Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	HEAT TRANSFER
COURSE CODE	:	BNL 30703
PROGRAMME	:	3 BNL
EXAMINATION DATE	:	JUNE 2015/JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

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

Q1 (a) What is an infinitely long cylinder? When is it proper to treat an actual cylinder as being infinitely long, and when is it not?

(5 marks)

(b) A 12 m long and 5 m high wall is constructed of two layers of 1 cm thick sheetrock (k = 0.17 W/m·°C) spaced 12 cm by wood studs (k = 0.11 W/m·°C) whose cross section is 12 cm x 5 cm. The studs are placed vertically 60 cm apart, and the space between them is filled with fiberglass insulation (k = 0.034 W/m·°C). The house is maintained at 20°C and the ambient temperature outside is -5°C. Taking the heat transfer coefficients at the inner and outer surfaces of the house to be 8.3 and 34 W/m^2·°C, respectively, determine;

(i) the thermal resistance of the wall considering a representative section of it;
(ii) the rate of heat transfer through the wall.

(20 marks)

Q2 (a) What is the difference between the fin effectiveness and the fin efficiency?

(5 marks)

(b) Hot water is to be cooled as it flows through the tubes exposed to atmospheric air. Fins are to be attached in order to enhance heat transfer. Would you recommend attaching the fins inside or outside the tubes?

(3 marks)

(c) Steam in a heating system flows through tubes whose outer diameter is 5 cm and whose walls are maintained at a temperature of 180°C. Circular aluminum alloy 2024-T6 fins (k = 186 W/m·°C) of outer diameter 6 cm and constant thickness 1 mm are attached to the tube. The space between the fins is 3 mm, and thus there are 250 fins per meter length of the tube. Heat is transferred to the surrounding air at T_∞ = 25°C, with a heat transfer coefficient of 40 W/m^2·°C, as shown in **Figure Q2(c).** Determine the increase in heat transfer from the tube per meter of its length as a result of adding fins.

(17 marks)

Q3 (a) In which mode of heat transfer is the convection heat transfer coefficient usually higher, natural convection or forced convection? Give justification on your answer.

(5 marks)

(b) An average man has a body surface area of 1.8 m 2 and a skin temperature of 33°C. The convection heat transfer coefficient for a clothed person walking in still air is expressed as $h = 8.6v^{0.53}$ for $0.5 < v < 2$ m/s, where v is the walking velocity in m/s. Assuming the average surface temperature of the clothed person to be 30°C, determine the rate of heat loss from an average man walking in still air at 10°C by convection at a walking velocity of,

(i) 0.5 m/s;
(ii) 1.0 m/s;
(iii) 1.5 m/s;
(iv) 2.0 m/s.

(8 marks)

(c) During air cooling of potatoes, the heat transfer coefficient for combined convection, radiation, and evaporation is determined experimentally to be as shown in **Table Q3(c)**

Table Q3(c)

Air Velocity, m/s	Heat Transfer Coefficient, W/m^2 °C
0.66	14.0
1.00	19.1
1.36	20.2
1.73	24.4

Consider a 10 cm diameter potato initially at 20°C with a thermal conductivity of 0.49 W/m °C. Potatoes are cooled by refrigerated air at 5°C at a velocity of 1 m/s. Determine the initial rate of heat transfer from a potato, and the initial value of the temperature gradient in the potato at the surface.

(12 marks)

Q4 (a) Consider laminar flow of a fluid over a flat plate maintained at a constant temperature. Now the free-stream velocity of the fluid is doubled. Determine the change in the drag force on the plate and rate of heat transfer between the fluid and the plate. Assume the flow to remain laminar.

(10 marks)

(b) During a cold winter day, wind at 55 km/h is blowing parallel to a 4 m high and 10 m long wall of a house. If the air outside is at 5°C and the surface temperature of the wall is 12°C, determine the rate of heat loss from that wall by convection. The properties of air at 1 atm and the film temperature of 8.5°C are, $k = 0.02428$ W/m·°C, $v = 1.413 \times 10^{-5}$ m^2/s and $Pr. = 0.7340$.

(15 marks)

Q5 (a) Classify heat exchangers according to flow type and explain the characteristics of each type.

(5 marks)

(b) Steam in the condenser of a steam power plant is to be condensed at a temperature of 50°C (h_{fg} = 2305 kJ/kg) with cooling water (C_p = 4180 J/kg·°C) from a nearby lake, which enters the tubes of the condenser at 18°C and leaves at 27°C as in **Figure Q5(b)**. The surface area of the tubes is 58 m^2, and the overall heat transfer coefficient is 2400 W/m^2·°C. Determine the mass flow rate of the cooling water needed and the rate of condensation of the steam in the condenser.

(8 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 $h_i = 5000$ W/m^2·°C. Water flows through the shell at a rate of 0.3 kg/s. Determine the overall heat transfer coefficient of this heat exchanger. The properties water at 20°C are, $k = 0.598$ W/m·°C, $Pr. = 7.01$ and $v = 1.004 \times 10^{-6}$ m^2/s.

(12 marks)

- END OF QUESTION -

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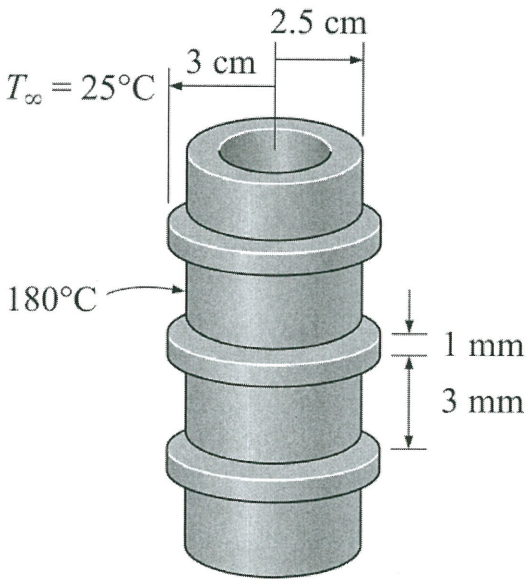

Figure Q2 (c)

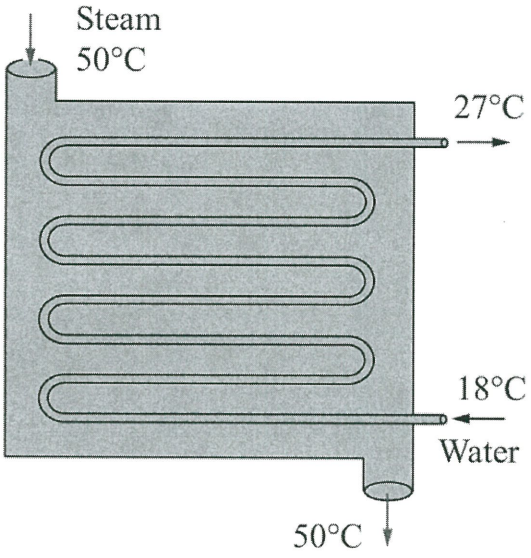

Figure Q5 (b)

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