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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

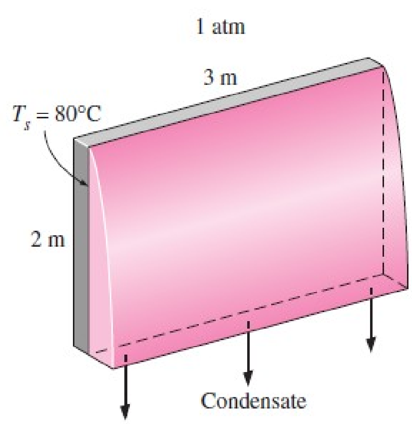
End Semester Examination, May 2018

Program: B. Tech (ASE) **Semester – IV**
Subject (Course): Heat Transfer Processes **Max. Marks : 100**
Course Code : GNEG 256 **Duration : 3 Hrs**
No. of page/s: 03

Instructions:

Assume suitable data if missing with proper justification

Q. No	Question	Marks	CO
	Section-A **Answer all the questions**		
1	A 100 mm diameter pipe carrying a hot chemical at 250°C is covered with layers of insulation, each 50mm thick. The length of the pipe is 5 m. The outer surface temperature of the composite is 35°C. The rate of heat loss through the pipe is 270 W. If the thickness of the outer insulation is increased by 25%, the heat loss is reduced to 260 W. Calculate the thermal conductivities of the two insulating materials.	10	CO1
2	A sphere of 2 cm outside diameter maintained at a uniform temperature T_i = 225°C is exposed to an ambient air at $T\infty$ = 25°C with a convection heat transfer coefficient h=10 W/m^2. °C. Calculate the critical thickness of the insulation (k = 0.08 W/ m. °C.) required to maximize the rate of heat loss while the sphere is maintained at T_i = 225°C.	10	CO2
3	Air at 1 atm and 30°C blows across a 15 mm diameter sphere at a free stream velocity of 5 m/s. A small heater inside the sphere maintains the surface temperature at 80°C. Compute the rate heat lost by the sphere. Properties: $\mu_s = \mu_{@80\,°C} = 2.096 \times 10^{-5}$ kg/m.s At T_∞ = 30°C and 1 atm: $\mu_\infty = 1.872\times10^{-5}$ kg/m.s, Pr = 0.7282, k = 0.02588 W/ m. °C, ρ = 1.164 kg/m^3	10	CO2
4	Consider the 5-m × 5-m × 5-m cubical furnace, whose surfaces closely approximate black surfaces. The base, top, and side surfaces of the furnace are maintained at uniform temperatures of 800 K, 1500 K, and	10	CO3

	500 K, respectively. Determine (*a*) the net rate of radiation heat transfer between the base and the side surfaces, (*b*) the net rate of radiation heat transfer between the base and the top surface, and (*c*) the net radiation heat transfer from the base surface Data: $F_{12} = 0.2$		
5	A rectangular fin of 30 cm length, 30 cm width and 2 mm thickness is attached to a surface at 300°C. The fin is made of aluminium (k = 204 W/m K) and is exposed to air at 30°C. The fin end is uninsulated and can lose heat through its end also. The convection heat transfer coefficient between the fin surface and air is 15 10 W/m^2. K. Determine (a) the temperature of the fin at 30 cm from the base. (b) the rate of heat transfer from the fin, and (c) the fin efficiency.	10	CO1
6	(a) Discuss film condensation and flow regims in film condensation	5	CO2
	(b) Saturated steam at atmospheric pressure condenses on a 2-m-high and 3-m wide vertical plate that is maintained at 80°C by circulating cooling water through the other side. Determine (*a*) the rate of heat transfer by condensation to the plate and (*b*) the rate at which the condensate drips off the plate at the bottom. (5M)  	5	CO2
Section-B **Answer all the questions**			
7	(a) Discuss boiling curve and boiling regims in pool boiling	8	CO2
	(b) Water is to be boiled at atmospheric pressure in a mechanically polished stainless steel pan placed on top of a heating unit. The inner surface of the bottom of the pan is maintained at 108°C. If the diameter of the bottom of the pan is 30 cm, determine (*a*) the rate of	12	CO2

	heat transfer to the water and (*b*) the rate of evaporation of water. The properties of water at the saturation temperature of 100°C are $\sigma = 0.0589$ N/m $\rho_l = 957.9$ kg/m^3 $h_{fg} = 2257.0 \times 10^3$ J/kg $Pr_l = 1.75$ $\rho_v = 0.6$ kg/m^3 $\mu_l = 0.282 \times 10^{-3}$ kg. m/s $C_{pl} = 4217$ J/kg.°C $C_{sf} = 0.0130$ n = 1.0		
8	(a). Discuss overall heat transfer coefficient (U) for a parallel flow heat exchanger	8	CO4
	(b) A double-pipe (shell-and-tube) heat exchanger is constructed of a stainless steel (k = 15.1 W/m · °C) inner tube of inner diameter D_i = 1.5 cm and outer diameter D_o = 1.9 cm and an outer shell of inner diameter 3.2 cm. The convection heat transfer coefficient is given to be h_i = 800 W/m^2 · °C on the inner surface of the tube and h_o = 1200 W/m^2 · °C on the outer surface. For a fouling factor of $R_{f,i}$ = 0.0004 m^2 · °C/ W on the tube side and $R_{f,o}$ = 0.0001 m^2 · °C/ W on the shell side, determine (*a*) the thermal resistance of the heat exchanger per unit length and (*b*) the overall heat transfer coefficients, U_i and U_o based on the inner and outer surface areas of the tube, respectively.	12	CO4