$$

$$= \frac{1}{h_o} + \frac{\Delta x}{K} + \frac{1}{h_i}$$

8. Number of transfer unit (NTU)

$$NTU \equiv \frac{UA}{C_{min}}$$

where, NTU = number of transfer unit in dimensionless parameter

U = Overall heat Transfer Coefficient

A = Area surface

C_{min} = depending the value of C_h and C_c . $C = mC_p$

$$q = \varepsilon C_{min}\left(T_{h,i} - T_{c,i}\right)$$

where Q = the rate transfer by NTU method

ε = effectiveness

C_{min} = Heat capacity rate.

$T_{h,I}$ = temperature hotter inlet

$T_{c,I}$ = Temperature cooler inlet