Registration no:

Total Number of Pages: 02 | **B. Tech**
PCME4305

6th Semester Regular / Back Examination 2015-16

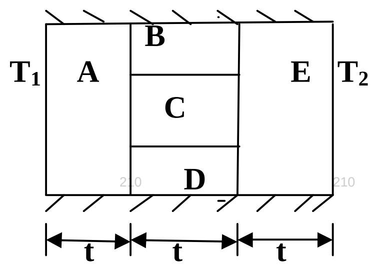
HEAT TRANSFER

BRANCH(S): AERO, MECHANICAL, PLASTIC
Time: 3 Hours
Max Marks: 70
Q.CODE: W584
Answer Question No.1 which is compulsory and any five from the rest.
The figures in the right hand margin indicate marks.

Q1 Answer the following questions: **(2 x 10)**

- **a)** A plane wall of 150 mm thick and its wall cross sectional area is 4.5 m^2. If its conductivity is 9.35 $w/(m^0C)$, calculate thermal resistance of the wall.
- **b)** Define ‘temperature coefficient of thermal conductivity’ and write the units for it.
- **c)** What is the critical thickness of insulation of a material? Write the formula for the cylinder.
- **d)** What is the difference between cross flow and counter flow heat exchanger?
- **e)** Which non-dimensional number is used to find the heat transfer coefficient in convection? Write that number with appropriate symbols..
- **f)** Write the formula for Stanton number in terms of Nusselt number, Reynolds number and Prandtl number. Write the physical significance of that number.
- **g)** If a vertical hot plate is inserted into a stationary fluid why the gravitational force is included in the heat transfer calculation?
- **h)** Write the dimensionless number in free convection which will distinguish from laminar to turbulent flow. What is the critical value for transition flow over a vertical flat plate?
- **i)** Define critical flux in heating.
- **j)** What is reflectivity and its type?

Q2 **a)** Figure shows a composite material arranged in parallel and series paths. Draw an equivalent thermal resistance network and calculate the total thermal resistance in the path of heat flow from $\mathbf{T_1}$ to $\mathbf{T_2}$. The cross-sectional area and thermal conductivity of **B**,**C**,**D** are **a** each and **k** each respectively. The cross-sectional area for **A** and **E** are 2**a** each and thermal conductivity for **A** and **E** are 2**k** each, **t** be thickness of each material. **(5)**



b) Derive the general differential equation for a rectangular fin of length ‘l’ which is normal to the wall, ‘b’ be the width of the fin, ‘t’ be the thickness of the fin and ‘k’ be the thermal conductivity of the wall. The temperature at the base of the fin is T_0 and T_∞ be the temperature of the surrounding. The heat transfer coefficient due to convection is ‘h’. **(5)**

Q3 a) A 50cmx30cm copper slab 6.25 mm thick has a uniform temperature of 300^{0}C. It is suddenly dipped into the liquid at 36^{0}C whose heat transfer coefficient is 90 w/(m^2 ^{0}C). Calculate the time required for the plate to reach the temperature 108^{0}C. The density of the copper slab is 9000 kg/m^3, specific heat of copper is 0.38 kj/(kg^{0}C) and thermal conductivity of copper slab is 370 w/(m^{0}C). **(5)**

b) Air at atmospheric pressure and 40^{0}C flows with a velocity of 5 m/sec over a 2m long flat plate whose surface is kept at uniform temperature of 120^{0}C. Determine the average heat transfer coefficient for the flow where the boundary layer is laminar. Also find out the rate of heat transfer between the plate and the air per 1m width of the plate during laminar zone. [The properties of air at 80^{0}C are: ν=2.107x10^{-5}m^2/sec, k=0.03025w/(m^{0}k), Pr=0.6965, critical Reynolds number = 2x10^5]. **(5)**

Q4 The effective temperature of a body having an area of 0.10 m^2 is 627^{0}C. Calculate the following (i) total rate of energy emission, (ii) the intensity of normal radiation, (iii) the wavelength at which emission is maximum and (iv) the maximum emissive power. **(10)**

Q5 a) A surface condenser consists of a number of thin walled circular tubes (each tube is 22 mm in diameter and 5 m long) arranged in parallel through which turbulent water flows. If the mass flow rate of water through the tube bank is 160 kg/sec and its inlet and outlet temperatures are known to be 21 ^{0}C and 29^{0}C respectively, calculate the number of tubes if the average heat transfer coefficient associated with the flow of water is 7566.27 w/(m^2 ^{0}C). Mc Adam's relation for turbulent flow is given by $\overline{Nu} = 0.023(\mathrm{Re})^{0.8}(\mathrm{Pr})^{0.4}$. The properties of water at 25^{0}C: ρ=996.65kg/m^3, μ=0.862x10^{-3}kg/(msec), k=0.6079w/(m^{0}C), C_p=4.178 kj/(kg ^{0}C). **(5)**

b) A vertical cylinder of 180 mm diameter is maintained at 100 ^{0}C in an atmospheric environment of 20^{0}C. Calculate the heat loss per unit height by free convection from the surface of the cylinder. The average Nusselt number for free convection in turbulent flow is: $\overline{Nu} = 0.10(Gr\,\mathrm{Pr})^{\frac{1}{3}}$. [The properties of air at 60^{0}C: ρ=1.06 kg/m^3, ν=18.97x10^{-6} m^2/sec, k=0.1042 kj/(mh ^{0}C), C_p=1.004 kj/(kg^{0}C).] **(5)**

Q6 a) Classify and explain different methods of condensation. **(5)**

b) Classify and explain different methods of boiling. **(5)**

Q7 a) Define overall heat transfer coefficient in a heat exchanger. Write its formula for a single plane wall, concentric tube wall with respect to inner and outer surface. **(4)**

b) A counter flow shell and tube heat exchanger is used to heat water at the rate of 0.8 kg/sec from 30^{0}C to 80^{0}C with hot oil entering at 120^{0}C and leaving at 85^{0}C. The overall heat transfer coefficient is 125w/(m^2 ^{0}C), C_p of water is 4180 j/(kg^{0}C). Calculate the heat transfer area required. **(6)**

Q8 Write short notes on any two: **(5 x 2)**

a) Fouling factor

b) Ɛ-NTU method in heat exchanger

c) Black-body radiation

d) Shape factor.