UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

SUBJECT	:	HEAT TRANSFER
CODE	:	BDA 3063
PROGRAMME	:	3 BDD
EXAMINATION DATE	:	APRIL / MEI 2011
DURATION	:	2 ½ HOURS

INSTRUCTIONS:

1. ANSWER ONLY **FOUR (4)** QUESTIONS FROM **SIX (6)** QUESTIONS
2. SYMBOLS HAVE COMMON DEFINITION UNLESS STATED OTHERWISE
3. STATE RELEVANT ASSUMPTIONS WHERE NECESSARY

THIS QUESTION PAPER CONTAINS **SIX (6)** PAGES

Q1 (a) Consider a stainless steel spoon (k = 15.1 W/m.°C) partially immersed in boiling water at 95°C in a kitchen at 25°C, as shown in **Figure Q1 (a)**. The handle of the spoon has a cross section of 0.2 cm × 1.3 cm, and extends 18 cm in the air from the free surface of the water. If the heat transfer coefficient at the exposed surfaces of the spoon handle is 17 W/m^2.°C, determine the temperature difference across the exposed surface of the spoon handle.

(13 marks)

(b) Stainless steel ball bearings (ρ = 8085 kg/m3, k = 15.1 W/m · °C and C_p = 480 J/ kg · °C) having a diameter of 1.2 cm are to be quenched in water. The balls leave the oven at a uniform temperature of 900°C and are exposed to air at 30 °C for a while before they are dropped into the water. If the temperature of the balls is not to fall below 850°C prior to quenching and the heat transfer coefficient in the air is 125 W/m^2 · °C, determine how long they can stand in the air before being dropped into the water.

(12 marks)

Q2 (a) Engine oil flows at a rate of 5 kg/s through a 3 cm diameter smooth tube. The oil enters at 90 °C and is heated to 150 °C as it flows through the tube. If a constant heat flux is maintained along the tube and the tube wall is at a temperature of 20 °C higher than the engine oil, calculate the length of tube required to affect the heat transfer. Take the properties of engine oil at average bulk temperature.

(15 marks)

(b) Consider a 5 m x 5 m thin plate suspended vertically in quiescent air at 30°C, with both of its surfaces are at 90°C. Determine the total heat transfer from the plate as a result of natural convection.

(10 marks)

Q3 (a) Counter flow arrangements are preferred compared to parallel flow heat exhangers due to its higher heat duty for a given heat exchange area. However, in certain cases, parallel flow is used. By giving a relevant example, explain why counter flow heat heat exchangers are NOT always advantageous to parallel flow.

(6 marks)

(b) A double-pipe counter-flow heat exchanger is to cool ethylene glycol (C_p = 2560 J/kg · °C) flowing at a rate of 3.5 kg/s from 80 °C to 40 °C by water (C_p = 4180 J/kg ·°C) that enters at 20 °C and leaves at 55 °C. The overall heat transfer coefficient based on the inner surface area of the tube is 250 W/m^2 ·°C. If the inner tube is thin-walled with a diameter of 10 cm, determine:

(i) the rate of heat transfer;

(ii) the mass flow rate of water;

(iii) the heat transfer surface area on the inner side of the tube; and

(iv) the length of tube.

(19 marks)

Q4 (a) Under what conditions is the ε–NTU method definitely preferred over the LMTD method in heat exchanger analysis?

(4 marks)

(b) Hot oil (C_p = 2200 J/kg · °C) is to be cooled by water (C_p = 4180 J/kg · °C) in a two shell passes and 12 tube-passes heat exchanger. The tubes are thin-walled and are made of copper with a diameter of 1.8 cm. The length of each tube pass in the heat exchanger is 3 m, and the overall heat transfer coefficient is 340 W/m^2 · °C. Water flows through the tubes at a total rate of 0.1 kg/s, and the oil through the shell at a rate of 0.2 kg/s. The water and the oil enter at temperatures 18°C and 160°C, respectively. Calculate the rate of heat transfer in the heat exchanger and the outlet temperatures of the water and the oil.

(21 marks)

Q5 (a) Consider an enclosure consisting of 5 surfaces.

(i) Calculate how many view factors does this geometry involve.

(ii) How many of these view factors can be determined by the application of the reciprocity and the summation rules?

(8 marks)

(b) Two parallel disks of diameter $D = 0.6$ m separated by $L = 0.4$ m are located directly on top of each other, as shown in **Figure Q5 (b)**. Both disks are black and are maintained at a temperature of 700 K. The back sides of the disks are insulated, and the environment that the disks are in can be considered to be a blackbody at $T_3 = 300$ K. Determine the net rate of radiation heat transfer from the disks to the environment.

(17 marks)

Q6 (a) Explain with appropriate examples the idealizations made in the analysis of radiation heat transfer below:

(i) gray bodies; and

(ii) diffuse bodies

(6 marks)

(b) **Figure Q6 (b)** shows part of a two storey office building aligned perpendicular to a car park. Each floor is 4 m high and 20 m wide. The car park is 10 m in depth is made of asphalt with emissivity of 0.95. If the surface temperature of the car park is at 70°C, determine:

(i) the radiation from the car park incident on the wall surface of the ground floor;

(ii) the radiation from the car park incident on the wall surface of the building's top floor; and

(iii) difference of the amount of heat radiating from the car park to the top and ground floor.

(19 marks)

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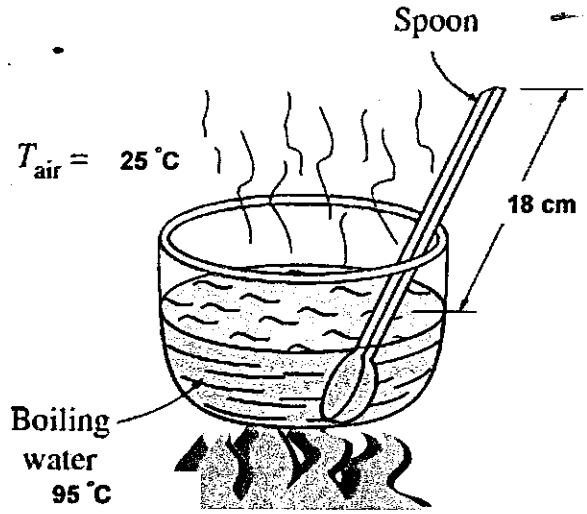

Figure Q1 (a)

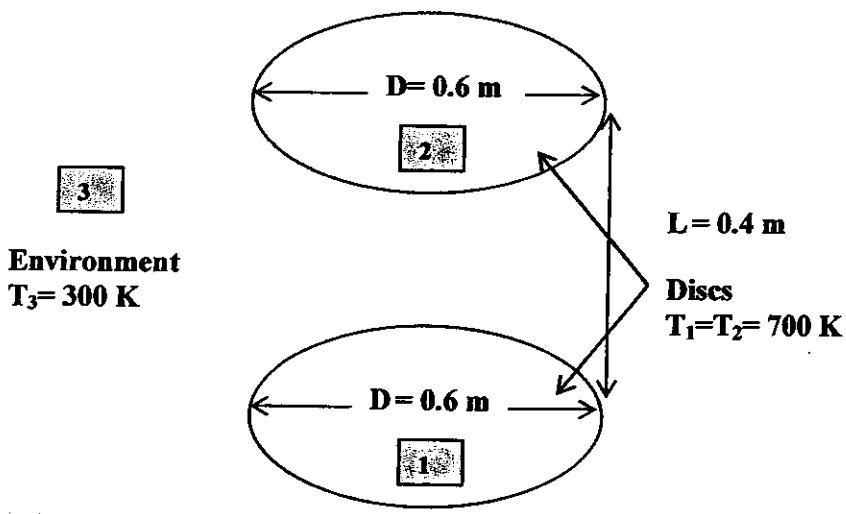

Figure Q5 (b)

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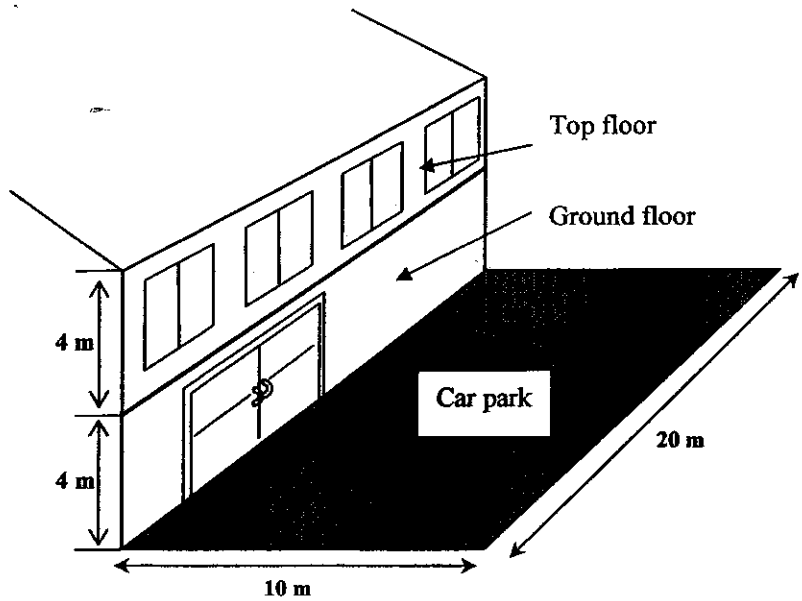

Figure Q6 (b)