Total No. of (Questions	: 10	0
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P2840

SEAT No.:

[Total No. of Pages: 4

[4958]-1013 **T.E.**(Mechanical)

HEAT TRANSFER

(2012 Course) (Semester-I) (302042)(End Semester)

Time: 2½ Hours] IMax. Marks: 70

Instructions to the candidates:

- Solve Q.1 or Q.2,Q.3 or Q.4,Q.5 or Q.6,Q.7 or Q.8,Q.9 or Q.10.
- 2) Draw neat diagrams wherever necessary.
- 3) Use of scientific calculator is allowed.
- Assume suitable data wherever necessary. 4)
- Figures to the right indicate full marks. *5*)
- Derive an expression for critical radius of insulation of sphere. **Q1**) a) [6]
 - A 2 kW resistance heater wire whose thermal conductivity is 15 W/m. b) °C has a diameter of 4 mm and length of 0.5 m. It is used for boiling water. If the outer surface temperature of wire is 105 °C, determine the temperature at the centre of the wire. [4]

OR

Q2) a) Prove that
$$\frac{\theta}{\theta_i} = \frac{T - T_{\infty}}{T_i - T_{\infty}} = \exp\left[-\left(\frac{hA_s}{\rho VCp}\right)t\right]$$
 with usual notations. [6]

- Explain the concept of Thermal Resistance. b)
- *Q3*) a) What is response and time constant of a thermocouple? [4]
 - b) The temperature distribution across a wall of 1 m thick at a certain instant of time is given as $T(x)=a+bx+cx^2$ where T is in degrees Celsuis and x is in meters, while a =800 °C,b = -350 °C/m, and c=-60 °C/m². A uniform heat generation, = 1000 W/m^3 , is present in the wall of area 10m^2 having the properties = 1600kg/m^3 , k= $40 \text{ W/m.K,and } c_p = 4 \text{kJ/kg.K. Determine:}$ [6]
 - i) the rate of heat transfer entering the wall (x=0) and leaving the wall (x = 1m)
 - the rate of change of energy storage in the wall. ii)

[4]

- **Q4)** a) Derive the three dimensional heat diffusion equation in Cartesian co-ordinates from first principles. [6]
 - b) Calculate the temperature at the tip of fin of a 3 mm diameter, 3 cm long fin if fin is made up of [4]
 - i) Copper(k= 350 W/m.K) and
 - ii) Teflon (k=0.35W/mK)

Take temperature at the fin base = 120° C, ambient temperature = 20° C h=10W/m².K

- **Q5)** a) Define and give the significance of following dimensionless numbers used in Natural Convection. [6]
 - i) Prandtl Number,
 - ii) Grashof Number
 - b) Explain: Local and Average heat transfer coefficient. [5]
 - c) Consider a 0.6-m 3 0.6-m thin square plate in a room at 30°C. One side of the plate is maintained at a temperature of 90°C, while the other side is insulated. Determine the rate of heat transfer from the plate by natural convection if the plate is vertical.

Use following correlation.

 $Nu = 0.59 \text{ RaL}^{\frac{1}{4}}$

Properties of air at 60° C: k = 0.02808 W/m.K, Pr = 0.7202,

$$v = 1.896 \times 10^{-5} \text{ m}^2/\text{s}$$
 [6]

OR

- **Q6)** a) Differentiate: Natural convection and Forced convection. [5]
 - b) Explain concept of velocity and thermal boundary layer. [6]
 - c) A 25-cm-diameter stainless steel ball (ρ=8055 kg/m³, c_p= 480J/kg.K) is removed from the oven at a uniform temperature of 300°C. The ball is then subjected to the flow of air at 1atm pressure and 25°C with a velocity of 3m/s. The surface temperature of the ball eventually drops to 200°C.Determine the average convection heat transfer coefficient during this cooling process and estimate how long the process will take.

Nu=2+[0.4× Re^{1/2} + 0.06× Re^{2/3}] Pr
$$^{0.4}(\mu_{\infty} / \mu_{s})^{1/4}$$

The properties of air at the free-stream temperature of 25°C and 1 atm:

$$k = 0.02551 \text{ W/m.K}, v = 1.562 \times 10^{-5} \text{m}^2/\text{s}, \mu = 1.849 \times 10^{-5} \text{kg/m.s Pr} = 0.7296$$

Take
$$\mu_s = 2.76 \times 10^{-5} \text{kg/m.s}$$
 [6]

Q 7)	a)	Writ	te a note on radiation shields.			[4]
	b)		te the statements and mathematicandiation heat transfer:	l expre	essions of the following la	aws [6]
		i)	Planck's law	ii)	Wien's law	
	c)		nsider a 20- cm- diameter spheric uming the ball closely approxima		-	air. [6]
		i)	the total blackbody emissive por	wer,		
		ii)	the total amount of radiation em	itted by	y the ball in 5 min.	
		iii)	the spectral blackbody emissive	power	at a wavelength of 3mm	1.
		Take	e $C_1 = 3.74177 \times 10^8$ W. $\mu m^4/m^2$, 0	$C_1 = 1$.43878× 10 ⁴ μm.K	
			OR			
Q8)	a)	Wha	at is a gray body? How does it di	ffer fro	om a black body?	[4]
	b)		te the statements and mathematicandiation heat tranfer:	l expre	essions of the following la	aws [6]
		i)	Kirchhoff's law ii)	Lam	bert's law	
	c)	duct of 6 0.6 a	nermocouple used to measure the t whose walls are maintained at 4 to 50 K. Assuming the emissivity of and the convection heat transfer conactual temperature of the air.	00 K s	hows a temperature read hermocouple junction to nt as 80 W/m ² .°C, determ	ing be
	d)	Defi	ine: Radiosity			[2]
Q9)	a)	Deri	ive an expression for LMTD of co	ounter	flow heat exchanger.	[6]
	b)	Exp	lain working of a heat pipe with n	eat ske	etch.	[6]
	c)	to 8 geot	ounter-flow double -pipe heat exc 30°C at a rate of 1.2 kg/s. The lathermal water available at 160°C er tube is thin-walled and has a dia	neating at a m	g is to be accomplished ass flow rate of 2 kg/s.	by Гhe

OR

transfer coefficient of the heat exchanger is 640 W/m².K, determine the length of the heat exchanger required to achieve the desired heating. [5]

- Q10) a) Derive an expression for effectiveness of parallel flow heat exchanger.[7]
 - b) Compare: Film wise and drop wise condensation. [4]
 - c) Cold water enters a counter-flow heat exchanger at 10°C at a rate of 8 kg/s, where it is heated by a hot-water stream that enters the heat exchanger at 70°C at a rate of 2kg/s, Assuming the specific heat of water to remain constant at Cp=4.18kJ/kg.K, determine the maximum heat transfer rate and the outlet temperatures of the cold-and the hot-water streams for this limiting case. [6]

