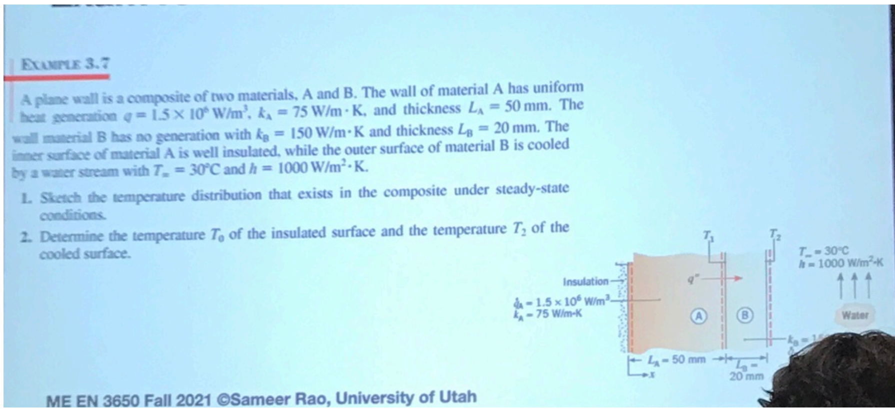


WHY HEAT GEN → PARABOLIC?

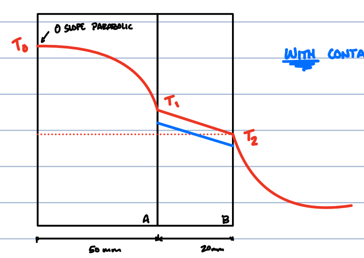
ASSUMPTIONS:
1. 1D HEAT X-FER IN x
2. STEADY STATE
3. NEGLIGIBLE CONTACT RESISTANCE
4. ADIABATIC WALL ON LEFT
5. CONSTANT k

FEATURES WE EXPECT

WALL A:
- WE <u>DON'T</u> EXPECT LINEAR DISTRIBUTION
  - BASED ON SOLUTION: x^2 (PARABOLIC)
- INSULATED ⇒ 0 SLOPE @ INSULATION INTERFACE

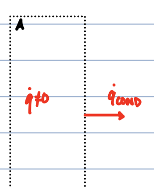
WALL B:
- LINEAR T PROFILE
- $k_B > k_A$

CONVECTION
- AT OUTSIDE WALL B



WITH CONTACT RESISTANCE

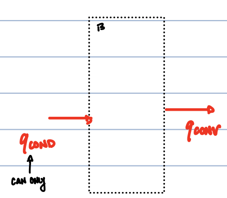
T_1:



$$\dot{q}(L_A A) = q''_{cond} A$$

$$q''_{cond} = \dot{q} L_A$$

$\dot{q}$ = VOLUMETRIC HEAT GEN



$$\dot{E}_{IN} = \dot{E}_{OUT}$$

$$q_{cond} A = q_{conv} A$$

$$\dot{q} L_A = h(T_2 - T_\infty)$$

$$\Rightarrow T_2 = T_\infty + \frac{\dot{q} L_A}{h} = 105\,°C \qquad \boxed{T_2 = 105\,°C}$$

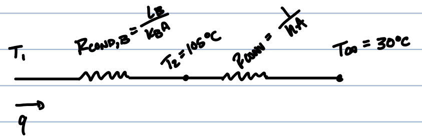
$T_0 = ?$

ANALYTICAL SOLUTION

$$T_0 = \frac{\dot{q} L_A^2}{2K_A} + \underbrace{T_1}$$

WE DON'T HAVE T_1

BE CAREFUL W/AREAS



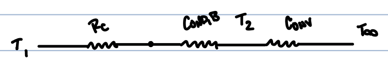
$q = q''_{COND} A = q_{COND}$

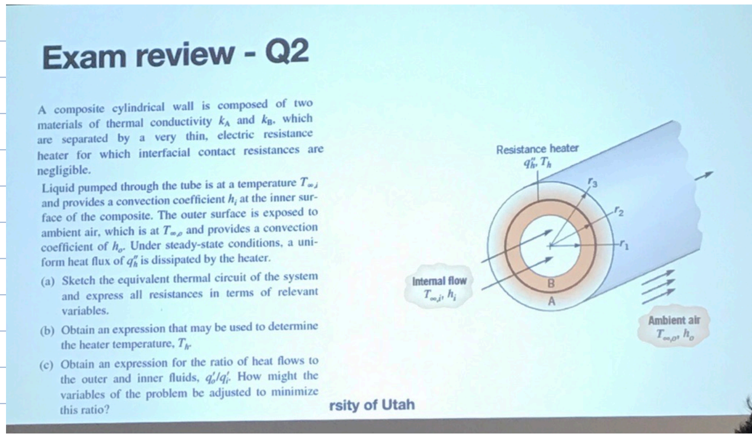
$$\frac{T_1 - T_\infty}{\left(\frac{L_B}{K_B A} + \frac{1}{hA}\right)} = \dot{q} A$$

$\hookrightarrow T_1 = T_\infty + \left(\frac{L_B}{K_B} + \frac{1}{h}\right) \dot{q} L_A$

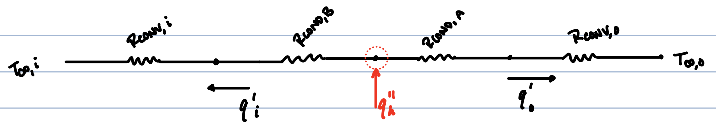
$\rightarrow T_1 = 115 °C$

$\Rightarrow \boxed{T_0 = 140 °C}$





ASSUME : STEADY STATE



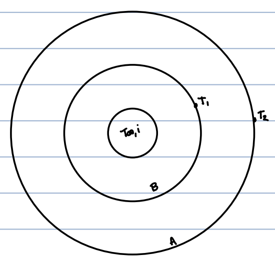
$$R_{COND,r} = \frac{\ln\left(\frac{r_2}{r_1}\right)}{2\pi k L}$$

WE CAN DO THIS ON A PER UNIT LENGTH BASIS

$$R_{CONV,i} = \frac{1}{hA} \qquad R_{COND,B} = \frac{\ln(r_2/r_1)}{2\pi k_B}$$

$$R'_{CONV,i} = \frac{1}{h_i 2\pi r_1} \qquad R_{COND,A} = \frac{\ln(r_3/r_4)}{2\pi k_A}$$

$$R_{CONV,o} = \frac{1}{h 2\pi r_3}$$



$T_1 \to T_\infty$

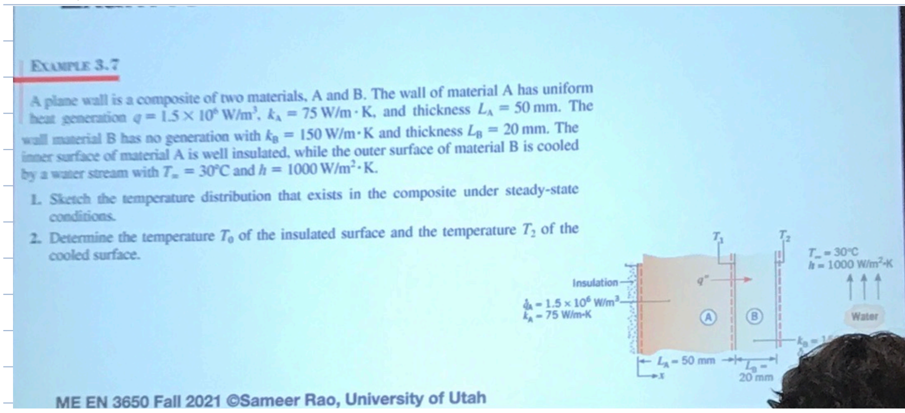
$\dot{E}_{IN} = \dot{E}_{OUT}$

$$q''_h \underbrace{(2\pi r_2)}_{\text{WHERE } q_h \text{ COMES IN}} = q'_i + q'_o$$

$q'_i \to T_1 \to T_{\infty,i}$

$q'_o \to T_1 \to T_{\infty,o}$

TRY 1

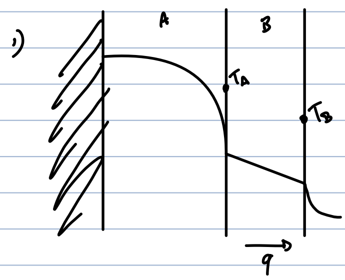


$q = 1.5 \cdot 10^6 \frac{W}{m^3}$ $\quad k_A = 75 \frac{W}{mK}$ $\quad L_A = 50mm$

$k_B = 150 \frac{W}{mK}$ $\quad L_B = 20mm$

$T_\infty = 30°C$ $\quad h = 1000 \frac{W}{m^2K}$

1)



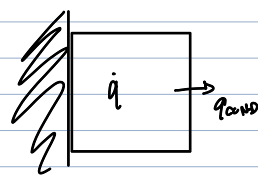
$T(x) = -\frac{q}{2k} + C_1 x + C_2$

IN A:

$\cancel{\dot{E}_{IN}}^{0} - \dot{E}_{OUT} + \dot{E}_g = \cancel{\dot{E}_{SYS}}^{0}$

$\dot{E}_g = \dot{E}_{OUT}$

ASSUME $L = 1$



$L_A \quad \dot{E}_g$

$\dot{q} \, L_A A = q_{COND}$

$\dot{q} L_A = q''_{COND}$

$\Rightarrow$

$\dot{q} L_A = h(T_B - T_\infty)$

$\Rightarrow T_B = \frac{\dot{q} L_A}{h} + T_\infty = 105°C$

$q L_A = k\left(\frac{T_A - T_B}{L_B}\right)$ SOLVE FOR T_A

$\frac{L_B}{k} \dot{q} L_A = T_A - T_B \quad \Rightarrow \frac{L_B}{k_B} \dot{q} L_A + T_B = T_A = \boxed{115°C}$

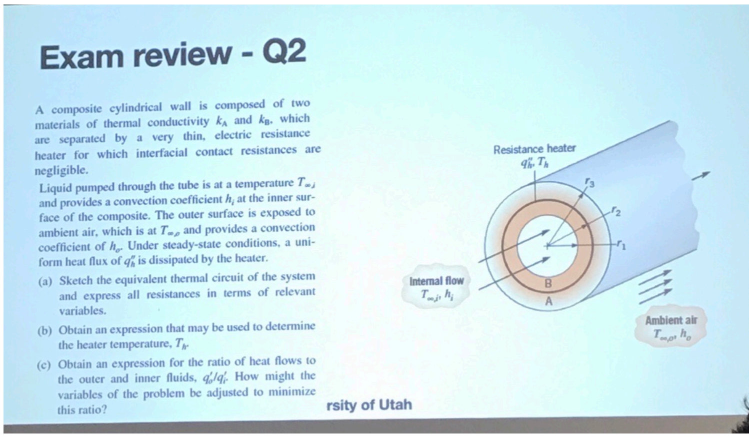
$\frac{(T_0 - T_A)}{L_A} k_A = k_B \frac{T_A - T_B}{L_B}$

IN B: $h(T_B - T_\infty) = q''A$

$\dot{E}_{IN} - \dot{E}_{OUT} + \cancel{\dot{E}_g}^{0} = \cancel{\dot{E}_s}^{0}$

$\dot{E}_{IN} = \dot{E}_{OUT}$

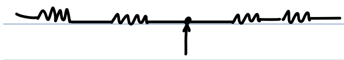
$(T_B - T_\infty) h = k \frac{(T_A - T_B)}{L_B}$



$T_{\infty,i}$ $T_{\infty,o}$

h_i

q''_h



q''_h