Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2019

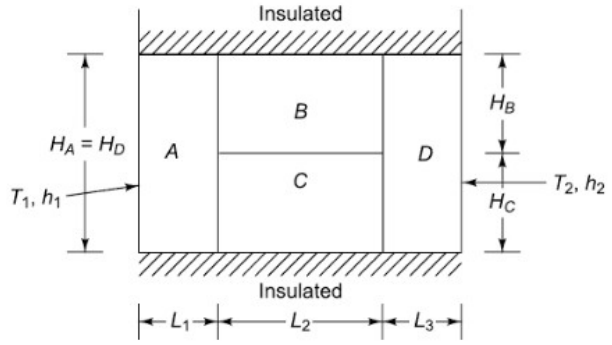
Programme Name: B.Tech - ADE | **Semester : VI**
Course Name : Heat Transfer | **Time : 03 hrs**
Course Code : GNEG 351 | **Max. Marks : 100**
Nos. of page(s) : 2
Instructions : Assume suitable data if required.

SECTION A

S. No.		Marks	
Q 1	What is the difference between thermodynamics and heat transfer?	**4**	**CO1**
Q 2	How the hydrodynamic and thermal boundary layer thicknesses are different? Explain?	**4**	**CO2**
Q 3	What is the physical significance of Grashof number with reference to heat transfer by natural convection? What is the Rayleigh number?	**4**	**CO2**
Q 4	What is the mode of heat transfer in a Vacuum? Define Absorptivity, Reflectivity, and Transmissivity.	**4**	**CO3**
Q 5	Explain the following terms. a) Black body b) Emissivity c) Emissive power d) Stefan-Boltzmann law	**4**	**CO3**

SECTION B

Q 6	The amount of F_{12} used in a compression refrigeration system is 4 tonnes/hour. The brine, flowing at 850 kg/min. with an inlet temperature of 12^0C, is cooled in the evaporator. Assuming F_{12} entering and leaving the evaporator as saturated liquid and saturated vapor respectively, determine the area of evaporator required. Take the following properties: For F12: Saturation temperature : -23^0C; C_p = 1.17 kJ/kg ^{0}C; h_{fg} = 167.4 kJ/kg C_p (brine) = 6.3 kJ/kg ^{0}C; U = 8369 kJ/m^2 h ^{0}C.	**10**	**CO5**
Q 7	Water at 10^0 C flows over a flat plate (at 90^0C) measuring 1mx1m with a velocity of 2m/s. Properties of water at 50^0C are $\rho = 988.1^0$C, $\nu = 0.556X10^{-6}$ m^2/s, Pr = 3.54 and k = 0.648 W/ m K. find (i) The length of plate over which the flow is laminar (ii) the rate of heat transfer from the entire plate [For Laminar flow $Nu = 0.664(Re)^{1/2}(Pr)^{1/3}$, For turbulent flow $Nu = 0.036(Re)^{0.8}(Pr)^{1/3}$]	**10**	**CO2**
Q 8	a) Derive an expression for the radiation heat exchange between two black surfaces. [5M] b) Explain the meaning of the term shape factor in relation to heat exchange by radiation.	**10**	**CO3**

	Derive an expression for the geometric factor F_{11} for the inside surface of a block hemispherical cavity of radius R with respect to itself. [5M]		
Q 9	a) Derive three-dimensional heat conduction equation with uniform heat generation. (OR) b) The composite wall having unit length normal to the plane of the paper and the equivalent thermal circuit is shown in Fig. Find the rate of heat transfer to the wall. $H_A = H_D = 3$ m, $H_B = H_C = 1.5$ m $L_1 = L_3 = 0.05$ m, $L_2 = 0.1$ m $k_A = k_D = 50$ W/mK, $k_B = 10$ W/mK, $k_C = 1$ W/mK $T_1 = 200°C$, $h_1 = 50$ W/m^2 K, $T_2 = 25°C$, $h_2 = 10$ W/m^{2}K.  	**10**	**CO1**
	SECTION-C		
Q 10	An aluminum pipe carries steam at 110^{0}C. The pipe (k=185W/m^{0}C) has an inner diameter of 100mm and an outer diameter of 120mm. The pipe is located in a room where the ambient air temperature is 30^{0}C and the convective heat transfer coefficient between the pipe and air is 15W/m^2 ^{0}C. (i) Determine the heat transfer rate per unit length of pipe. To reduce the heat loss from the pipe it is covered with a 50mm thick layer of insulation (k = 0.20W/m^{0}C). (ii) Determine the heat transfer rate per unit length from the insulated pipe. **Assume that the convective resistance of the steam is negligible**	**20**	**CO1**
Q 11	**a)** In an oil cooler, respectively. Determine the exit temperature of oil and water if the two fluids flow in opposite directions. Assume that the flow rates of the two fluids and U_0 remain unaltered. What would be the minimum temperature to which oil could be cooled in parallel flow and counter flow operations? **(OR)** **b) (i)** In a counter-flow double pipe heat exchanger; water is heated from 25^{0}C to 65^{0}C by oil with a specific heat of 1.45 kJ/kg K and mass flow rate of 0.9 kg/s. The oil cooled from 230^{0}C to 160^{0}C. If the overall heat transfer coefficient is 420W/m^2 ^{0}C, calculate the following: the rate of heat transfer, the mass flow rate of water, and the surface area of the heat exchanger. [10M] **(ii)** A tube of an oil cooler is submerged in a large pool of stagnant water at the temperature of 25^{0}C. The inside diameter of the tube is 25 mm and its length is 35 m. Estimate the overall heat transfer coefficient of this system if the temperature of the oil drops from 85^{0}C to 35^{0}C and the average velocity of the oil is 0.6 m/s. Assume for oil	**20**	**CO4**

	specific heat = 2.51 kJ/kg K and specific gravity = 0.8. [10M]		