Name: Enrolment No:	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2019

Course : Heat Transfer Processes

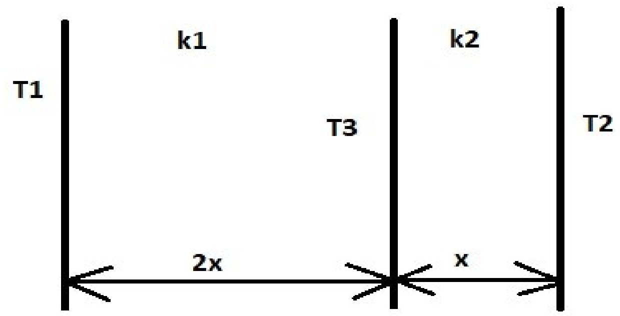
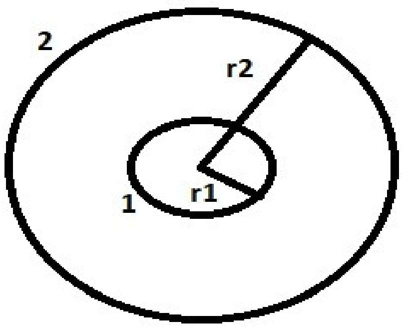
Course Code: CHCE2001 **Semester : IV**

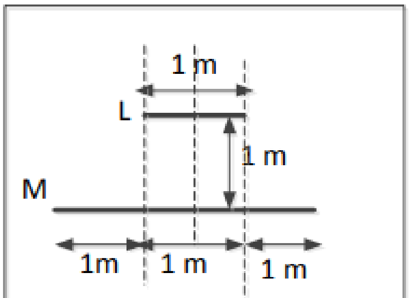
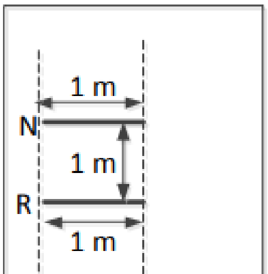
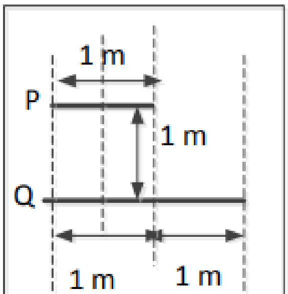
Programme : B.Tech ASE

Time : 03 hrs. **Max. Marks : 100**

Instructions : All questions are compulsory
Assume data if missing.

SECTION A

S. No.		Marks	CO
Q 1	In a composite slab, the temperature at the interface (T_3) between two materials is equal to the average of the temperatures at the two ends (T_1 , T_2) as shown in figure. Assuming steady one-dimensional heat conduction, find out the ratio of conductivities (k_1/k_2). 	4	CO1
Q 2	Discuss about the non-dimensional parameters that governs transition from laminar to turbulent flow in free convection heat transfer?	4	CO2
Q 3	A solid sphere of radius r_1 = 20 mm is placed concentrically inside a hollow sphere of radius r_2 = 30 mm as shown in figure below. Find out the view factor F_{21} for radiation heat transfer. 	4	CO3
Q 4	i. At a particular temperature, analyze the dependence of monochromatic emissive power on wavelength for a black body. ii. At a particular wavelength, analyze the dependence of monochromatic emissive power on temperature for a black body.	4	CO3
Q 5	Emphasis on various performance parameters of an evaporator.	4	CO5

	SECTION B		
Q 6	A 1mm diameter wire is maintained at a temperature of 400ºC and exposed to a convection environment at 40ºC with h = 120 W/m^2K. Calculate the thermal conductivity that will just cause an insulation thickness of 0.2 mm to produce a 'critical radius'. What should be the insulation thickness to reduce the heat transfer by 75% from that which would be experienced by the bare wire.	**10**	**CO1**
Q 7	Atmospheric air at 300K and with a freestream velocity 30m/s flows over a flat plate parallel to the side of length 2m and is maintained at uniform temperature of 400K The physical properties of air at film temperature of 350K are as follows: k = 0.026W/mºC Pr = 0.705 $\nu = 16.5 \times 10^{-6}\ m^2/s$ Determine: i. The average heat transfer coefficient over the region where boundary layer is laminar. ii. The average heat transfer coefficient over the entire length of the plate (2m). iii. The total heat transfer rate to the air from the entire plate for width of 1m. OR Consider a rectangular plate 0.2m X 0.4m which is maintained at a uniform temperature of 100ºC. The plate is placed vertically in still water at 30ºC. Find the rate of heat transfer: i. When 0.2m side is vertical ii. When 0.4m side is vertical	**10**	**CO2**
Q 8	Three sets of parallel plates LM, NR, PQ are given in figure 1,2 and 3 respectively. The shape factor F_{LM} and F_{NR} are 0.8 and 0.4 respectively. Determine the value of F_{PQ}. Figure 1 Figure 2 Figure 3	**10**	**CO3**
Q 9	Hot oil is cooled from 80ºC to 50°C in an oil cooler which uses air as the coolant. The air temperature rises from 30ºC to 40°C. The designer uses a LMTD value of 28.85°C. Find out the type of heat exchanger.	**10**	**CO4**
	SECTION-C		
Q 10	Derive the expression for LMTD for double pipe parallel flow heat exchanger. Hot oil (c_p = 2.09 KJ/kgK) flows through a counter flow heat exchanger at the rate of 0.7 kg/s. It enters at 200ºC and leaves at 70ºC. Cold oil (c_p = 1.67 KJ/kgK) exits at 150ºC at rate of 1.2 kg/s. Determine the surface area of heat exchanger required for the purpose if the overall heat transfer co-efficient is 650 W/m^2K. OR	**20**	**CO4**

	Derive the expression for effectiveness for double pipe parallel flow heat exchanger. Water enters a cross flow heat exchanger (both fluid unmixed) at 20°C and flows at the rate of 7kg/s to cool 10 kg of air per second from 125°C. If the overall heat transfer coefficient of heat exchanger and its surface area are 220 W/m^2K and 250m^2 respectively. Determine the exit air temperature. Take specific heat of air as 1.01 KJ/kgK and that of water as 4.18 KJ/kgK.		
Q 11	Outline the working principle of evaporators. Emphasis on need of feeding mechanism in the evaporators. Classify the evaporators on the basis of various parameters.	**20**	**CO5**

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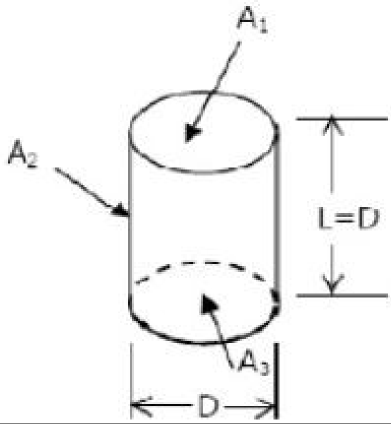
SECTION A

S. No.		Marks	CO
Q 1	A slender rod of length L and Diameter d (L>>d) and thermal conductivity k_1 is joined with another rod of identical dimensions but of thermal conductivity k_2, to form a cylindrical composite rod of length 2L. The heat transfer in radial direction and contact resistance are negligible. Determine the effective thermal conductivity of the rod.	**4**	**CO1**
Q 2	A sphere, a cube and a thin circular plate, all made of same material and having same mass are initially heated to a temperature of 250°C and then left in air at room temperature for cooling. Arrange the geometry in ascending order of rate of cooling.	**4**	**CO2**
Q 3	For the circular tube of equal length and diameter shown below, the view factor F_{13} is 0.17. Determine the value of $F_{21.}$ 	**4**	**CO3**
Q 4	Determine the change in emissive power of the body if the temperature of a solid body is increased from 27°C to 627°C.	**4**	**CO3**
Q 5	Emphasis on the parameters involved in selection of suitable evaporator.	**4**	**CO5**

SECTION B

S. No.		Marks	CO
Q 6	A 250 mm outer diameter steam pipe is maintained at 150°C is exposed to ambient conditions at 25°C with a convection heat transfer coefficient of 50W/m^2 °C. Calculate the thickness of asbestos insulation (k = 0.1 W/m°C) required to reduce the heat loss from pipe by 50%.	**10**	**CO1**
Q 7	A long horizontal pressurized hot water pipe of 200mm diameter passes through a room where the air temperature is 25^0C. The pipe surface temperature is 130°C. Neglecting the radiation loss from the pipe, determine the rate of heat transfer to room air meter of pipe length. The properties of air at 77.5°C are:	**10**	**CO2**

	k = 0.03 W/m°C Pr = 0.7 $\nu = 21 \times 10^{-6}$ m^2/s OR Engine oil at 40°C flows with the freestream velocity of 1m/s over 2m long flat plate whose surface s maintained at uniform temperature of 90°C. Determine: i. The local heat transfer coefficient at edge of the plate (L = 2m). ii. The average heat transfer coefficient over the 2m length of the plate. iii. The rate of heat transfer from the plate.		
Q 8	The surface temperature and radius of the sun is 5779K and 6.95×10^5 km. The distance between sun and earth is 1.496×10^8 km. Assume the surface of sun as black body. Determine the following: i. Wavelength at which maximum monochromatic emissive power occurs ii. Maximum monochromatic emissive power iii. Emissive power Also determine the above values as received on earth's surface.	**10**	**CO3**
Q 9	Derive the expression for effectiveness and NTU of a parallel flow double pipe heat exchanger.	**10**	**CO4**
SECTION-C			
Q 10	Derive the expression of Log Mean Temperature Difference for double pipe parallel flow heat exchanger. A cross flow heat exchanger with both fluids unmixed is used to heat water (c_p = 4,18 KJ/kgK) from 50°C to 90°C, flowing at the rate of 1 kg/s. Determine the overall heat transfer coefficient if the hot engine oil (c_p = 1.9 KJ/kgK) flowing at the rate of 3kg/s enters at 100°C. The area of the heat exchanger is 20m^2. OR Discuss the types of heat exchangers. Consider oil to oil double pipe heat exchanger whose flow arrangement is not known. The temperature measurement indicate that the cold oil enters at 20°C and leaves at 55°C, while the hot oil enters at 80°C and leaves at 45°C. Is it a parallel flow or counter flow heat exchanger? Assume the mass flow rate of both fluids to be same, determine the effectiveness of heat exchanger. (c_p = 2.2 KJ/kgK)	**20**	**CO4**
Q 11	Emphasis on various thermal and mechanical parameters to be consider while designing an evaporator. Outline the process to determine various performance parameters of an evaporator.	**20**	**CO5**