ME 310 (Heat Transfer)

Jan 26, 1999

1) A tube bank uses an in-line arrangement with $S_n = S_p = 4.9$ cm and 33 mm-diameter tubes. Six rows of tubes are employed with a stack of 8 tubes high. The surface temperature of the tubes is constant at 10°C, and atmospheric air at 20°C is forced across them at an inlet velocity of 4.5 m/s before the flow enters the tube bank. Calculate the total heat transfer per unit length for the tube bank.

2) A square plate 0.5 x 0.5 m is thermally insulated on one side and subjected to a radiation flux $q'' = 600\ W/m^2$ on the other side which is considered as black body. The plate makes an angle $\theta = -60°$ with the vertical so that the hot surface is facing upward. The heated surface dissipates heat by free convection into quiescent pool of water at $T_\infty = 300$ K. Calculate the equilibrium temperature of the plate.

3) The emission of radiation from a surface can be approximated as a blackbody radiation at $T = 1000$ K.

a) What fraction of the total energy emitted is below $\lambda = 5\ \mu m$?

b) What is the wavelength below which the emission is 10.5 % of the total emission at 1000 K?

c) What is the wavelength at which the maximum spectral emission occurs at 1000 K?

4) The radiation properties and the surface conditions for a 4-zone enclosure with all sides equal are as follows:

Surface	1	2	3	4
Temp [K]	900	500	400	Insulated
ε	1	0.8	0.8	

Sketch the radiation network with the different resistances.

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1) See Example 6-9

2) $\frac{q}{A} = 600 W/m^2$ $\quad T_\infty = 300K \rightarrow T_\infty = 27°C$

$$\frac{q}{A} = \sigma(T^4 - T_s^4) + h(T - T_\infty)$$

$h = ?$ $\quad \rightarrow T_w = 100.626°C.$

Assuming $T_e = 82.22°C \rightarrow \frac{g\beta\rho^2 c_p}{\mu k} = 1.09 \times 10^{11}$.

$$Gr_e Pr = 1.09 \times 10^{11} \times 0.5^3 \times (T_w - T_\infty) = 1.003 \times 10^{12}$$

$Gr_e Pr \cos(-60) = 5.015 \times 10^{11}$. assuming eq. 7-46 works.

$\rightarrow \overline{Nu_e} = \text{---}$

$\rightarrow h = \text{---}$

$T = \text{---}$.

Iterate —.

3) $T = 1000\,K$

$\rightarrow \lambda T = 5 \times 1000 \xrightarrow{\text{Table (8-1)}} \frac{E_{b,\lambda}}{\sigma T^4} = \text{---}$

$\frac{E_{b,\lambda}}{\sigma T^4} = 0.105 \rightarrow \lambda T = \text{---} \Rightarrow \lambda = \text{---}$

$\frac{E_{b,\lambda}}{\sigma T^4} = 1 \rightarrow \lambda T = \text{---} \Rightarrow \lambda = \text{---}$

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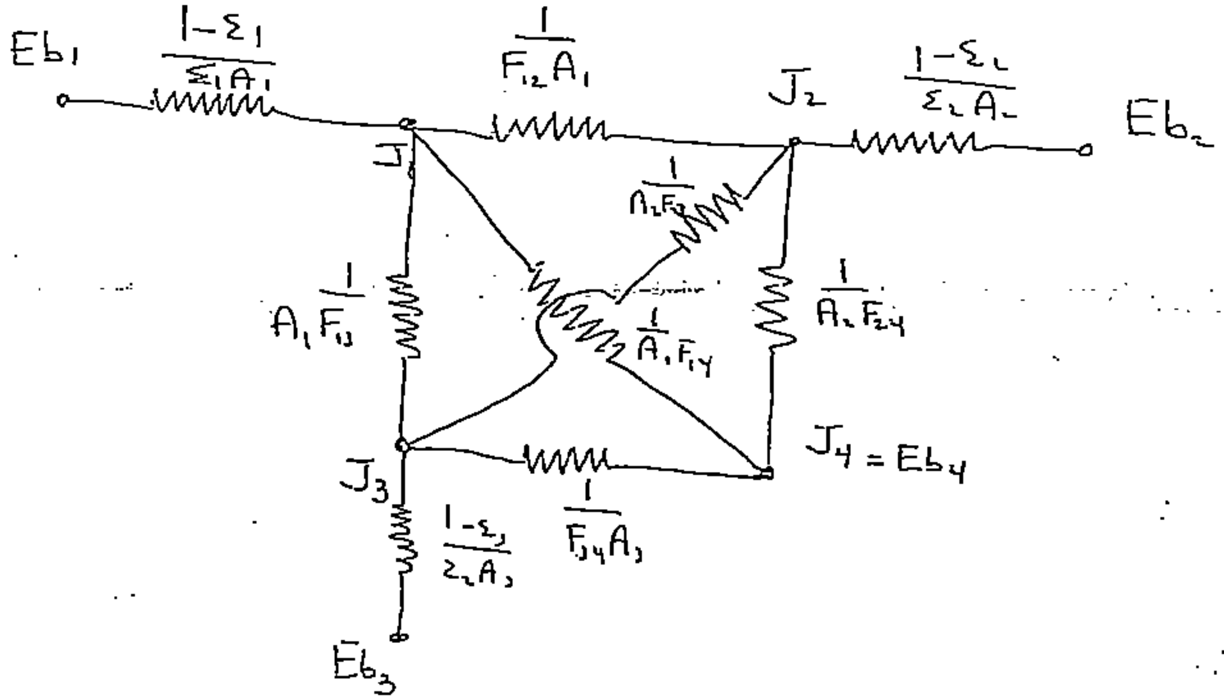
(4)



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