Note: - Pl. start your question paper from next page

Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

END Semester Examination, December 2022

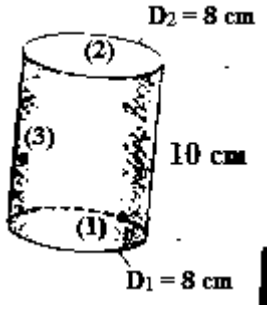
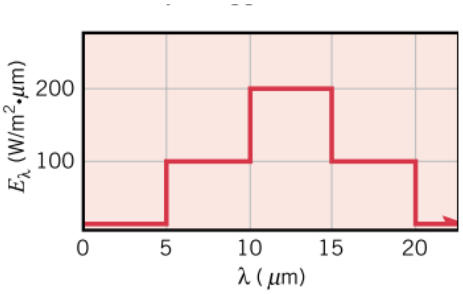
Programme Name: B. Tech- ADE **Semester : V**
Course Name : Automotive Thermal Management **Time : 03 hrs.**
Course Code : MECH 3027 **Max. Marks: 100**
Nos. of page(s) : 3

Instructions:

i. *There are three sections viz. Section A, Section B and Section C. Section A carries 20 marks, Section B carries 40 marks and Section C carries 40 marks*
ii. *Attempt all the questions in Section A, B and C*
iii. *Make appropriate assumptions wherever required*

SECTION A – 20 Marks

S. No.		**Marks**	**CO**
Q 1	A student working heat transfer problems late at night needs a cup of hot cocoa to stay awake. She puts milk in a pan on an electric stove and seeks to heat it as rapidly as she can, without burning the milk, by turning the stove on high and stirring the milk continuously. Explain how this work using an analogous electric circuit. Is it possible to bring the entire bulk of the milk up to the burn temperature without burning part of it?	**4**	**CO1**
Q 2	Explain the critical radius of insulation with mentioning graph of heat transfer rate with respect to radius of insulation.	**4**	**CO1**
Q 3	A counter flow heat exchanger is used to heat water from 20 ^{0}C to 80 ^{0}C by using hot exhaust gas entering at 140 ^{0}C and leaving at 80 ^{0}C. Find log mean temperature difference of the heat exchanger.	**4**	**CO4**
Q.4	Explain the effect of temperature on thermal conductivity of metals, Non-Metals, liquid and gases.	**4**	**CO1**
Q.5	Explain clearly, what you understand by the terms velocity boundary layer and thermal boundary layer. Give their importance in the field of engineering.	**4**	**CO1**
	SECTION B-40 Marks		
Q 6	800 W/m^3 of heat is generated within a 10 cm diameter nickel-steel sphere for which k = 10 W/mK. The environmental is at 20 ^{0}C and there is a natural convection heat	**10**	**CO2**

	transfer coefficient of 10 W/m^2 K around the outside of the sphere. What is its center temperature at the steady state?		
Q 7	A fused quartz sphere has a thermal diffusivity of 9.5 ×10^{-7} m^2 /s. a diameter of 25mm and k=1.52 W/mK the sphere is initially at a uniform temperature Ti = 25 °C. It is suddenly subjected to a convection environment at T∞ = 200 °C and h = 110 W/m^{2}K. Calculate the temperature at the center and at the radius of 6.4mm after 4min.	**10**	**CO2**
Q.8	For the internal surfaces of the right circular cylinder shown in figure, determine F_{13} and F_{33}.  ***OR*** The variation of monochromatic emissive power with wavelength is given in figure. Find:  (a) total emissive power? (b) total intensity of the radiation emitted in the normal direction and at an angle of 30° from the normal?	**10** **10**	**CO1**
Q.9	Illustrate phase change material cooling technique for battery cooling in electric vehicles. Also, describe active and passive cooling technique used in motor and battery of electric vehicle.	**10**	**CO5**
SECTION C (40 Marks)			

<table>
<tr>
<td>Q 10</td>
<td>Consider a concentric tube heat exchanger with hot and cold-water inlet temperature of 200 ^{0}C and 35 ^{0}C respectively. The flow rates of the hot and cold fluid are 42 and 84 kg/h, respectively. Assume the overall heat transfer coefficient is 180 W/m^{2}K.
(a) What is the maximum heat transfer rate that could be achieved for the prescribed inlet conditions?
(b) If the exchanger is operated in counterflow with a heat transfer area of 0.33 m^2, determine the outlet fluid temperature.</td>
<td>20</td>
<td>CO4</td>
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<td>Q.11</td>
<td>Engine oil at 100 ^{0}C and a velocity of 0.1 m/s flows over both surfaces of a 1m long flat plate maintained at 20 ^{0}C. Determine:

(a) The velocity and thermal boundary layer thickness at the trailing edge (5 Marks)

(b) The local heat flux and surface shear stress at the trailing edge (5 Marks)

(c) The total drag force and heat transfer per unit width of the plate (5 Marks)

(d) Plot the boundary layer thickness and local value of the surface shear stress, convection coefficient and heat flux as a function of x for$0 \leq x \leq 1m$. (5 Marks)

OR

A horizontal high pressure steam pipe of 0.1 m outside diameter passes through a large room whose wall and air temperature are 23 ^{0}C. The pipe has an outside surface temperature of 165 ^{0}C and an emissivity of 0.85. Estimate the heat loss from the pipe per unit width.

Thermophysical properties of air at T_f = 367 K: k = 0.0313 W/mK, $\upsilon = 22.8 \times 10^{-6}$ m^2/s

$Nu = C\ Ra_d^n$, where C and n are given in table:
<table>
<tr><th>Ra$_d$</th><th>C</th><th>n</th></tr>
<tr><td>$10^{-10} – 10^{-2}$</td><td>0.675</td><td>0.058</td></tr>
<tr><td>$10^{-2} – 10^{2}$</td><td>1.02</td><td>0.148</td></tr>
<tr><td>$10^{2} – 10^{4}$</td><td>0.850</td><td>0.188</td></tr>
<tr><td>$10^{4} – 10^{7}$</td><td>0.480</td><td>0.250</td></tr>
<tr><td>$10^{7} – 10^{12}$</td><td>0.125</td><td>0.333</td></tr>
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<td>20</td>
<td>CO3</td>
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