FDE 208 HEAT TRANSFER AND THERMAL PROCESSES

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RADIATION HEAT TRANSFER

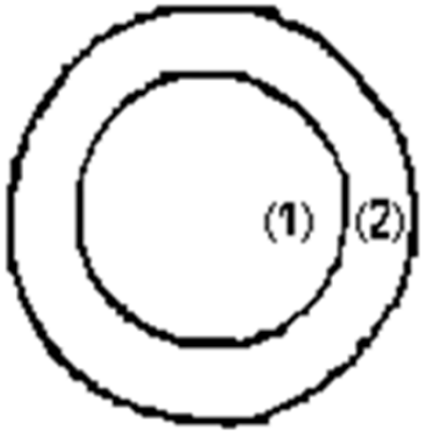
CALCULATION OF SHAPE FACTOR

Shape factor can be defined as the ratio how much energy leaving a surface reaches to the other surface.

For the system given in the figure

$F_{12}=1$

$F_{11}=0$

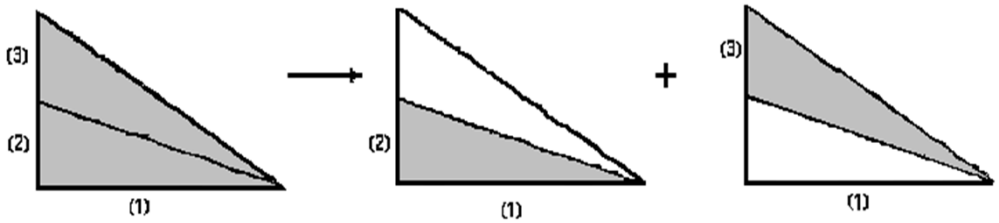


$$A_i = A_j \Rightarrow F_{ij} = F_{ji}$$

$$A_i \neq A_j \Rightarrow A_i F_{ii} = F_{ii} A_i$$

$$\sum_{j=1}^{N} F_{ij} = 1$$

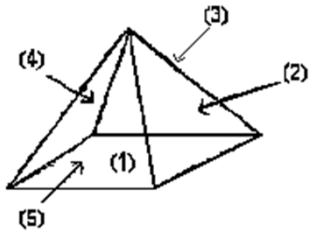
$$\Rightarrow \begin{matrix} F_{11} + F_{12} = 1 \\ F_{21} + F_{22} = 1 \end{matrix}$$



$$F_{1\rightarrow(2,3)} = F_{12} + F_{13}$$

$$(A_2 + A_3)\, F_{(2,3)\rightarrow 1} = A_2 F_{21} + A_3 F_{31}$$

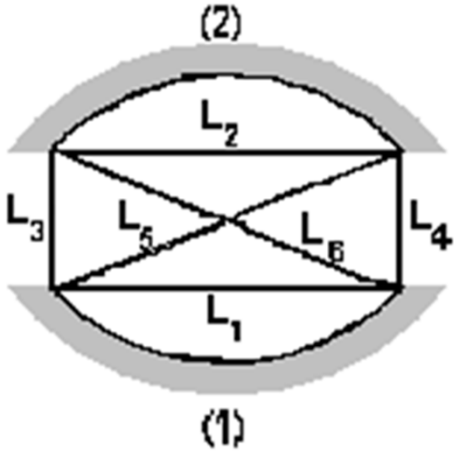
- Symmetry rule



$$F_{12} = F_{13} = F_{14} = F_{15}$$

$$F_{11} + F_{12} + F_{13} + F_{14} + F_{15} = 1 \Rightarrow F_{12} = 0,25$$

- Diagonality rule:



$$F_{12} = \frac{(L_5 + L_6) - (L_3 + L_4)}{2L_1}$$

$$F_{21} = \frac{(L_5 + L_6) - (L_3 + L_4)}{2L_2}$$

- Radiosity (J):

$$J_i = \varepsilon_i \cdot E_i + (1 - \varepsilon_i) \cdot G_i$$

$$\left.\begin{array}{c} \phi = \varepsilon(Kirchoff) \\ \Psi = 0 \end{array}\right\} \Rightarrow \chi = (1 - \varepsilon)$$

$$E_i = \sigma \cdot T_i^4$$

$$\varepsilon_i = 1 \Rightarrow J_i = E_i = \sigma \cdot T_i^4$$

Radiation energy=energy from the surface-energy to the surface

$$Q_i = A_i\left(J_i - G_i\right)$$

$$G_i = \frac{J_i - \varepsilon_i \cdot E_i}{1-\varepsilon_i} \Rightarrow Q_i = A_i\left(J_i - \frac{J_i - \varepsilon_i \cdot E_i}{1-\varepsilon_i}\right) = A_i\left(-\frac{\varepsilon_i\left(J_i + E_i\right)}{1-\varepsilon_i}\right)$$