I affirm that all the work done on this exam is my own and that I have not given nor received any help during this exam. I understand that any indication of violation of this word of honour may lead to a zero grade on this exam and to a disciplinary action.
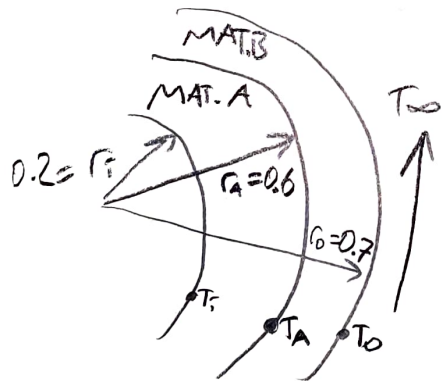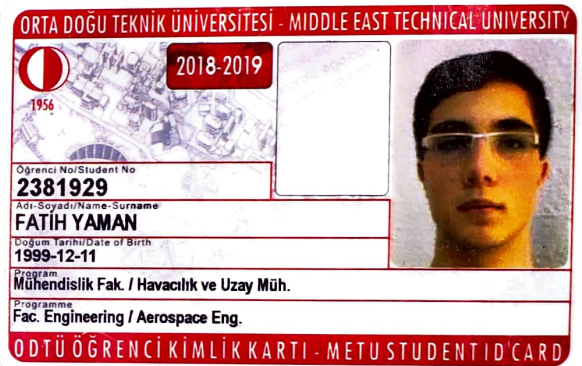
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2.12.2021

(signature)

AEE 331   Mid-Term 1

Question 1

$k_A = 40\ W/mK$
$k_B = 15\ W/mK$
$h_0 = 80\ W/m^2K$
$T_\infty = 300\ K$
$T_i = 500\ K$

Assumptions:

1) 1D problem (in r direction)
2) Steady state
3) No heat generation
   (i.e. Heat is inputted through the inner surface)
4) Gray surface for radiation

$$R_{t,cond} = \frac{1}{4\pi k}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

$$R_{t,cond,A} = \frac{1}{4\pi\,40}\left(\frac{1}{0.2} - \frac{1}{0.6}\right) = 6.631456\times10^{-3}$$

$$R_{t,cond,B} = \frac{1}{4\pi\,15}\left(\frac{1}{0.6} - \frac{1}{0.7}\right) = 1.263134\times10^{-3}$$

$$R_{t,conv} = \frac{1}{h4\pi r_2^2}$$

$$R_{t,conv,B} = \frac{1}{(80)4\pi(0.7)^2} = 2.030038\times10^{-3}$$

then   this system is:

q is constant throughout the network

q_{input} T_i $R_{t,cond,A}$ T_A $R_{t,cond,B}$ T_o $R_{t,conv,B}$ T_∞

$$q_{input} = \frac{T_i - T_\infty}{R_{t,cond,A} + R_{t,cond,B} + R_{t,conv,B}} = \frac{500-300}{9.924628\times10^{-3}}$$

$$q_{input} = 20151.889\,W \cong 20.152\,kW$$

Answer of (a) is this.

Now   we   need T_o.

$$q_{input} = \frac{T_i - T_o}{R_{t,cond,A} + R_{t,cond,B}} = \frac{500 - T_o}{7.894590 \times 10^{-3}} = 20151.889$$

$$T_o = -20151.889 \times 7.894590 \times 10^{-3} + 500$$

$$\boxed{T_o = 340.909\ ^\circ K}$$ Temperature of the outer surface of B.
Answer of (b) is this.