Heat Transfer Question Sheet-3

1.Two insulating materials of thermal conductivities k and 2k are available for lagging a pipe carrying hot fluid. If the radial thickness of each material is same, then

(a)material with higher thermal conductivity should be used for inner layer and one with lower thermal conductivity for the outer layer.

(b)material with lower thermal conductivity should be used for the inner layer and the one with higher thermal conductivity for the outer layer.

(c)it is immaterial in which sequence the insulating materials are used.

(d)it is not possible to judge unless numerical values of dimensions are given.

ANS:-(b)

2. Heat conduction equation in cylindrical coordinates can be written as

(a) $\frac{\frac{\partial}{\partial r}\left(\frac{r\partial T}{\partial r}\right)}{r}+\frac{\dot{q}}{k}=\frac{\left(\frac{\partial T}{\partial t}\right)}{\alpha}$

(b) $\frac{\frac{\partial}{\partial r}\left(\frac{r^2\partial T}{\partial r}\right)}{r^2}+\frac{\dot{q}}{k}=\frac{\left(\frac{\partial T}{\partial t}\right)}{\alpha}$

(c) Both a and b

(d) None of the above

ANS:-(a)

3.Lumped system analysis is the simplest and most convenient method that can be used to solve transient conduction problems. This analysis can be used only when Biot Number(Bi) is

(a)less than 0.1 (b)more than 0.1

(c)less than 1.0 (d)more than 1.0

ANS:-(a)

4.A body of volume V, surface area A, at its initial temperature To ,is immersed in an infinite volume of a fluid of density ρ,specific heat c, at temperature $T\infty$.If the coefficient of convection is h,then using lumped heat analysis,the temperature difference T-$T\infty$ at any moment t,would be given by

(a) (T-T∞)exp($\frac{hA}{\rho Vc}$)

(b) (T-T∞)exp($\frac{\rho Vc}{A}$)

(c) (T-T∞)exp(- $\frac{hA}{\rho Vc}$)

(d) (T-T∞)exp($-\frac{\rho Vc}{hA}$)

ANS:(c)

5. In descending order of a magnitude, the thermal conductivities of (a) pure iron (b)liquid water, (c)saturated water vapour and (d) aluminium can be arranged as

(a) a,b,c,d (b) b,c,a,d
(c) d,a,b,c (d) d,c,b,a

ANS:-(c)

6. A steel steam pipe 10 cm inner diameter and 11 cm outer diameter is covered with an insulation having a thermal conductivity of 1 W/mk. If the convective heat transfer coefficient between the surface of insulation and the surrounding air is 8 W/m^2 K, the critical radius of insulation is.

(a) 10cm (b) 11cm
(c)12.5cm (d) 15cm

ANS:-(c)

7. A solid sphere and hollow sphere of the same material and size are heated to the same temperature and allowed to cool in the same surroundings. If the temperature difference between the body, and that of surroundings is T, then.

(a)Both spheres will cool at the same rate for small values of T.

(b)Both spheres will cool at the same rate only for large values of T .

(c)Hollow sphere will cool at a faster rate for all the values of T

(d)Solid sphere will cool at a faster rate for all the values of T

ANS:-(c)

8. A furnace is made of red brick wall of thickness 0.5 m and conductivity 0.7 W/mk. For the same heat loss and temperature drop, this can be replaced by a layer of diatomic earth of conductivity 0.14 W/mk and thickness?

(a)0.05 m (b)0.1 m
(c)0.2m (d)0.5 m

ANS:-(b)

9. The temperature distribution at a certain instant, of time in a concrete slab during curing is given by

$$T = 3x^2 + 3x + 16$$

Where x is in cm and T is in K. The rate of temperature change with time is given by (assuming diffusivity to be 0.0003 cm^2/s)

(a) +0.0009K/s
(b) +0.0048K/s
(c) -0.0012K/s
(d) -0.0018K/s

ANS:-(d)

10. A 0.5 m thick plane wall has its two surfaces kept at 300^0C and 200^oC. Thermal conductivity of wall varies linearly with temperature and its values at 300 ^{0}C and 200 ^{0}C are 25W/mk and 15 W/mk respectively. Then the steady state heat flux through the wall is.

(a)8KWm^2 (b)5KW/m^2

(c)4KW/m^2 (d)3KW/m^2

ANS:-(c)

11.A plane wall is 25 cm thick with an area of 1m^2 and has a thermal conductivity of 0.5W/mk. If a temperature difference of 60^o C is imposed across it, What is heat flow?

(a)120W (b)140W

(c)160W (d)180W

ANS:-(a)

12.A composite hollow sphere with steady internal heating is made of two layers of materials of equal thickness with thermal conductivities in the ratio of 1:2 for inner to outer layers. Ratio of inside to outside diameter is 0.8. What is the ratio of temperature drop across the inner and outer layers?

(a)0.4 (b)1.6
(c)0.8 (d) 2.5

ANS:-(d)

13.A composite wall having three layers of thickness 0.3m, 0.2 m and 0.1m and of thermal conductivities 0.6, 0.4 and 0.1 W/mk, respectively, is having surface area $1m^2$.If the inner and outer temperature of the composite wall are 1840 K and 340 K respectively, What is the rate of heat transfer?

(a)150 W (b)1500 W

(c)75W (d)750 W

ANS:-(d)

14.For conduction through a spherical wall with constant thermal conductivity and with inner side temperature greater than the outer wall temperature (one-dimensional heat transfer), What is the type of temperature distribution?

(a)Linear
(b)Parabolic
(c)Hyperbolic
(d)None of these

ANS:-(b)

15.A wall of thickness 0.6 m width has a normal area $1.5m^2$ and is made up of material of thermal conductivity 0.4 W/mk. The temperature on the two sides are 8000 ^{0}C and 1000 ^{0}C. What is the thermal resistance of the wall?

(a)1W/k (b)1.8 W/k
(c)1K/W (d)1.8K/W

ANS:-(c)

16.A composite wall of a furnace has 2 layers of equal thickness having thermal conductivities in the ratio of 3:2. What is the ratio of temperature drop across the two layers?

(a)2:3 (b)3:2
(c)1:2 (d)ln2:ln3

ANS:-(a)

17.A composite wall of a furnace has 3 layers of equal thickness having thermal conductivities in the ratio of 1:2:4. What will be temperature drop ratio across the three respective layers?

(a)1:2:4
(b)4:2:1
(c)1:1:1
(d)log4:log2:log1

ANS:-(a)

18.A large concrete slab 1 in thick has one -dimensional temperature distribution

$$T = 4 - 10x + 20x^2 + 10x^3$$

Where t is temperature and x is distance from one face towards the other face of wall. If the slab material has thermal diffusivity of 2×10^{-3} m^2 /h. What is the rate of change of temperature at the other face of wall?

(a)0.10^o C/h (b)0.2 ^{o} C/h

(c)0.3^o C/h (d)0.4 ^{o} C/h

ANS:-(b)

19.For a current wire of 20 mm diameter exposed to air(h= 20W/m^2K),maximum heat dissipation occurs when thickness of insulation (κ=0.5W/mk) is

(a)20 mm (b)25 mm

(c)15mm (d)10mm

ANS:-(a)

20.A steel ball of mass 1 kg and specific heat of 0.4 KJ/kg is at temperature of 60 ^{0} C.It is dropped into 1 kg water at 200 C .The Final steady state temperature of water is

(a)23.5^{o}C (b)30^{o}C

(c)35^{o}C (d)40^{o}C

ANS:-(a)