



UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JANUARY 2011 SESSION

SUBJECT CODE	:	FRD 20303
SUBJECT TITLE	:	HEAT TRANSFER & HEAT EXCHANGER
LEVEL	:	DIPLOMA
TIME / DURATION	:	9.00 am – 12.00 noon (3 HOURS)
DATE	:	08 MAY 2011

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. Formulae is appended.
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THERE ARE 10 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. The higher thermal conductivity between copper and wood is copper. Why?

(3 marks)

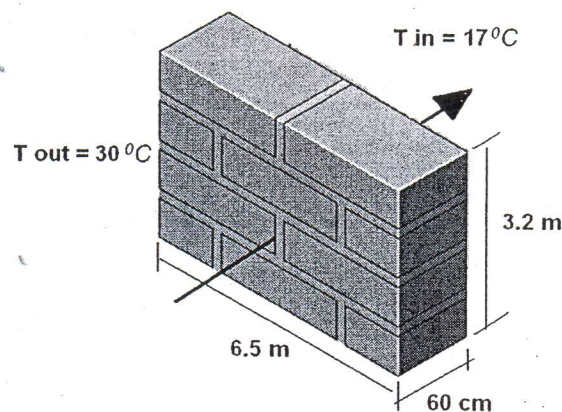


Figure Q1: Brick Wall

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 6.5 m x 3.2 m and 60 cm thickness brick wall. Given the thermal conductivity for brick wall is $0.7 \text{ W/m}\cdot^{\circ}\text{C}$. Calculate:-

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

(6 marks)

(c) The amount of heat transfer (kWh) where the period of the transfer is 12 hours

(3 marks)

(d) The rate of heat transfer (kW) if the brick wall thickness increases to 900 mm. What is your conclusion between answer (b) and (d)?

(6 marks)

Question 2

- (a) What are the fundamental similarity between conduction and convection? (2 marks)
- (b) Heat transfer by convection involves of 2 (Two) types of convection,
- What are the 2 (Two) types of convection? (2 marks)
 - Sketch a figure to show the 2 (Two) types of convection. (4 marks)

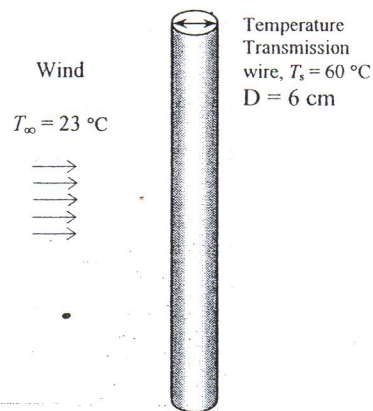


Figure Q2: Heat transfer by Convection

Referring to figure Q2, The wind is blowing over a 6 cm diameter transmission wire with a wind temperature of 23°C . The length of wire is 300 cm and the convective heat transfer coefficient is $120 \text{ W/m}^2\text{C}$. The surface temperature of the wire is 60°C . Calculate:-

- (c) The rate of heat transfer at the wire due to by convection in kW (6 marks)
- (d) The amount of heat transfer (kJ) in 12 hours if the convective heat transfer coefficient increases to $200 \text{ W/m}^2\text{C}$ and the wind temperature decreases to 18°C . (6 marks)

QUESTION 3

(a) Thermal radiation defined as *portion of the electromagnetic spectrum length*.

i. Write 2 (Two) types of waves length for radiation.

(2 marks)

ii. Give 1 (one) example for each types in question (a) i.

(2 marks)

(b) Describe 3 (Three) of the striking radiation onto a solid surface. Please sketch the striking radiation onto a solid surface.

(6 marks)

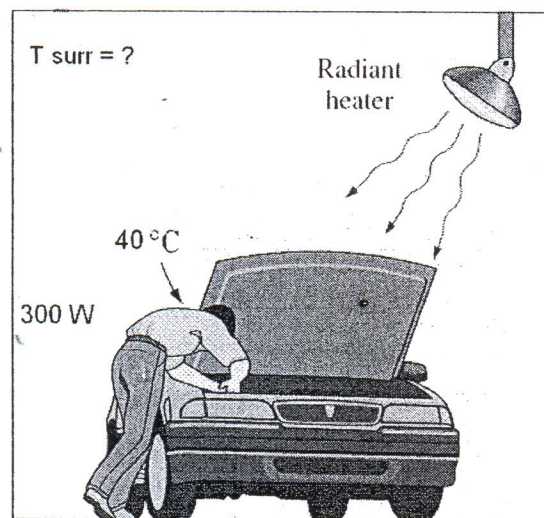


Figure Q3: Radiant heater emitted to the Surrounding

Referring to figure Q3, the radiation from the heaters incident on the person is 300 w. The emissivity of mechanic can be taken to be 0.95 and consider the surface area to be 1.8 m^2 . The temperature surface is 40°C and is the surrounding temperature does not exceed 40°C . Given that Stefan Boltzman coefficient is $5.676 \times 10^{-8} \text{ W/m}^2.\text{K}^4$, Calculate:-

(c) The surrounding temperature in Celsius

(6 marks)

(d) The rate of heat transfer by radiation in w, if the person is "black body" and assuming the surrounding temperature is 17°C

(4 marks)

SECTION B (Total: 40 marks)

INSTRUCTION: Answer only TWO questions.

Please use the answer booklet provided.

QUESTION 4

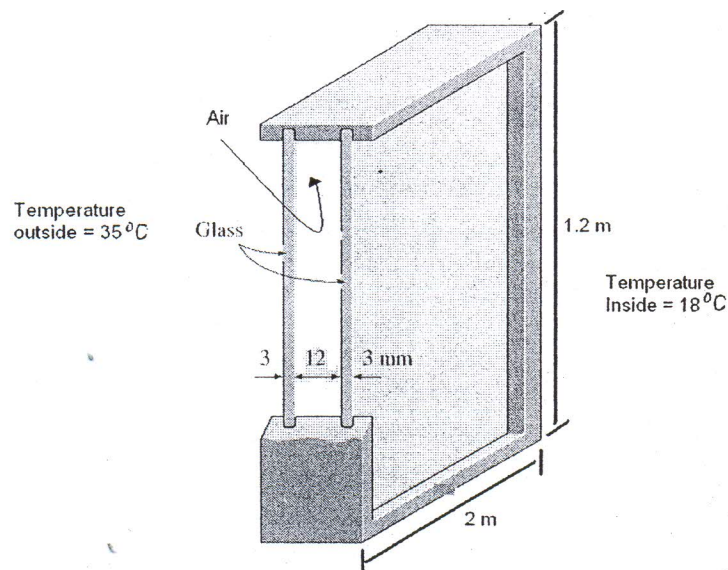


Figure Q4: Double Pane Windows.

Referring to figure Q4, 1.2 m high and 2 m wide double pane windows consisting of two layer of glass each having a thickness glass is 3 mm separated by a 12 mm wide stagnant air space. The thermal conductivity of the glass and air are given to be $k_{\text{glass}} = 0.98 \text{ W/m}\cdot^{\circ}\text{C}$ and $k_{\text{air}} = 0.026 \text{ W/m}\cdot^{\circ}\text{C}$. The outside and inside temperature is 35 °C and 18 °C respectively. Take the convective heat transfer coefficient on the inner and the outer surfaces to be $h_{\text{in}} = 10 \text{ W/m}^2\text{C}$ and $h_{\text{out}} = 25 \text{ W/m}^2\text{C}$. Calculate:-

- The Total Thermal resistance through the windows, in $\text{m}^2\text{C/W}$ (6 marks)
- The U-value coefficient, in $\text{W/m}^2\cdot\text{C}$ (4 marks)
- The heat transmission loss through the Pane windows in W (5 marks)
- The U-value coefficient ($\text{W/m}^2\cdot\text{C}$) if the glass thickness increases to 12mm. (5 marks)

QUESTION 5

- (a) Sketch the temperature profile across the two tubes for:-
- Counter Flow heat exchanger operation and,
 - Parallel Flow heat exchanger operation

(6 marks)

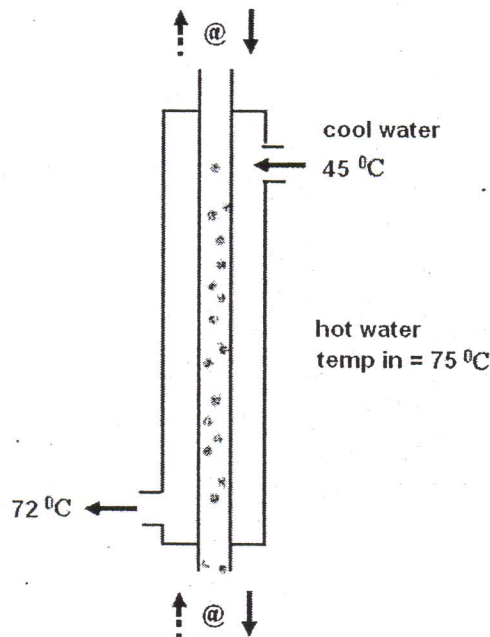


Figure Q5: Heat Exchanger

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

- (b) The temperature exiting in the hot fluid in $^\circ\text{C}$

(5 marks)

- (c) Whether the exchanger operate parallel flow or counter flow? (Please show the temperature profile figure)

(4 marks)

- (d) The Log Mean Temperature Different, ΔLMTD in Kelvin

(5 marks)

QUESTION 6

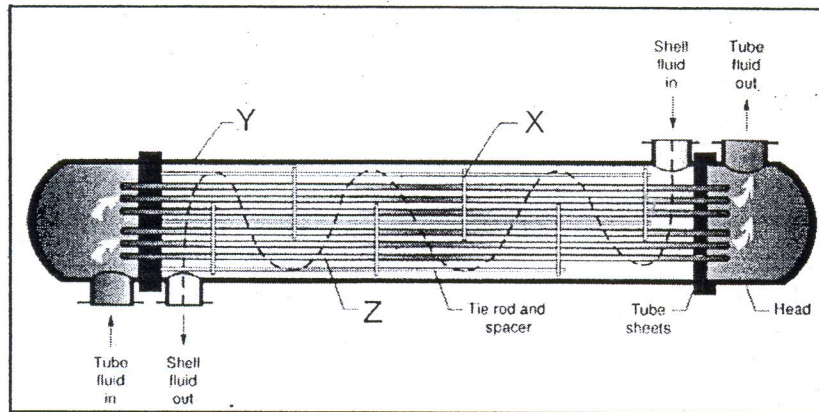


Figure Q6a: Major component of a Shell-And-Tube heat exchanger

- (a) Referring figure 6, name the components labeled under X, Y & Z. What is the function of component X?

(5 marks)

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

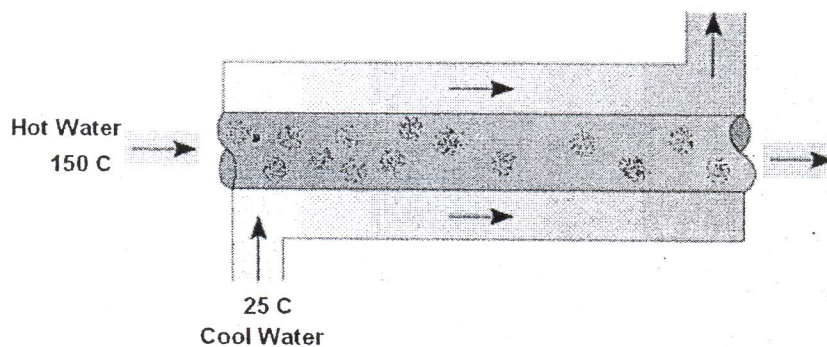


Figure Q6b: Basic Shell-And-Tube heat exchanger

Cold flow enters at 25 °C; mass flow rate, $m = 2.0 \text{ kg/s}$

Hot flow enters at 150 °C; mass flow rate, $m = 8.0 \text{ kg/s}$

Heat Exchanges Surface Area, $A = 45.0 \text{ m}^2$,

Overall heat transfer coefficient, $U: 464.4 \text{ W/m}^2.\text{K}$

Calculate:-

- (b) The Capacitance rate of C_{\max} and C_{\min} ?
(4 marks)
- (c) The 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?
(2 marks)
- (f) The rate of heat exchanger by NTU Method, in kW
(3 marks)

END OF QUESTION

APPENDIX 1 (TO BE RETURNED)

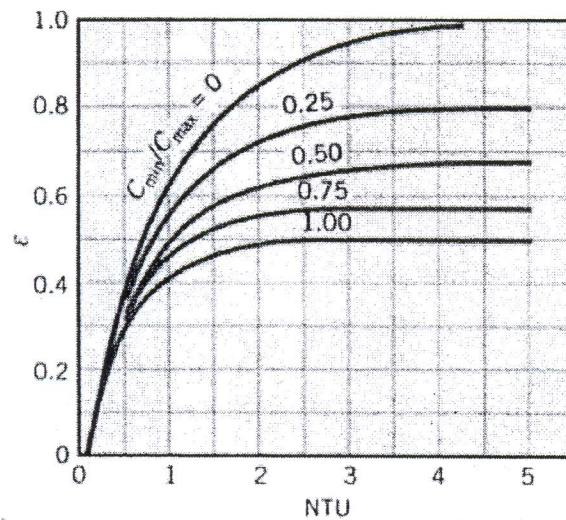
The effectiveness of parallel and counter-flow heat exchangers from CHART

FIGURE 11.14 Effectiveness of a parallel-flow heat exchanger

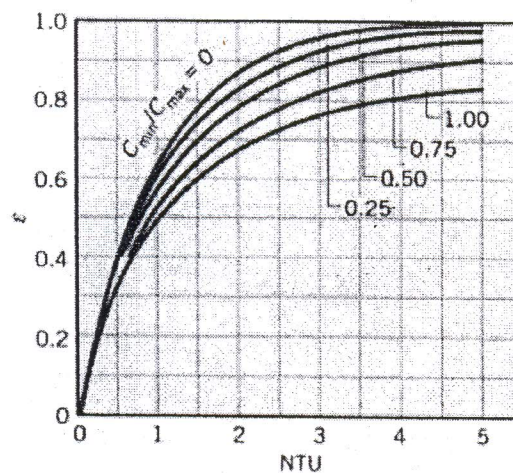


FIGURE 11.15 Effectiveness of a counterflow heat exchanger

APPENDIX 2

1. Fourier Law's

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

Where

\dot{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 $^{\circ}C$, $^{\circ}F$

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

2. Log Mean Different Temperature, $\Delta LMTD$

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

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

3. 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-ft 2 - $^{\circ}F$)

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

T = temperature of the immersed object (surface) $^{\circ}C$

T_0 = temperature of the fluid sufficiently far from the surface $^{\circ}C$

4. Stefan Boltzman Law's

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

and

$$q = \epsilon \sigma A (T_s^4 - T_{\infty}^4)$$

Where:

\dot{Q} = heat transfer, Btu/hr or Kw

σ = Stefan-Boltzman constant

$$0.1714 \times 10^{-8} \text{ Btu/hr-ft}^2.R^4 \quad \text{and} = 5.676 \times 10^{-8} \text{ W/m}^2.K^4$$

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 $^{\circ}R$

T_2 = Temperature of second body, K or $^{\circ}R$

5. Heat transmission, $Q = A \cdot U \cdot (T_{out} - T_{in})$

Where, A = Area of the wall surface, m^2 or ft^2
 U = U-Value, $W/m^2 \cdot C$ or $BTU/(hr \cdot ^\circ F \cdot ft^2)$
 T_{out} = Temperature out, $^\circ C$ or $^\circ F$
 T = Temperature in, $^\circ C$ or $^\circ F$

6. U-Value factor

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

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

where,

$$\sum R = R_1 + R_2 + R_3 + \dots + R_n$$

Thermal Resistance Formula =

$$\text{Convective heat transfer surface} = \frac{1}{h_o} \text{ and } \frac{1}{h_i}$$

$$\text{Thermal conductivity} = \frac{\Delta x}{k}$$

$$\text{Thermal Conductance} = \frac{1}{C}$$

7. 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 , $C = mC_p$

8. The rate of heat Exchanger:-

By LMTD method

By NTU method

$$Q = U \cdot A \cdot \Delta T_{LMTD} \quad \dots \dots \dots q = \epsilon C_{min} (T_{h,i} - T_{c,i})$$

where

Q = heat transfer rate (W)

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

A = area (m^2)

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

Where Q = the rate transfer by NTU method, w

ϵ = effectiveness

C_{min} = Heat capacity rate, w/K

$T_{h,i}$ = temperature hotter inlet, K

$T_{c,i}$ = Temperature cooler inlet, K