UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2012/2013

COURSE NAME	:	HEAT TRANSFER
COURSE CODE	:	BDA 3063 / BDA 30603
PROGRAMME	:	3 BDD / 4 BDD
EXAMINATION DATE	:	JUNE 2013
DURATION	:	3 HOURS

INSTRUCTIONS:

1. ANSWER ONLY **FIVE (5)** QUESTIONS FROM **SEVEN (7)** QUESTIONS
2. SYMBOLS HAVE COMMON DEFINITION UNLESS STATED OTHERWISE
3. STATE RELEVANT ASSUMPTIONS WHERE NECESSARY

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) List 3 types of fin by the aid of illustration.

(5 marks)

(b) A hot surface at 100°C is to be cooled by attaching 3cm long, 0.25cm diameter aluminum pin fins (k =237 W/m · °C) to it, with a center-to-center distance of 0.6 cm as in **Figure Q1 (b)**. The temperature of the surrounding medium is 30°C, and the heat transfer coefficient on the surfaces is 35 W/m^2 · °C.

Determine for a 1m x 1m section of the plate;

(i) the efficiency of the fins,

(ii) the heat transfer from unfinned base,

(iii) the total heat transfer with fins attached to the plate,

(iv) the fin effectiveness.

(15 marks)

Q2 (a) Explain combination criteria for a fin Biot number; $\frac{hLc}{k}$

(6 marks)

(b) Carbon steel balls (ρ = 7833 kg/m^3, k = 54 W/m. K, C_p = 0.465 kJ/kg. °C, and α = 1.474 × 10^{-6} m^2/s) 8 mm in diameter are annealed by heating them first to 900°C in a furnace and then allowing them to cool slowly to 100°C in ambient air at 35°C as in **Figure Q2 (b)**. The average heat transfer coefficient is 75 W/m^2. K, Determine;

(i) how long the annealing process will take?

(ii) the total rate of heat transfer from balls to the ambient if 2500 balls are to be annealed per hour.

(14 marks)

Q3 (a) Most of the engineering systems today that involves fluid flow are streamlined to reduce the drag coefficient. Explain briefly whether the streamlining will affect the heat transfer if the overall surface area before and after streamlining remains the same.

(5 marks)

(b) An electrical cable with an ellipse cross-section is exposed to gentle wind, blowing at 10 km/h at 10°C as in **Figure Q3 (b)**. Electrical current of 50 A is flowing in the cable which has a resistance of 0.002 Ω. Determine the surface temperature of the wire if it is 1 m long.

(15 marks)

Q4 (a) Imagine a hot copper ball suspended in a spacecraft filled with stagnant air. If the spacecraft lands on the moon, will the copper ball cools faster or slower in comparison on landing on the surface of earth? Discuss briefly.

(5 marks)

(b) Consider a square thin plate, with 1 m edge in a room at 27 °C. One side of the plate is at 93 °C while the other side is insulated. Proof that the natural convection heat transfer is more when the plate is placed vertically rather than horizontally with the hot surface facing upwards as shown in **Figure Q4 (b)**.

(15 marks)

Q5 (a) What are the common approximations made to simplify the analysis of heat exchangers? List three (3) of them.

(6 marks)

(b) A 2-shell passes and 8-tube passes heat exchanger is used to heat glycerin (C_p = 2480 J/kg . °C) in the shell with hot water in the tubes. The glycerin enters the shell at 20°C and leaves at 55°C. The water enters the tubes at 90°C at mass flow rate of 5 kg/s and leaves at 60°C. The tubes are thin-walled 1.5 cm diameter and the total length of the tubes in the heat exchanger is 40 m. Determine;

(i) the mass flow rate of the glycerin,

(ii) the correction factor, F, and

(iii) the overall heat transfer coefficient of the heat exchanger.

(14 marks)

Q6 (a) Can the temperature of the hot fluid drop below the inlet temperature of the cold fluid at any location in the heat exchanger? Explain.

(5 marks)

(b) Cold water (C_p = 4180 J/kg .K) enters the tubes of a heat exchanger with 2-shell passes and 20-tube passes at 14°C at a rate of 3 kg/s, while hot oil (C_p = 2200 J/kg .K) enters the shell at 200°C at same mass flow rate. The overall heat transfer coefficient based on the outer surface area of the tube is 300 W/m^2 .K and the heat transfer surface area on that side is 20 m^2. Determine the rate of heat transfer using the ε - NTU method.

(15 marks)

Q7 (a) State when will the view factor from a surface to itself is equal to zero ($F_{i-i} = 0$) and not equal to zero ($F_{i-i} \neq 0$).

(3 marks)

(b) Calculate the view factor F_{12} between the rectangular surfaces as in **Figure Q7 (b)**.

(12 marks)

(c) This experiment is conducted to determine the emissivity of a certain material. A long cylindrical rod of diameter $D_1 = 0.01$ m is coated with this new material and is placed in an evacuated long cylindrical enclosure of diameter $D_2 = 0.1$ m and emissivity, $\varepsilon_2 = 0.95$, which is cooled externally and maintained at a temperature of 200 K at all times. The rod is heated by passing electric current through it. When steady operating conditions are reached, it is observed that the rod is dissipating electric power at rate of 12 W per unit of its length and its surface temperature of 600 K. Based on these measurements, determine the emissivity of the coating on the rod.

(5 marks)

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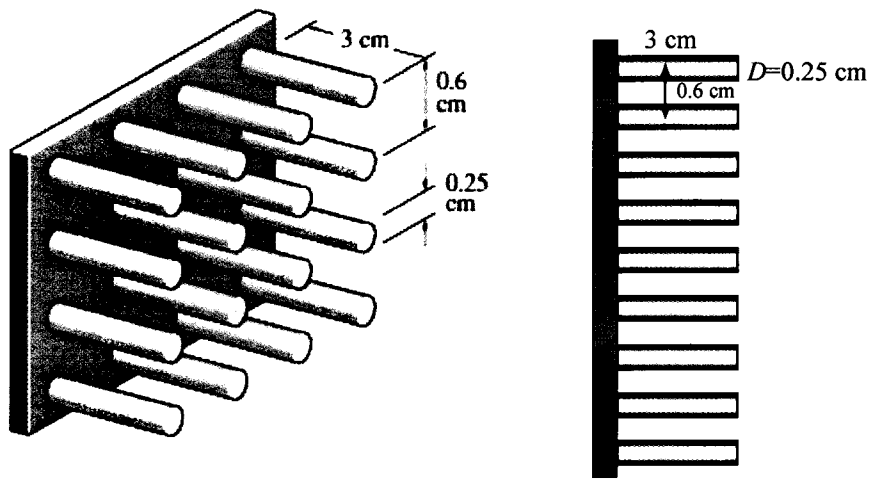

FIGURE Q1 (b)

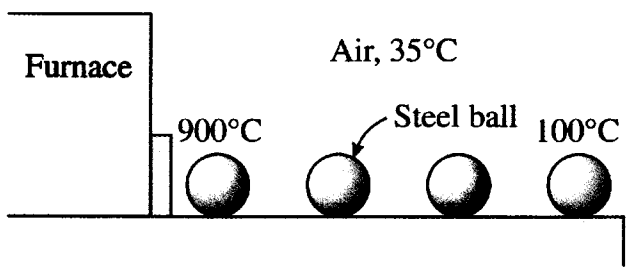

FIGURE Q2 (b)

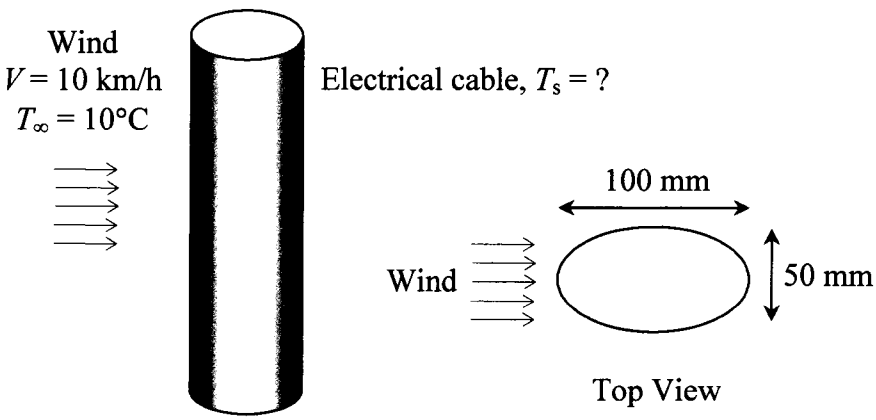

FIGURE Q3 (b)

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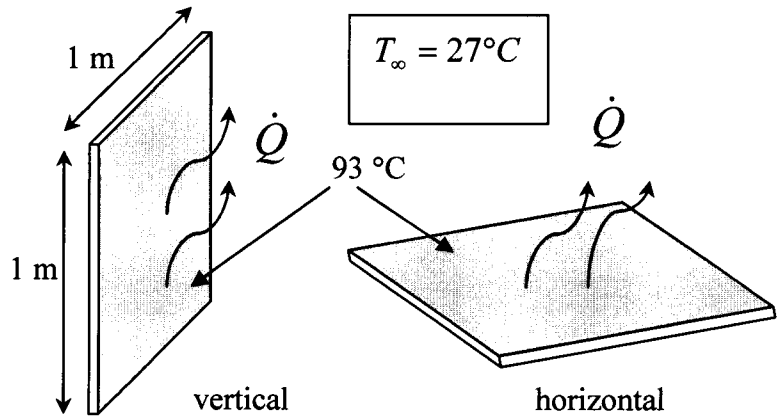

FIGURE Q4 (b)

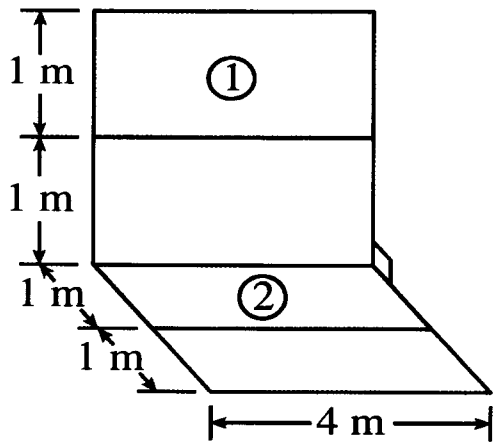

FIGURE Q7 (b)

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