Chapter 13, Solution 6.

An enclosure consisting of five surfaces is considered. The number of view factors this geometry involves and the number of these view factors that can be determined by the application of the reciprocity and summation rules are to be determined.

**Analysis** A five surface enclosure \(N=5\) involves \(N^2 = 5^2 = 25\) view factors and we need to determine \(\frac{N(N-1)}{2} = \frac{5(5-1)}{2} = 10\) view factors directly. The remaining \(25-10 = 15\) of the view factors can be determined by the application of the reciprocity and summation rules.

Chapter 13, Solution 8.

The view factors between the rectangular surfaces shown in the figure are to be determined.

**Assumptions** The surfaces are diffuse emitters and reflectors.

**Analysis** From Fig. 13-6,

\[
\begin{align*}
\frac{L_3}{W} &= \frac{1}{3} = 0.33 \quad \Rightarrow \quad F_{31} = 0.27 \\
\frac{L_1}{W} &= \frac{1}{3} = 0.33
\end{align*}
\]

and

\[
\begin{align*}
\frac{L_3}{W} &= \frac{1}{3} = 0.33 \\
\frac{L_1 + L_2}{W} &= \frac{2}{3} = 0.67
\end{align*}
\]

\(F_{3\rightarrow(1+2)} = 0.32\)

We note that \(A_1 = A_3\). Then the reciprocity and superposition rules gives

\[A_1 F_{13} = A_3 F_{31} \Rightarrow F_{13} = F_{31} = 0.27\]

\[F_{3\rightarrow(1+2)} = F_{31} + F_{32} \Rightarrow 0.32 = 0.27 + F_{32} \Rightarrow F_{32} = 0.05\]

Finally, \(A_2 = A_3 \Rightarrow F_{23} = F_{32} = 0.05\)
Chapter 13, Solution 9.

A cylindrical enclosure is considered. The view factor from the side surface of this cylindrical enclosure to its base surface is to be determined.

**Assumptions** The surfaces are diffuse emitters and reflectors.

**Analysis** We designate the surfaces as follows:

- Base surface by (1),
- top surface by (2), and
- side surface by (3).

Then from Fig. 13-7

\[
\begin{align*}
\frac{L}{\eta_1} &= \frac{4}{\eta_1} = 4, \\
\frac{r_2}{L} &= \frac{r_2}{4r_2} = 0.25
\end{align*}
\]

summation rule: \( F_{11} + F_{12} + F_{13} = 1 \)

\[
0 + 0.05 + F_{13} = 1 \rightarrow F_{13} = 0.95
\]

reciprocity rule: \( A_1 F_{13} = A_3 F_{31} \rightarrow F_{31} = \frac{A_1}{A_3} F_{13} = \frac{\pi r_1^2}{2\pi L} F_{13} = \frac{\pi r_1^2}{8\pi L} F_{13} = \frac{1}{8} (0.95) = 0.119
\]

**Discussion** This problem can be solved more accurately by using the view factor relation from Table 13-1 to be

\[
R_1 = \frac{\eta_1}{\eta} = \frac{\eta_1}{4r_1} = 0.25
\]

\[
R_2 = \frac{r_2}{L} = \frac{r_2}{4r_2} = 0.25
\]

\[
S = 1 + \frac{1 + R_2^2}{R_1^2} = 1 + \frac{1 + 0.25^2}{0.25^2} = 18
\]

\[
F_{12} = \frac{1}{2} \left\{ S - \left[ S^2 - 4 \left( \frac{R_2}{R_1} \right)^2 \right]^{0.5} \right\} = \frac{1}{2} \left\{ 18 - \left[ 18^2 - 4 \left( \frac{1}{4} \right)^2 \right]^{0.5} \right\} = 0.056
\]

\[
F_{13} = 1 - F_{12} = 1 - 0.056 = 0.944
\]

reciprocity rule: \( A_1 F_{13} = A_3 F_{31} \rightarrow F_{31} = \frac{A_1}{A_3} F_{13} = \frac{\pi r_1^2}{2\pi L} F_{13} = \frac{\pi r_1^2}{8\pi L} F_{13} = \frac{1}{8} (0.944) = 0.118
\]