CLASS TEST

S.No.: 01DLSK_IJKLM_230726

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HEAT TRANSFER

MECHANICAL ENGINEERING

Date of Test : 23/07/2026

ANSWER KEY

1.	(a)	7.	(a)	13.	(a)	19.	(b)	25.	(b)
2.	(d)	8.	(b)	14.	(c)	20.	(d)	26.	(c)
3.	(b)	9.	(b)	15.	(b)	21.	(d)	27.	(b)
4.	(d)	10.	(b)	16.	(b)	22.	(c)	28.	(b)
5.	(d)	11.	(c)	17.	(b)	23.	(c)	29.	(b)
6.	(d)	12.	(b)	18.	(b)	24.	(a)	30.	(c)

DETAILED EXPLANATIONS

1. (a)

$$\frac{T - T_\infty}{T_0 - T_\infty} = e^{-\left[\frac{hA}{\rho VC}t\right]}$$

$$(T - T_\infty) = (T_0 - T_\infty)e^{-\left[\frac{hA}{\rho VC}t\right]}$$

$$(T - T_\infty) \propto \exp^{-\left[\frac{hA}{\rho VC}t\right]}$$

2. (d)

- $$\text{Biot number } (Bi) = \frac{\text{Internal thermal resistance of a solid}}{\text{Boundary layer thermal resistance}}$$

$$Bi = \frac{h \cdot s}{k_{solid}}$$

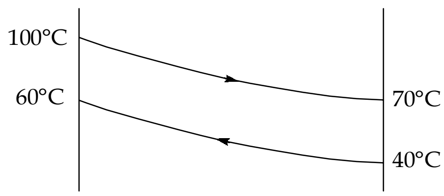
- $$\text{Grashof number } (Gr) = \frac{\text{Bouyancy force}}{\text{Viscous force}}$$

$$= \frac{g\,\beta(T_W - T_\infty)L^3}{\nu^2}$$

$$\text{Schmidt number, } S_c = \frac{\text{Momentum diffusivity}}{\text{Mass diffusivity}}$$

$$S_c = \frac{\nu}{D}$$

3. (b)



$$\Delta T_1 = (T_{h_i} - T_{c_o}) = 100°C - 60°C = 40°C$$

$$\Delta T_2 = (T_{h_o} - T_{c_i}) = 70°C - 40°C = 30°C$$

$$\text{LMTD} = \frac{\Delta T_1 - \Delta T_2}{\ln\left(\frac{\Delta T_1}{\Delta T_2}\right)} = \frac{40°C - 30°C}{\ln\left(\frac{40°C}{30°C}\right)}$$

$$\text{LMTD} = 34.76°C$$

4. (d)

Statement (d) is general statement it is not specifically related to black body.

5. (d)

$$(Q)_{x=1} = -kA\left(\frac{dT}{dx}\right)_{x=1}$$
$$= -25 \times 0.005 \times (-150 + 20x)_{x=1}$$
$$= 16.25 \text{ W}$$

6. (d)

$$d = 5 \text{ mm}$$
$$p = \pi d = \pi \times 0.005 = 0.0157 \text{ m}$$
$$T_0 = 100°\text{C}$$
$$h = 100 \text{ W/m}^2\text{K}$$
$$k = 398 \text{ W/mK}$$
$$T_\infty = 25°\text{C}$$

Assume infinite length of rod

$$Q = \sqrt{hpkA_c}\,(T_0 - T_\infty)$$
$$= \sqrt{100 \times 0.0157 \times 398 \times \frac{\pi \times (0.005)^2}{4}}(100 - 25)$$
$$= 8.3 \text{ W}$$

7. (a)

$r_2 = \frac{1.6}{2} = 0.8$ m, $r_1 = 0.8 - 0.08 = 0.72$ m, k = 0.09 W/m°C, $\Delta t = t_1 - t_2 = 250°$C

∴ The rate of heat transfer through the spherical shaped vessel,

$$Q = \frac{(t_1 - t_2)}{\frac{(r_2 - r_1)}{4\pi k r_1 r_2}} = \frac{250 \times 4 \times \pi \times 0.09 \times 0.8 \times 0.72}{0.8 - 0.72}$$
$$= 2035.75 \text{ W}$$

8. (b)

$$\text{Peclet number} = \text{Re}\cdot\text{Pr}, \text{ Stanton number} = \frac{Nu}{\text{Re}\cdot\text{Pr}} = \frac{h}{\rho V c_p}$$

9. (b)

For a fully developed turbulent flow through pipes,

$$\text{Nu} = \frac{hd}{k} = 0.023\left(\frac{Vd\rho}{\mu}\right)^{0.8}\text{Pr}^{0.4}$$
$$\therefore \frac{h_2}{h_1} = (2)^{0.8} = 1.741$$

10. (b)

The most generalised conduction equation in cylindrical co-ordinates is given by

$$\frac{\partial^2 T}{\partial r^2} + \frac{1}{r}\frac{\partial T}{\partial r} + \frac{1}{r^2}\frac{\partial^2 T}{\partial \phi^2} + \frac{\partial^2 T}{\partial z^2} + \frac{\dot{q}}{k} = \frac{1}{\alpha}\frac{\partial T}{\partial T}$$

where r is radial, z is axial and ϕ is azimuthal co-ordinate

Since no heat generation, $\dot{q}$ is zero.

Since 1-D conduction $\frac{\partial^2 T}{\partial \phi^2} = 0$ and $\frac{\partial^2 T}{\partial z^2} = 0$

Therefore, ans is (b).

11. (c)

$$\text{Wall thickness, } \delta = 10 \text{ mm} = 0.01 \text{ m}$$

As given in question,

$$\text{Thermal conductivity, } k = ax + b$$

$$\text{Heat flux, } q'' = -k\frac{dT}{dx}$$

$$q'' = -(ax+b)\frac{dT}{dx}$$

$$\frac{q''}{ax+b}dx = -dT$$

On integrating,

$$q''\int_0^{\delta}\frac{dx}{ax+b} = -\int_{T_1}^{T_2} dT$$

$$\Rightarrow \quad \frac{q''}{a}[\ln|ax+b|]_0^{\delta} = -(T_2 - T_1)$$

$$\Rightarrow \quad \frac{q''}{a}\ln\left|\frac{a\delta+b}{a\times 0+b}\right| = (T_1 - T_2)$$

$$\Rightarrow \quad \frac{q''}{a}\ln\left|\frac{a\delta+b}{b}\right| = (T_1 - T_2)$$

$$\frac{3.723\times 10^6}{7\times 10^4}\ln\left|\frac{7\times 10^4\times 0.01+200}{200}\right| = (100 - T_2)$$

$$T_2 = 20.0046°\text{C}$$

$$T_2 \simeq 20°\text{C}$$

12. (b)

Given: $T_\infty = 38°\text{C}$, $T = 94°\text{C}$, $N = 32 \text{ km/h} = \frac{32\times 5}{18} = 8.89 \text{ m/s}$

$$\text{Re}_L = \frac{VL}{v} = \frac{8.89\times 0.45}{1.967\times 10^{-5}} = 2.034\times 10^5$$

$\therefore$ Flow is laminar everywhere.

$$\overline{Nu} = \frac{\bar{h}L}{k} = 0.664\,\text{Re}_L^{1/2}\,\text{Pr}^{1/3}$$

$$= 0.664(2.034\times 10^5)^{1/2}(0.699)^{1/3} = 265.7$$

$$\bar{h} = \frac{k}{L} \times \overline{Nu} = \frac{2.917 \times 10^{-2}}{0.45} \times 265.7$$
$$= 17.22 \text{ W/m}^2\text{K}$$

Rate of heat transfer, $q = \bar{h}A\Delta T = 17.22 \times 0.3 \times 0.45 \times (94 - 38) = 130.2$ Watt

13. (a)

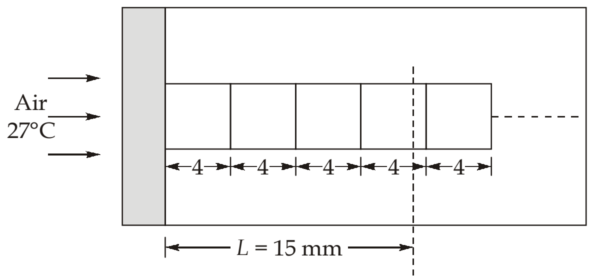
The rate of radiation heat transfer,

$$Q = \sigma \cdot A \in \left(T_1^4 - T_2^4\right)$$
$$= \sigma \cdot A \in \left(T_1^2 + T_2^2\right)\left(T_1 + T_2\right)\left(T_1 - T_2\right)$$
$$Q = h_{radiation} \cdot A(T_1 - T_2)$$

∴ The radiation heat transfer coefficient,

$$h_r = \sigma \cdot \in \left(T_1^2 + T_2^2\right)\left(T_1 + T_2\right)$$
$$= 5.67 \times 10^{-8} \times 0.8 \times (400^2 + 380^2) \times (400 + 380)$$
$$= 10.76 \text{ W/m}^2\text{K}$$

14. (c)



$$L = 15 \text{ mm}$$

Heat removed for the length of 15 mm = Heat removed from three devices + Heat removed from $\frac{3}{4}^{th}$ part of fourth device

$$= (0.040 \times 3) + \frac{3}{4} \times 0.040$$
$$= 0.15 \text{ W}$$

$$\text{Re}_{x = 15} = \frac{Vx}{\nu} = \frac{10 \times 0.015}{\alpha \times \text{Pr}} = \frac{0.15}{24.7 \times 10^{-6} \times 0.705} = 8614$$

$$\text{Nu} = \frac{hx}{k} = 0.886 \times (8614 \times 0.705)^{1/2} = 69.04$$

$$h = 69.04 \times \frac{0.0274}{0.015} = 126.12 \text{ W/m}^2\text{K}$$

$$\text{Heat flux } (q'') = \frac{0.15}{A} = \frac{0.15}{0.004 \times 0.015} = 2500 \text{ W/m}^2$$

$$q'' = h(T_{x=15} - T_\infty)$$

$$\Rightarrow \quad 2500 = 126.12\,(T - 27)$$

$$T = 46.8°\text{C}$$

15. **(b)**

$$\text{Heat generated} = \text{Heat convected}$$

$$\Rightarrow \quad \dot{q} \times \pi r_0^2 L = h \times 2\pi r_0 L \times (T_s - T_\infty)$$

$$\Rightarrow \quad T_s = T_\infty + \frac{\dot{q} r_0}{2h}$$

$$= 100 + \frac{16.4 \times 10^6 \times 0.6 \times 10^{-2}}{2 \times 3200}$$

$$= 115.375°\text{C}$$

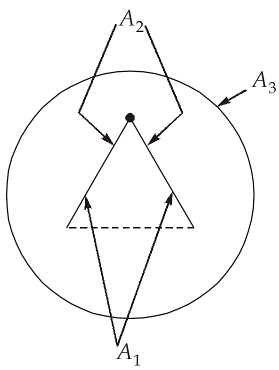
Temperature at the centreline of the wire (T_0)

$$T_0 - T_s = \frac{\dot{q} r_0^2}{4k} = \frac{16.4 \times 10^6 \times (0.6 \times 10^{-2})^2}{4 \times 15.2} = 9.710$$

$$T_0 = 115.375 + 9.710$$

$$= 125.08°\text{C}$$

16. **(b)**



Surface (3) can be represented by dashed line.

Because symmetry $F_{13} = 0.5$, $F_{23} = 1$

Now from reciprocity theorem,

$$A_3F_{31} = A_1F_{13}$$

$$A_3F_{31} = 2L \times 0.5 = 1 \text{ m}$$

$$A_3F_{32} = A_2F_{23} = 2L \times 1 = 2 \text{ m}$$

The net radiation heat transfer

$$Q = A_3F_{31}\sigma(T_w^4 - T_p^4) + A_3F_{32}\sigma(T_w^4 - T_p^4)$$

$$= 1 \times 5.67 \times 10^{-8}\,(1000^4 - 300^4) + 2 \times 5.67 \times 10^{-8}\,(1000^4 - 300^4)$$

$$= 3 \times 5.67 \times 10^{-8}\,(1000^4 - 300^4)$$

$$= 1.68 \times 10^5 \text{ W/m}$$

17. (b)

Total transmissivity of the cover is

$$\tau = \frac{\int_0^\infty \tau_\lambda G_\lambda d\lambda}{\int_0^\infty G_\lambda d\lambda}$$

where the irradiation G_λ is due to solar emission and sun = Emits as blackbody at 5800 K

$$G_\lambda(\lambda) \propto E_\lambda b \text{ (5800 K)}$$

$$\tau = \frac{\int_0^\infty \tau_A E_\lambda b(5800\,\text{K})d\lambda}{\int_0^\infty E_\lambda b(5800\,\text{K})d\lambda}$$

$$\tau = \frac{0.90\int_{0.3}^{2.5} E_\lambda b(5800\,\text{K})d\lambda}{E_b(5800\,\text{K})}$$

$$= \lambda_1 = 0.3\ \mu\text{m},\ T = 5800$$

$\Rightarrow$ $\lambda_1 T = 1740\ \mu\text{m.K},\ F_{0-\lambda_1} = 0.0335$

$$\lambda_2 = 2.5\ \mu\text{m},\ T = 5800\ \text{K},\ \lambda_2 T = 14500\ \mu\text{m.K}$$

$$F_{0-\lambda_2} = 0.9664$$

$$\tau = 0.90\ [F_{0-\lambda_2} - F_{0-\lambda_1}]$$

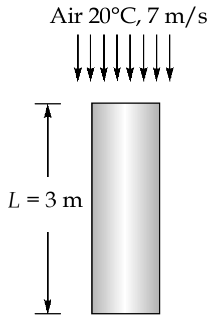
$$= 0.90\ [0.9660 - 0.0335]$$

$$= 0.839 \simeq 0.84$$

18. (b)

Value of R ranges from 0 to ∞, with R = 0 corresponds to phase change on shell side and R → ∞ corresponds to phase change on tube side.

19. (b)



The flow is along 3 m side of the plate, and thus the characteristic length is L = 3 m. Both sides are exposed to air flow,

$$A = 2 \times w \times L$$

$$= 2 \times 2 \times 3 = 12\ \text{m}^2$$

For flat plates, drag force is equivalent to friction force.

$$F_f = C_f A_s \frac{\rho V^2}{2}$$

$$C_f = \frac{F_f}{\frac{1}{2}\rho A_s V^2} = \frac{0.86}{1.204 \times 12 \times \frac{1}{2} \times (7)^2} = 0.00243$$

From Reynolds Analogy,

$$St \times (\mathrm{Pr})^{2/3} = \frac{C_f}{2} = \frac{0.00243}{2}$$

$$St = \frac{h}{\rho V c_p}$$

$$h = 0.00149 \times 1.204 \times 7 \times 1007$$
$$= 12.64 \text{ W/m}^2\text{K}$$

20. (d)

$$\dot{m}_h = \frac{1000}{3600} = 0.277 \text{ kg/s}$$

Hot fluid, $T_{hi} = 70°\text{C}$

$T_{ho} = 40°\text{C}$

$c_{ph} = 2 \text{ kJ/kgK}$

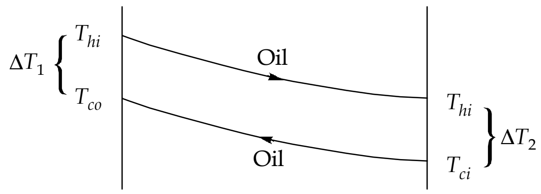
Cold fluid, $T_{ci} = 25°\text{C}$

$T_{co} = 40°\text{C}$

$c_{pc} = 4.2 \text{ kJ/kgK}$

$U = 0.2 \text{ kW/m}^2\text{K}$

Counter flow temperature profile



$$\Delta T_1 = 70°\text{C} - 40°\text{C} = 30°\text{C}$$
$$\Delta T_2 = 40°\text{C} - 25°\text{C} = 15°\text{C}$$

$$\text{LMTD} = \frac{\Delta T_1 - \Delta T_2}{\ln\left(\frac{\Delta T_1}{\Delta T_2}\right)} = \frac{30°\text{C} - 15°\text{C}}{\ln\left(\frac{30°\text{C}}{15°\text{C}}\right)}$$

$$\text{LMTD} = 21.64°\text{C}$$

$$\text{Heat transfer} = \dot{m}_h c_{ph}(T_{hi} - T_{ho}) = U.A(\text{LMTD})$$

$$10^3 \times 0.277 \times 2 \times (70 - 40) = 0.2 \times 1000 \times A \times 21.64$$
$$A = 3.84 \text{ m}^2$$

21. (d)

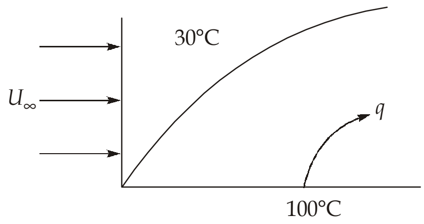
The relative magnitude of the dimensionless parameter $\frac{Gr}{\mathrm{Re}^2}$ governs the relative importance of natural convection in relation to forced convection where,

$$\frac{Gr}{\mathrm{Re}^2} = \frac{g\beta(T_w - T_\infty)L}{U_0^2}$$

which represents the ratio of the buoyancy forces to inertia forces.

22. (c)

Velocity of air, $U_\infty = 30 \text{ m/s}$



$$\text{Reynold number, } Re_L = \frac{U_\infty L}{\nu} = \frac{30 \times L}{18.97 \times 10^{-6}}$$

$$= 1.5814 \times 10^6 \text{ L} \qquad \text{...(1)}$$

As we know,

$$\text{Drag force, } F_D = C_D \times \frac{1}{2} \rho U_\infty^2 A$$

$$10.5 = \frac{0.0742}{(1.5814 \times 10^6 L)^{1/5}} \times \frac{1}{2} \times 1.06 \times 30^2 \times L^2$$

$$10.5 = 2.0376 L^{(2 - 0.2)}$$

$$L^{1.8} = 5.1532$$

$$L = (5.1532)^{1/1.8}$$

$\Rightarrow$ $$L = 2.486 \text{ m}$$

From eq. (1)

$$Re_L = 1.5814 \times 10^6 \times 2.486$$

$$= 3.9314 \times 10^6$$

$$C_D = \frac{0.0742}{(3.9314 \times 10^6)^{1/5}} = 3.5604 \times 10^{-3}$$

By simple Reynolds analogy,

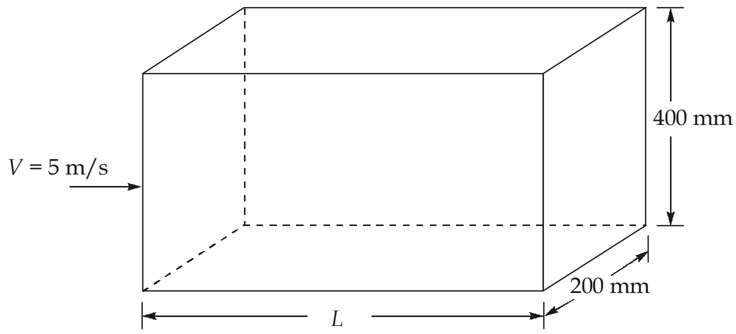
$$\overline{St} = \frac{C_D}{2}$$

$\Rightarrow$ $$\frac{\bar{h}}{\rho U_\infty c_p} = \frac{C_D}{2}$$

$\Rightarrow$ $$\bar{h} = \frac{3.5604 \times 10^{-3}}{2} \times 1.06 \times 30 \times 1.005 \times 1000$$

$$= 56.893 \text{ W/m}^2\text{K}$$

23. (c)



Hydraulic diameter, $D_h = \dfrac{4A}{P} = \dfrac{4\times 200\times 400}{2(200+400)}$

$$D_h = 266.667 \text{ mm}$$

Reynolds number, $\text{Re} = \dfrac{VD_h}{\nu} = \dfrac{5\times 0.266667}{15.06\times 10^{-6}}$

$$= 88.535 \times 10^3 > 2000$$

So, flow is turbulent,

Prandtl number, $\text{Pr} = \dfrac{\nu}{\alpha} = \dfrac{15.06\times 10^{-6}}{7.71\times 10^{-2}/3600} = 0.7032$

For heating of fluid case,

$$\text{Nu} = 0.023(\text{Re})^{0.8}(\text{Pr})^{0.4}$$

$$= 0.023(88.535 \times 10^3)^{0.8}(0.7032)^{0.4}$$

$$\text{Nu} = 181.239$$

$\Rightarrow$ $$\frac{h\times D_h}{k} = 181.239$$

$$\frac{h\times 0.266667}{0.026} = 181.239$$

$\Rightarrow$ $$h = 17.671 \text{ W/m}^2\,°\text{C}$$

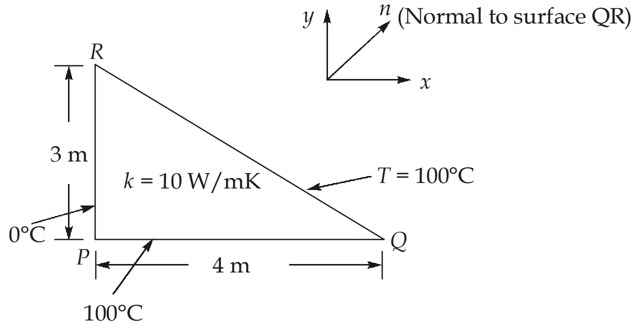
Heat transfer rate per unit length per unit temperature difference,

$$Q = h(PL)(\Delta T)$$

$$\frac{Q}{L\Delta T} = 17.671 \times 2(0.2 + 0.4)$$

$$\frac{Q}{L\Delta T} = 21.205 \text{ W/m°C}$$

24. (a)



At surface PQ

$$q_{PQ} = -k \times A \frac{\partial T}{\partial y} = -10 \times 4 \times -30 = 1200 \text{ W/m}$$

At surface RQ

$$q_{RQ} = -k \times A \frac{\partial T}{\partial n} = -10 \times 5 \times 60 = -3000 \text{ W/m}$$

From energy balance,

$$q_{PQ} + q_{PR} = q_{RQ}$$

$$1200 + q_{PR} = -3000$$

$$q_{PR} = -4200 \text{ W/m} = -10 \times 3 \times \frac{\partial T}{\partial x}$$

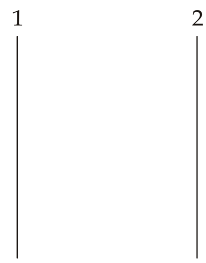
$$\frac{\partial T}{\partial x} = 140 \text{ K/m}$$

$$\frac{\partial T}{\partial y} = 0 \qquad (\because \text{Heat flows normal to surface})$$

25. (b)

Without shield

Radiation heat transfer rate,

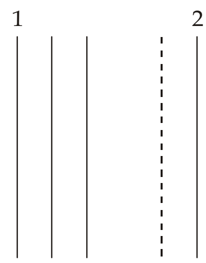


$$q = \frac{\sigma\left(T_1^4 - T_2^4\right)}{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1}$$

Let number of shields be N.

With shield

Radiation heat transfer rate,



Shields

$$q' = \frac{\sigma\left(T_1^4 - T_2^4\right)}{\left(\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1\right) + N\left(\frac{2}{\varepsilon} - 1\right)}$$

As per the conditions,

$$q' = (1 - 0.9)q$$

$$\frac{q}{q'} = \frac{1}{0.1} = 10$$

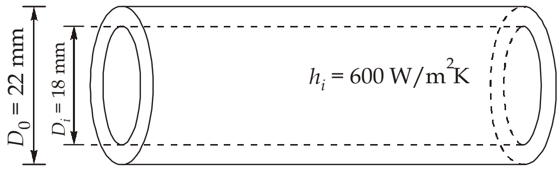
$$\frac{\left(\frac{1}{\varepsilon_1}+\frac{1}{\varepsilon_2}-1\right)+N\left(\frac{2}{\varepsilon}-1\right)}{\left(\frac{1}{\varepsilon_1}+\frac{1}{\varepsilon_2}-1\right)} = 10$$

$$\frac{\left(\frac{1}{0.8}+\frac{1}{0.6}-1\right)+N\left(\frac{2}{0.29}-1\right)}{\left(\frac{1}{0.8}+\frac{1}{0.6}-1\right)} = 10$$

Number of shields, $N = 2.925$

$N \simeq 3$

26. (c)



Fouling factor,

$$R_o = 0.009 \text{ m}^2\text{K/W}$$

With Fouling

Overall heat transfer coefficient based on outside area (U_o) is given by:

$$\frac{1}{U_oA_o} = \frac{1}{h_iA_i}+\frac{\ln\left(\frac{D_o}{D_i}\right)}{2\pi kl}+\frac{1}{h_oA_o}+\frac{R_o}{A_o}$$

Since, thermal resistance offered by copper tube is to be neglected,

$$\frac{\ln\left(\frac{D_o}{D_i}\right)}{2\pi kl} = 0$$

$$\frac{1}{U_oA_o} = \frac{1}{h_iA_i}+\frac{1}{h_oA_o}+\frac{R_o}{A_o}$$

$$\frac{1}{U_o} = \frac{1}{h_i}\left(\frac{A_o}{A_i}\right)+\frac{1}{h_o}+R_o$$

$$U_o = \frac{1}{\frac{1}{h_i}\left(\frac{A_o}{A_i}\right)+\frac{1}{h_o}+R_o} = \frac{1}{\frac{1}{h_i}\left(\frac{\pi D_oL}{\pi D_iL}\right)+\frac{1}{h_o}+R_o}$$

$$U_o = \frac{1}{\frac{1}{h_i}\left(\frac{D_o}{D_i}\right)+\frac{1}{h_o}+R_o} = \frac{1}{\frac{1}{600}\times\frac{22}{18}+\frac{1}{150}+0.009}$$

$$U_o = 56.485 \text{ W/m}^2\text{K}$$

Without fouling

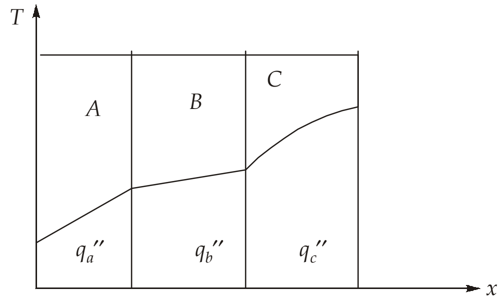
$$U_o' = \frac{1}{\frac{1}{h_i}\left(\frac{D_o}{D_i}\right)+\frac{1}{h_o}} = \frac{1}{\frac{1}{600}\times\frac{22}{18}+\frac{1}{150}}$$

$$U_o' = 114.8936 \text{ W/m}^2\text{K}$$

% increase

$$\frac{U_o'-U_o}{U_o}\times 100 = \frac{114.8936-56.485}{56.485} = 103.405\%$$

27. (b)



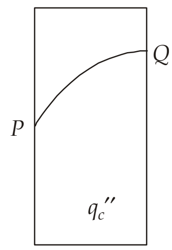
For 1-D steady state, constant k conditions.
Parabolic distribution in C implies heat generation.

$$\therefore \quad q_b'' > q_c''$$

For linear profiles in A and B,

$$q_a'' = q_b''$$

Note : Consider the last slab, as slope of temperature is changing then heat flux will also change at each point.



$$q'' = -kA\frac{\partial T}{\partial x}$$

$$\text{Slope at } P\left(\frac{\partial T}{\partial x}\right)_P = \text{Slope at } Q\left(\frac{\partial T}{\partial x}\right)_Q$$

That means, $\quad q_P'' > q_Q''$

As q'' is not constant throughout the wall C, so we should take average i.e.

$$(\text{Average})\, q_C'' = \frac{q_P''+q_Q''}{2}$$

and, $\quad q_C'' < q_P''$

But for wall B, $q_B'' = q_P''$, which is greater than q_C''

Here, the whole heat flux at left wall of C will go to the wall B for steady state.

28. (b)

$$\overline{Nu} = C\,\mathrm{Re}^m\,\mathrm{Pr}^n$$

$$\bar{h}L \propto (VL)^m$$

$$\frac{h_1L_1}{h_2L_2} = \left(\frac{V_1L_1}{V_2L_2}\right)^m$$

$$L_1 = L_2 = L$$

$$\therefore \quad \frac{60}{30} = \left(\frac{25}{15}\right)^m$$

$$\therefore \quad m = 1.3569$$

When $V = 40$ m/s

$$\frac{\bar{h}}{60} = \left(\frac{40}{25}\right)^{1.3569}$$

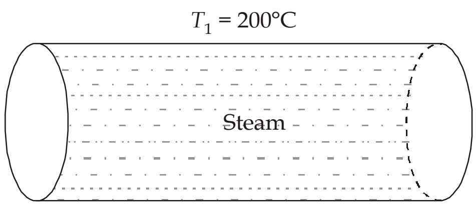
$$\Rightarrow \quad h = 113.53 \text{ W/m}^2\text{K}$$

29. (b)

Nu = 1 Implies heat transfer is by pure conduction,

Nu = 1 is a limiting case of convection.

30. (c)



Heat transfer rate due to radiation,

$$q = \varepsilon\sigma(T_1^4 - T_2^4)$$

$$= 0.8 \times 5.67 \times 10^{-8} \times [(200 + 273)^4 - (25 + 273)^4] = 1912.7638 \text{ W/m}^2$$

$$= h_r(T_1 - T_2)$$

where, h_r = Radiation heat transfer coefficient

$$\Rightarrow \quad 1912.7638 = h_r \times (200 - 25)$$

$$h_r = 10.93 \text{ W/m}^2\text{K}$$

Convection heat transfer coefficient

$$h_c = 6 \text{ W/m}^2\text{-K}$$

So, combined heat transfer coefficient

$$= h_r + h_c = 10.93 + 6 = 16.93 \text{ W/m}^2\text{-K}$$

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