Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2016/2017

COURSE NAME	:	HEAT TRANSFER
COURSE CODE	:	BDA 30603
PROGRAMME	:	BDD
EXAMINATION DATE	:	DECEMBER 2016/JANUARY 2017
DURATION	:	3 HOURS
INSTRUCTION	:	**ANSWER FIVE (5) FROM SEVEN (7) QUESTIONS**

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) What is the difference between fin effectiveness and fin efficiency?

(5 marks)

(b) **Figure Q1(b)** shows two 4 m long and 0.4 cm thick cast iron (k = 52 W/m.K) steam pipes of outer diamater 10 cm are connected to each other through two 1 cm thick flanges of outer diameter 18 cm. The steam flows inside the pipe at an average temperature of 200°C with a heat transfer coeffcient of 180 W/m^2.K. The outer surface of the pipe is exposed to an ambient at 12°C, with a heat transfer coefficent of 25 W/m^2.K, determine;

(i) the average outer surface temperature of the pipe by disregarding the flanges;

(9 marks)

(ii) the fin efficiency by treating the flanges as a fin, and temperature in **Q1(b)(i)** as the tempeature for the base of the flange; and

(3 marks)

(iii) the rate of heat transfer from the flanges.

(3 marks)

Q2 (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 heat generated 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)

Q3 (a) Nusselt number is a very important dimensionless parameter in heat transfer. Describe the physical interpretation of Nusselt number and differentiate between local and average Nusselt number.

(5 marks)

(b) Exhaust gases from a manufacturing plant are being discharged through a 10m tall exhaust stack with outer diameter of 0.7 m as shown in **Figure Q3(b)**. The exhaust gases are discharged at a rate of 1.2 kg/s, while temperature drop between inlet and exit of the exhaust stack is 30°C, and the constant pressure specific heat of the exhaust gases is 1600 J/kg·K. On

a particular day, wind at 27°C is blowing across the exhaust stack with a velocity of 3 m/s. Neglecting the radiative heat transfer and taking the air properties at 80°C, determine the exhaust stack outer surface average temperature.

(9 marks)

(c) The top management of the plant in **Figure Q3(b)** plan to replace the present cylindrical exhaust stack with square exhaust stack. As an engineer, you have been asked to evaluate the proposal. Discuss whether the proposal should be accepted or rejected and state your analysis for arguments.

(6 marks)

Q4 A door panel of a car with surface temperature of 25°C has a height of 0.3 m and a width of 0.6 m is 'oven-baked' and left to dry in a paint booth where the ambient air is at 55°C. A fan is installed to blow air parallel to the surface of the panel at a speed of 5 m/s. Calculate;

(i) the heat transfer rate between the panel surface and the surroundings without the fan;

(9 marks)

(ii) the total rate of heat transfer between the panel surface and the surroundings when the fan is turned on; and

(9 marks)

(iii) the percentage of heat transfer due to natural convection and determine whether natural convection is significant in this case.

(2 marks)

Q5 (a) What are the heat transfer mechanisms involved during heat transfer in a liquid-to-liquid heat exchanger from the hot to the cold fluid?

(4 marks)

(b) Consider the case shown in **Figure Q5(b)** between co-flow and counter-flow heat exchanger. For the same heat duty, which type of heat exchanger requires the least area?

(6 marks)

(c) A long thin-walled double-pipe heat exchanger with tube and shell diameters of 1.0 cm and 2.5 cm, respectively, is used to condense refrigerant-134a by water at 20°C. The refrigerant flows through the tube, with a convection heat transfer coefficient of h_i= 4100 W/m^2.K. Water flows through the shell at a rate of 0.3 kg/s. Determine the overall heat transfer coefficient of this heat exchanger.

(10 marks)

Q6 (a) What does the effectiveness of a heat exchanger represent? Can effectiveness be greater than one? On what factors does the effectiveness of a heat exchanger depend?

(6 marks)

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

(2 marks)

(c) Ethanol is vaporized at 78°C (h_{fg} = 846 kJ/kg) in a double-pipe parallel-flow heat exchanger at a rate of 0.03 kg/s by hot oil (C_p = 2200 J/kg.K) that enters at 115°C. If the heat transfer surface area and the overall heat transfer coefficients are 6.2 m^2 and 320 $W/m^2.K$, respectively, determine the outlet temperature and the mass flow rate of oil using the LMTD method and the ε-NTU method.

(12 marks)

Q7 (a) Determine the view factor F12 between the rectangular surfaces shown in **Figure Q7(a).**

(5 marks)

(b) A thin aluminum sheet with an emissivity, $\varepsilon = 0.15$ on both sides is placed between two very large parallel plates, which are maintained at uniform temperatures T_1 = 900 K and T_2 = 650 K and have emissivity, $\varepsilon_1 = 0.5$ and $\varepsilon_2 = 0.8$, respectively as shown in **Figure Q7(b)**. Determine the net rate of radiation heat transfer between the two plates per unit surface area of the plates and compare the result with and without the shield.

(15 marks)

- END OF QUESTION –

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2016/2017
COURSE : HEAT TRANSFER

PROGRAMME : BDD
COURSE CODE : BDA 30603

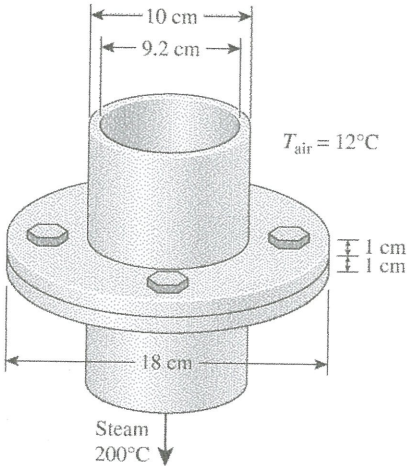

Figure Q1(b)

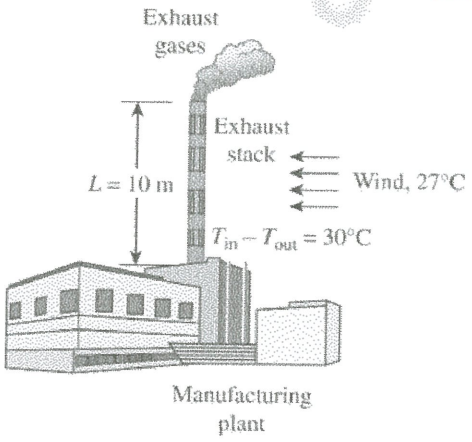

Figure Q3(b)

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2016/2017
COURSE : HEAT TRANSFER

PROGRAMME : BDD
COURSE CODE : BDA 30603

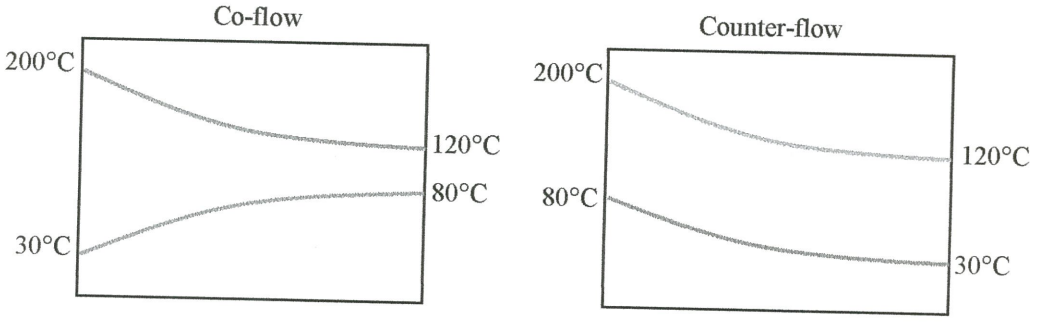

Figure Q5(b)

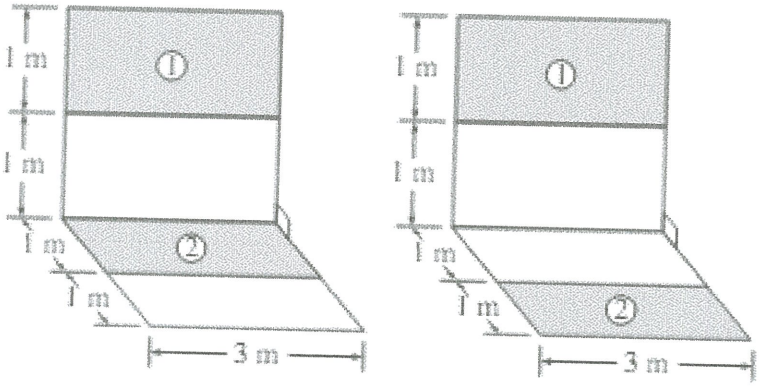

Figure Q7(a)

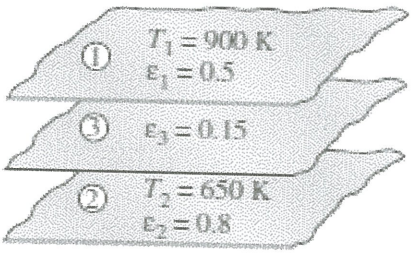

Figure Q7(b)