B.TECH. SEM -V MECHANICAL 2014 COURSE (CBCS) :
SUMMER - 2018
SUBJECT : HEAT & MASS TRANSFER

Day : **Thursday**
Date : **24/05/2018**

S-2018-2368

Time : **10.00 AM TO 01.00 PM**
Max. Marks: 60

N.B.:

1) All questions are **COMPULSORY**.
2) Figures to the right indicate **FULL** marks.
3) Use of non-programmable **CALCULATOR** is allowed.
4) Assume suitable data if necessary.

Q.1 Explain the general differential equation in Cartesian co-ordinate system, using standard notations. Also write simplified forms of heat conduction equations for: **[10]**

i) Poisson's equation
ii) Laplace equation
iii) Fourier's equation

OR

An exterior wall of house may be approximated by a 100 mm layer of common brick (k = 0.70 W/mK) followed by a 40 mm layer of gypsum plaster (k = 0.48 W/mK). What thickness of loosely packed Rockwool insulation (k = 0.065 W/mK) should be added to reduce the heat loss through the wall by 25%?

Q.2 Explain the critical radius of insulation with neat sketch. Calculate the critical radius of insulation for asbestos (k = 0.172 W/mK) surrounding a pipe and exposed to room air at 300 K with h = 2.8 W/m^2K. Calculate the heat loss from a 450 K and 60 mm diameter pipe when covered with the critical radius of insulation and without insulation. **[10]**

OR

Explain the variation of thermal conductivity with respect to following:

i) Temperature in metals
ii) Porosity

A 10 mm cable is to be laid in atmosphere of 20^0C with outside heat transfer coefficient of 8.5 $W/m^2\ ^0C$. The surface temperature of cable is likely to be 60^0C due to heat generation within. Will the rubber insulation k = 0.155 W/mK be effective? If yes how much?

Q.3 Give the classification of fin and explain effectiveness of fin. A very long 25 mm diameter copper rod (k = 380 W/m^0C) extends horizontally from a plane heated wall at 120^0C. The temperature of the surrounding air is 25^0C and the convective heat transfer coefficient is 9.0 $W/m^2\ ^0C$. **[10]**

OR

Explain the lumped heat capacity analysis.

One end to a very long aluminum rod 3 mm in diameter is connected to a wall at 410 K, while the other end protrudes into a room whose air temperature is 288 K. Determine the total heat dissipated by a rod.

P.T.O.

Q.4 Explain thermal boundary layer with neat sketch. **[10]**
Air at 101.32 Kpa of 300 K blows across a 10 mm diameter sphere at a free stream velocity of 4 m/s. A small heater inside a sphere maintains the surface temperature at 350 K. Estimate the heat loss by the sphere.

OR

Explain significances of following:

i) Nusselt number
ii) Reynolds number
iii) Grashoffs number
iv) Prandtl number
v) Rayleigh number

Q.5 Explain the concepts of black body and solid angle. **[10]**
Calculate the rate of heat transfer by radiation from an unlagged steam pipe 50 mm O.D. at 393 K to air at 293 K. Assume emissivity of 0.9.

OR

Explain the following:

i) Wein's displacement law
ii) Lambert's cosine law
iii) Radiation shield

Q.6 Explain Flick's Law of diffusion. **[10]**
Hot oil at a rate of 1.2 kg/sec (cp = 2083 J/kgK) flows through double pipe heat exchanger. It enters at 630 K and leaves at 570 K. The cold fluid enters at 303 K and leaves at 400 K if the overall heat transfer coefficient is 500 W/m^2K. Calculate the heat transfer area for: (i) parallel flow (ii) counter flow.

OR

Derive the expression for LMTD for counter flow arrangement using usual notations. Also give design considerations for heat exchanger design.

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