SUBJECT: Exam 1 DATE: 3/1/22 1/

1) a. Conduction
b. Convection
c. Conduction
d. convection
e conduction
F radiation
g conduction
h conduction
i convection
J. convection

2) B. Aluminum

3) $\Delta T = 90°C$ $(90°C(1.8)+\cancel{32}) - (0(1.8)+\cancel{32}) = \Delta T\,°F$

$$90(1.8) = \Delta T\,°F$$

$$\boxed{\Delta T = 162°F}$$

4) $q'' = -k\frac{dT(x)}{dx}$

$$q'' = -10\tfrac{W}{m\cdot K}\frac{d}{dx}(-100x^2+10x+5)$$

$$q'' = -10\tfrac{W}{m\cdot K}(-200x+10)\tfrac{K}{m}$$

$$q'' = -10(-200+10)$$

$$\boxed{q'' = 1900\ \tfrac{W}{m^2}}$$

5) $q = \dfrac{\Delta T \cdot 4\pi k}{\frac{1}{r_1} - \frac{1}{r^2}}$

$$\frac{\frac{1}{r_1} - \frac{1}{r_2}}{4\pi k} = \frac{\Delta T}{q} = \boxed{R = \frac{\frac{1}{r_1} - \frac{1}{r_2}}{4\pi k}}$$

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6) $L = 25m$ $T_p = 423.15K$ $h_c = 10 \frac{W}{m^2 \cdot K}$

$d = 100mm$ $T_\infty = 298.15K$ $\varepsilon = 0.8$

$h_r = 4 \cdot 0.8 \cdot 5.67 \times 10^{-8} (360.65)$

$h_r = 8.511 \frac{W}{m^2 \cdot K}$

$q = \Delta T / R =$

$q'' = \Delta T / \left(\frac{1}{h_r} + \frac{1}{h_c}\right)$

$q'' = 150 - 25 / \left(\frac{1}{8.511} + \frac{1}{10}\right)$

$q'' = 125 / 0.21749$

$\boxed{q'' = 574.73 \ W/m^2}$

or

$574.73 \frac{W}{m^2} (2\pi (0.05m) \cdot 25) m^2 = 4513.94W$

Total loss

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7) a. $\dot{m} = G \cdot A_c$

$\dot{m} = 45.25 \frac{kg}{m^2 \cdot s} (0.01 \times 0.03)\, m^2$

$\boxed{\dot{m} = 0.013575\ kg/s}$

b. $\dot{Q} = \dot{m}/\rho$

$\dot{Q} = 0.013575\ kg/s \,/\, 854\ kg/m^3$

$\boxed{\dot{Q} = 1.5896 \times 10^{-5}\ m^3/s}$

c. $V = \dot{Q}/A_c$

$V = 1.5896 \times 10^{-5}\ m^3/s \,/\, (0.01 \times 0.03)\, m^2$

$\boxed{V = 0.05299\ m/s}$

d. $Re = V \cdot D_h / \nu$

$Re = \left(0.05299 \cdot 4 \cdot \frac{3 \times 10^{-4}}{(0.01 \times 2 + 0.03 \times 2)}\right) / 4.1 \times 10^{-5}$

$\boxed{Re = 19.385}$

e. $h_c = Nu \frac{k}{D_h}$

$h_c = 4.8 \left(0.139 / 4 \cdot \frac{3 \times 10^{-4}}{0.08}\right)$

$\boxed{h_c = 44.48 \frac{W}{m^2 \cdot K}}$

f. $\Delta T_{w,f} = \frac{q''}{h_c}$

$\Delta T_{w,f} = 300/44.48$

$\boxed{\Delta T_{w,f} = 6.7446\, K}$

g. $\Delta T_{i,o} = q / \dot{m} \cdot c_p$

$\Delta T_{i,o} = 300 \cdot 3 \times 10^{-4} \cdot 0.1 \,/\, 0.013575(2120)$

$\boxed{\Delta T_{i,o} = 3.127 \times 10^{-4}\, K}$

h. $\Delta P = \frac{1}{2} \rho \cdot V^2 \cdot \frac{64}{19.385} \cdot \frac{0.1}{D_h}$

$\boxed{\Delta P = 28.45\ Pa}$

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8) Room: $T_{air} = 20°C$ $T_s = 32°C$

$T_{w,s} = 27°C$ $\varepsilon = 0.9$

$T_{w,w} = 14°C$ $h_c = 2\ W/m^2 \cdot K$

The heat loss is greater

Summer

$q'' \cdot A = \frac{\Delta T}{\sigma}$

$q'' = \frac{T_s - T_{ws}}{\frac{1}{h_r} + \frac{1}{h_c}}$

$q'' = \frac{(32-27)}{\frac{1}{5.46} + \frac{1}{2}}$

$q'' = 5K / 0.682998 \frac{K \cdot m^2}{W}$

$\boxed{q'' = 7.32\ W/m^2}$

$h_r = 4 \cdot 0.9 \cdot 5.67 \times 10^{-8} \cdot 299.15$

$h_r = 5.46$

Winter

$q'' = \frac{(32-14)K}{0.682998 \frac{K \cdot m^2}{W}}$

$\boxed{q'' = 26.35\ W/m^2}$

The heat loss during the winter is greater between the person and the wall.

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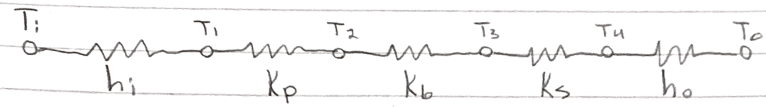
9) $h_o = 60 \frac{W}{m^2 \cdot K}$ $\quad K_p = 0.17$
$h_i = 30 \frac{W}{m^2 K}$ $\quad K_b = 0.038$ $\left.\right\} \frac{W}{m \cdot K}$
$A = 350 m^2$ $\quad K_s = 0.12$



$R_{h_i} = \frac{1}{h_i \cdot A} = \frac{1}{30 \cdot 350} = 9.5238 \times 10^{-5} \frac{K}{W}$
$R_{K_p} = \frac{L}{K \cdot A} = \frac{0.01}{0.17 \cdot 350} = 1.6807 \times 10^{-4} \frac{K}{W}$
$R_{K_b} = \cdots = \frac{0.1}{0.038(350)} = 0.007519 \frac{K}{W}$
$R_{K_s} = \cdots = \frac{0.02}{0.12(350)} = 4.7619 \times 10^{-4} \frac{K}{W}$
$R_{h_o} = \cdots = \frac{1}{60(350)} = 4.7619 \times 10^{-5} \frac{K}{W}$

$\Sigma R = 0.0083059$

$q = \Delta T / R = \frac{(20 - -15)K}{\Sigma R}$
$\boxed{q = 4213.87 W}$

New $R_{h_o} = \frac{1}{300(350)} = 9.5238 \times 10^{-6}$ $\quad \Sigma R = 0.00827$

$\boxed{q = 4233.28 W}$ % increase: $\boxed{0.4607 \% \text{ increase}}$

The glass fiber blanket has the largest resistance so it controls the majority of the heat flow.