UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2011/2012

COURSE NAME	:	HEAT TRANSFER
COURSE CODE	:	BDA 3063
PROGRAMME	:	3 BDD
EXAMINATION DATE	:	JANUARY 2012
DURATION	:	3 HOURS

INSTRUCTIONS:

:

1. ANSWER ONLY **FIVE (5)** 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 fully developed laminar flow in a circular pipe. If the viscosity of the fluid is reduced by half while flow rate is held constant, how will the pressure drop change?

(5 marks)

(b) Water is to be heated from 10°C to 80°C as flows through a 20 mm internal diameter, 13 m long tube. The tube is equipped with an electric resistance heater, which provides uniform heating throughout the surface of the tube. The outer surface of the heater is well insulated so that during steady operation, all generated heat will be transferred to the water. If the flow rate of the water is 5 L/min, determine the power rating of the heater and inner surface temperature of the pipe at the exit.

(15 marks)

Q2 (a) A hot boiled egg is suspended in a spacecraft that is filled with air at atmospheric pressure and temperature. Will the egg cool faster or slower when the spacecraft is in space instead of on the ground? Explain based on natural convection.

(5 marks)

(b) Consider a cylinder with a length of 15 cm and a diameter of 10 cm. The cylinder has a surface temperature of 43°C, while the room air temperature is 17°C. Based on natural convection, determine whether placing the cylinder horizontally or vertically would achieve higher heat transfer rate.

(15 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.

(5 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.

(15 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.

(16 marks)

Q5 (a) Determine the radiation view factors F_{12} and F_{21} for the geometries illustrated in **Figure Q5(a),(b),** and **(c)**.

(*View factor charts are available in the given heat transfer table*).

(10 marks)

(b) Two black parallel, coaxial discs, each of diameter 1 m, are separated by a distance of 0.25 m. The temperatures of the discs are T_1=20°C and T_2=60°C and the surroundings are at T_3=28°C. The rear surfaces of the discs are well insulated. Calculate the rate of radiative heat transfer to:-

(i) the cooler disc; and

(ii) the surroundings.

(*View factor charts are available in the given heat transfer table*).

(10 marks)

Q6 A graphite block has a cylindrical cavity 10 cm in diameter and serves as a crucible for laboratory experiments as in **Figure Q6**. It is heated from the bottom and the side walls are well insulated. The cavity is filled with melt at 600K to 5 cm below the opening. What will be the rate of heat loss from the melt by radiation if the surrounds are at 300K and all surface are approximated as being black.

(20 marks)

(*View factor charts are available in the given heat transfer table*).

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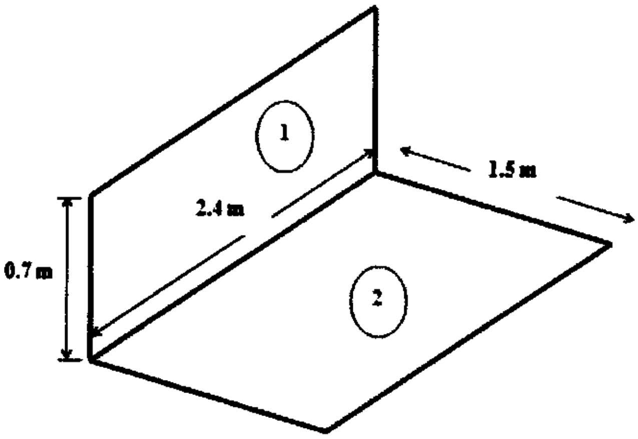

Figure Q5(a)

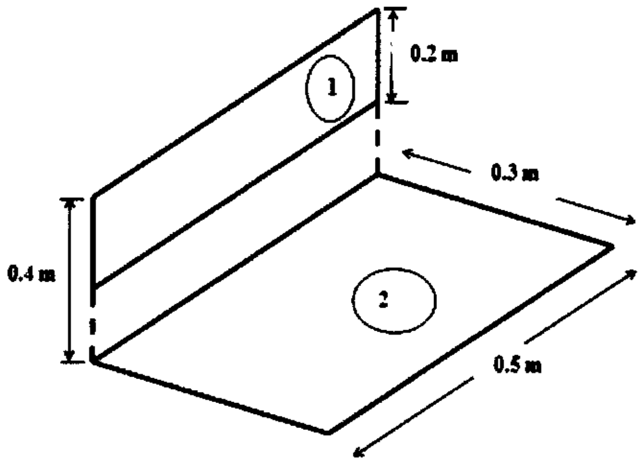

Figure Q5(b)

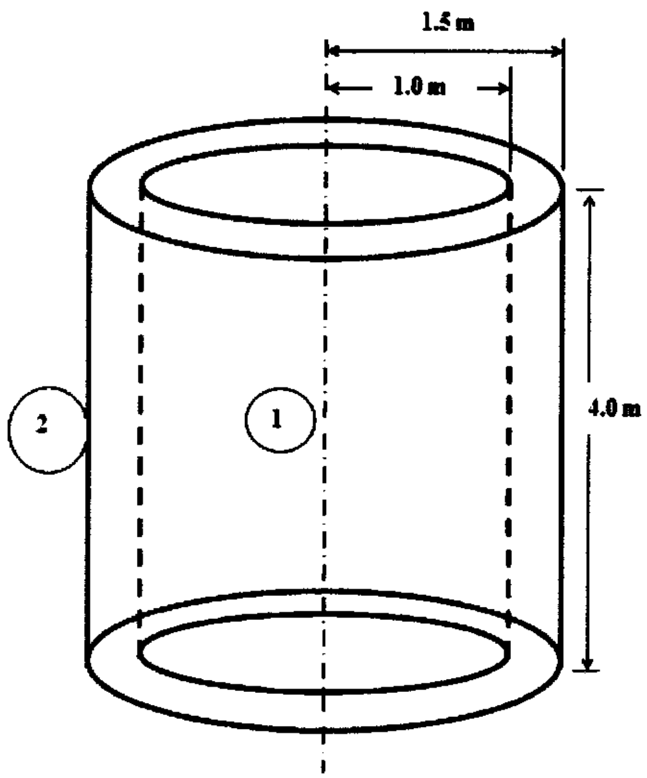

Figure Q5(c)

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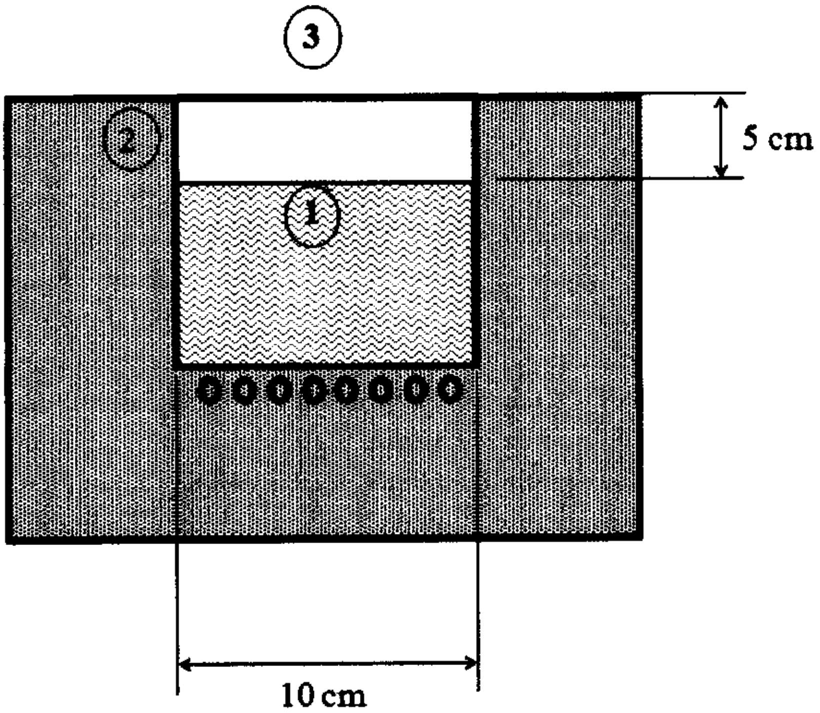

Figure Q6