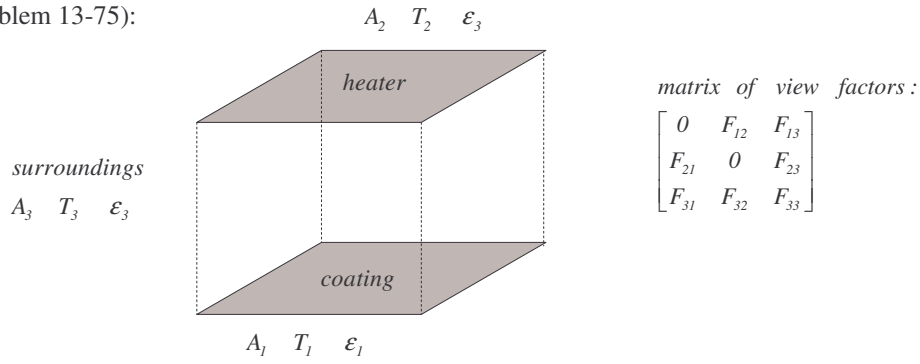


3-surface problem (Problem 13-75):



Given: $\begin{bmatrix} T_1 \\ T_2 \\ T_3 \end{bmatrix} \Rightarrow \begin{bmatrix} E_{b1} = \sigma T_1^4 \\ E_{b2} = \sigma T_2^4 \\ E_{b3} = \sigma T_3^4 \end{bmatrix} \Rightarrow \begin{bmatrix} E_{b1} \\ E_{b2} \\ E_{b3} \end{bmatrix}$ Find: $\begin{bmatrix} q_1'' \\ q_2'' \\ q_3'' \end{bmatrix}$

System of equations of NRM:

$$\begin{aligned} \frac{q_1''}{\epsilon_1} - F_{11} \left(\frac{1}{\epsilon_1} - 1 \right) q_1'' - F_{12} \left(\frac{1}{\epsilon_2} - 1 \right) q_2'' - F_{13} \left(\frac{1}{\epsilon_3} - 1 \right) q_3'' &= F_{11} (E_{b1} - E_{b1}) + F_{12} (E_{b1} - E_{b2}) + F_{13} (E_{b1} - E_{b3}) \\ \frac{q_2''}{\epsilon_2} - F_{21} \left(\frac{1}{\epsilon_1} - 1 \right) q_1'' - F_{22} \left(\frac{1}{\epsilon_2} - 1 \right) q_2'' - F_{23} \left(\frac{1}{\epsilon_3} - 1 \right) q_3'' &= F_{21} (E_{b2} - E_{b1}) + F_{22} (E_{b2} - E_{b2}) + F_{23} (E_{b2} - E_{b3}) \\ \frac{q_3''}{\epsilon_3} - F_{31} \left(\frac{1}{\epsilon_1} - 1 \right) q_1'' - F_{32} \left(\frac{1}{\epsilon_2} - 1 \right) q_2'' - F_{33} \left(\frac{1}{\epsilon_3} - 1 \right) q_3'' &= F_{31} (E_{b3} - E_{b1}) + F_{32} (E_{b3} - E_{b2}) + F_{33} (E_{b3} - E_{b3}) \end{aligned}$$

a) Black surfaces: $\epsilon_1 = \epsilon_2 = \epsilon_3 = 1$

$$\begin{aligned} q_1'' &= F_{12} (E_{b1} - E_{b2}) + F_{13} (E_{b1} - E_{b3}) \\ q_2'' &= F_{21} (E_{b2} - E_{b1}) + F_{23} (E_{b2} - E_{b3}) \\ q_3'' &= F_{31} (E_{b3} - E_{b1}) + F_{32} (E_{b3} - E_{b2}) \end{aligned}$$

b) Reradiating surface (insulated): $q_3'' = 0$

$$\begin{aligned} q_1'' &= F_{12} (E_{b1} - E_{b2}) + F_{13} (E_{b1} - E_{b3}) \\ q_2'' &= F_{21} (E_{b2} - E_{b1}) + F_{23} (E_{b2} - E_{b3}) \\ 0 &= F_{31} (E_{b3} - E_{b1}) + F_{32} (E_{b3} - E_{b2}) \end{aligned}$$

Given: $\begin{bmatrix} E_{b1} \\ E_{b2} \\ q_3'' = 0 \end{bmatrix}$ Find: $\begin{bmatrix} q_1'' \\ q_2'' \\ E_{b3} \end{bmatrix}$

Net flux q_2'' can be found also from the equation 13.25, which for the black surfaces is reduced to:

$$q_2'' = \frac{E_{b2} - E_{b1}}{\frac{1}{F_{21} + \frac{1}{\frac{1}{F_{23}} + \frac{1}{A_1 F_{13}}}}}} = (E_{b2} - E_{b1}) \left[F_{21} + \frac{1}{\frac{1}{F_{23}} + \frac{1}{A_1 F_{13}}}} \right] = (E_{b2} - E_{b1}) \left[F_{21} + \frac{1}{\frac{1}{F_{23}} + \frac{1}{F_{13}}} \right] \quad \text{Then } q_1'' = -\frac{A_2}{A_1} q_2''$$