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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2013/2014

COURSE NAME	:	HEAT TRANSFER
COURSE CODE	:	BNQ 20203
PROGRAMME	:	2 BNN
EXAMINATION DATE	:	DECEMBER 2013/JANUARY 2014
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

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

Q1 (a) Describe the transport analogy terms.

(5 marks)

(b) Define the Reynolds number and how is the Reynolds number related to laminar and turbulent flow?

(5 marks)

(c) Explain the term of radiation view factor.

(5 marks)

(d) Define briefly the Black and Gray Body terms.

(5 marks)

Q2 Steam saturated at 68.9 kPa is condensing on a vertical tube having an outside diameter of 0.0254 m and a surface temperature of 86.11 °C. Calculate the heat transfer coefficient for the 1.22 m tube by using the given information.

Given,

$T_{sat} = 89.44\ ^{o}C$
$T_w = 86.11\ ^{o}C$
$T_f = 87.8\ ^{o}C$
$h_{fg} = 2.283 \times 10^6$ J/kg
$\rho_l = 966.7$ kg/m^3
$\rho_v = 0$
$\mu_l = 3.24 \times 10^{-4}$ Pa.s
$k_l = 0.675$ W/m.K

(20 marks)

Q3 A 2 cm diameter, stainless steel ball (ρ=7865 kg/m^3, cp = 0.46 kJ/kg °C and k = 61 W/m °C) is uniformly heated to T_i = 800 °C. It is to be hardened by suddenly dropping it into an oil bath at T_∞=50 °C. The heat transfer coefficient between the surface of steel ball and the oil is h = 45 W/m^2. °C. If the hardening process completed when the temperature of steel ball reach 100 °C, solve the time needed for the ball to kept in the oil bath?

(20 marks)

Q4 Hot oil at a flow rate of 3 kg/s (cp = 1.92 kJ/kg.K) enters an existing counter flow exchanger at 400 K and is cooled by water entering at 325 K (under pressure) and flowing at a rate of 0.7 kg/s. The overall U = 350 W/m2.K and A = 12.9 m2.

(a) Calculate the heat transfer rate

(10 marks)

(b) Propose the exit oil temperature

(10 marks)

Q5 A horizontal oxidized steel pipe carrying steam and having an OD of 0.1683 m has a surface temperature of 374.9 K and is exposed to air at 297.1 K in a large enclosure.

(a) Calculate the convection and radiation heat transfer coefficient, h_r and h_c.

(10 marks)

(b) Calculate the heat loss for 0.305 m of pipe from natural convection plus radiation. For the steel pipe, use an ε of 0.79.

(10 marks)

- END OF QUESTION –

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Formula

1) Condensation

$$N_{Nu} = \frac{hL}{k_l} = 1.13\left[\frac{\rho_l(\rho_l - \rho_v)gh_{fg}L^3}{\mu_l k_l \Delta T}\right]^{\frac{1}{4}} \qquad \text{(Laminar)}$$

$$N_{Nu} = \frac{hL}{k_l} = 0.0077\left(\frac{g\rho_l^{2}L^3}{\mu_l^{2}}\right)^{\frac{1}{3}}(N_{\text{Re}})^{0.4} \qquad \text{(Turbulent)}$$

$$q = m'h_{fg} = Ah\,(T_{sat} - T_w)$$

$$N_{\text{Re}} = \frac{4\dot{m}}{\pi D\mu_l} = \frac{4\Gamma}{\mu_l} \qquad \text{(tube)}$$

$$N_{\text{Re}} = \frac{4\dot{m}}{W\mu_l} = \frac{4\Gamma}{\mu_l} \qquad \text{(plate)}$$

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2) Unsteady state heat transfer

$$N_{Bi} = \frac{hx_1}{k}$$

$$x_1 = \frac{V}{A} = \frac{r}{3}$$

$$\frac{(T - T_\infty)}{(T_o - T_\infty)} = e^{-(hA/c_p \rho V)t}$$

3) Radiation heat transfer

$$h_c = 1.32\left(\frac{\Delta T}{D}\right)^{1/4}$$

$$h_r = \varepsilon\sigma \frac{(T_1/100)^4 - (T_2/100)^4}{T_1 - T_2}$$

$$q = q_{conv} + q_{rad} = (h_c + h_r)A_1(T_1 - T_2)$$

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4) Heat Exchanger

$$\Delta T_{lm} = \frac{\Delta T_1 - \Delta T_2}{\ln\left(\dfrac{\Delta T_1}{\Delta T_2}\right)} = \frac{(T_{hi} - T_{co}) - (T_{ho} - T_{ci})}{\ln\left(\dfrac{T_{hi} - T_{co}}{T_{ho} - T_{ci}}\right)}$$

$$\Delta T_m = \Delta T_{lm} F_T$$

$$\varepsilon = \frac{q_{actual}}{q_{\max}} = \frac{\Delta T_{\text{min fluid}}}{\Delta T_{\max}}$$

$$q_{\max} = (\dot{m}c_p)_{\min}(T_{hi} - T_{ci}) = C_{\min}(T_{hi} - T_{ci}) = C_{\min}\Delta T_{\max}$$

$$q_{actual} = \varepsilon(\dot{m}c_p)_{\min}(T_{hi} - T_{ci})$$

where $C_{\min} = \varepsilon(\dot{m}c_p)_{\min}$