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COLLEGE OF ENGINEERING

CHEMICAL AND PETROLEUM ENGINEERING DEPARTMENT
PETROLEUM ENGINEERING DEPARTMENT

PTE 314: HEAT AND MASS TRANSFER

LOCKDOWN QUIZ

Instruction: To be submitted on or before 15th June, 2020 via lalam@abuad.edu.ng

Question 1

Show that the expression for the overall heat transfer coefficient (U) for three materials with individual heat coefficients: h1, h2 and h3 respectively, is given as equation 1. Assume all materials have the same surface area.

$$\frac{1}{U} = \frac{1}{h_1} + \frac{1}{h_2} + \frac{1}{h_3} \quad \text{----------} \quad (1)$$

Question 2

a. What is the driving force for heat transfer ?

b. What is heat flux ?

c. Briefly explain in less than 4 lines, the significance of thermal conductivity in heat transfer.

d. Consider a one dimensional steady state heat conduction in a slab in the region $0 \le L$ having boundary surface at $X = 0$ and $X = L$, kept at uniform temperature T_0 and T_1 respectively. Assuming that the thermal conductivity K of the material depends strongly on temperature as a linear function of temperature as given in Equation 2.

$$K(T) = K_0(1 + \beta T) \quad \text{----------} \quad (2)$$

i. Derive the mathematical formulation of the heat transfer rate for the problem, if there is no heat generation. **(11 Marks)**

ii. Determine the heat flux across the slab in i. above, if it's given that the slab is 0.8 ft thick, one phase is kept at 750 ^{0}R and the other phase at 300 ^{0}R. K_0 is 0.02 Btu/hr ft^2 ^{0}R and $\beta = 0.002 / ^0 R$ **(6 Marks)**

Question 3

a. Briefly describe the following relative to thermal radiation.

i. Black body radiation
ii. Emissivity
iii. Radiation configuration factor

b. i. Does any of the energy of the sun reach the earth by conduction or convection?
ii. Briefly explain the reason for the answer given in (b i.) above.

Question 4

a. A spherical container holding a cryogenic fluid at (– 140°C) and having an outer diameter of 0.4 m is insulated with three layers each of 50 mm thick insulations of K_1 = 0.02, K_2 = 0.06 and K_3 = 0.16 W/mK (starting from inside). The outside is exposed to air at 30°C with convective heat transfer coefficient of 15 W/m^{2}K.

i. determine the heat gain
ii. determine the various surface temperatures.