5.12 Use the Liang–Barsky algorithm to clip the lines in Fig. 5-19.

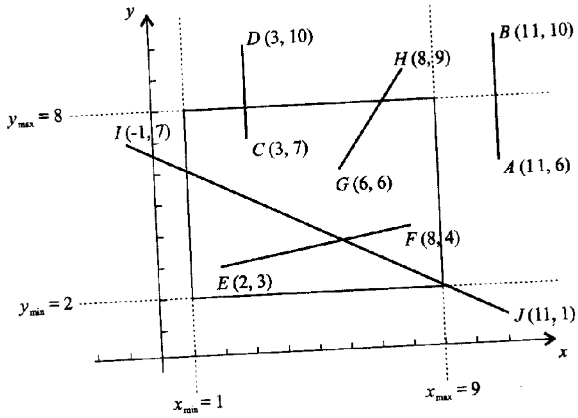

Fig. 5-19

SOLUTION

For line AB, we have

$$\begin{array}{ll} p_1 = 0 & q_1 = 10 \\ p_2 = 0 & q_2 = -2 \\ p_3 = -4 & q_3 = 4 \\ p_4 = 4 & q_4 = 2 \end{array}$$

Since $p_2 = 0$ and $q_2 < -2$, AB is completely outside the right boundary.

For line CD, we have

$$\begin{array}{lll} p_1 = 0 & q_1 = 2 & \\ p_2 = 0 & q_2 = 6 & \\ p_3 = -3 & q_3 = 5 & r_3 = -\frac{5}{3} \\ p_4 = 3 & q_4 = 1 & r_4 = \frac{1}{3} \end{array}$$

Thus $u_1 = \max(0, -\frac{5}{3}) = 0$ and $u_2 = \min(1, \frac{1}{3}) = \frac{1}{3}$. Since $u_1 < u_2$, the two endpoints of the clipped line are $(3, 7)$ and $(3, 7 + 3(\frac{1}{3})) = (3, 8)$.

For line EF, we have

$$\begin{array}{lll} p_1 = -6 & q_1 = 1 & r_1 = -\frac{1}{6} \\ p_2 = 6 & q_2 = 7 & r_2 = \frac{7}{6} \\ p_3 = -1 & q_3 = 1 & r_3 = -\frac{1}{1} \\ p_4 = 1 & q_4 = 5 & r_4 = \frac{5}{1} \end{array}$$

Thus $u_1 = \max(0, -\frac{1}{6}, -1) = 0$ and $u_2 = \min(1, \frac{7}{6}, 5) = 1$. Since $u_1 = 0$ and $u_2 = 1$, line EF is completely inside the clipping window.

For line GH, we have

$$\begin{array}{lll} p_1 = -2 & q_1 = 5 & r_1 = -\frac{5}{2} \\ p_2 = 2 & q_2 = 3 & r_2 = \frac{3}{2} \\ p_3 = -3 & q_3 = 4 & r_3 = -\frac{4}{3} \\ p_4 = 3 & q_4 = 2 & r_4 = \frac{2}{3} \end{array}$$

Thus $u_1 = \max(0, -\frac{5}{2}, -\frac{4}{3}) = 0$ and $u_2 = \min(1, \frac{3}{2}, \frac{2}{3}) = \frac{2}{3}$. Since $u_1 < u_2$, the two endpoints of the clipped line are $(6, 6)$ and $(6 + 2(\frac{2}{3}), 6 + 3(\frac{2}{3})) = (7\frac{1}{3}, 8)$.

For line IJ, we have

$$\begin{array}{lll} p_1 = -12 & q_1 = -2 & r_1 = \frac{1}{6} \\ p_2 = 12 & q_2 = 10 & r_2 = \frac{5}{6} \\ p_3 = 6 & q_3 = 5 & r_3 = \frac{5}{6} \\ p_4 = -6 & q_4 = 1 & r_4 = -\frac{1}{6} \end{array}$$

Thus $u_1 = \max(0, \frac{1}{6}, -\frac{1}{6}) = \frac{1}{6}$ and $u_2 = \min(1, \frac{5}{6}, \frac{5}{6}) = \frac{5}{6}$. Since $u_1 < u_2$, the two endpoints of the clipped line are $(-1 + 12(\frac{1}{6}), 7 + (-6)(\frac{1}{6})) = (1, 6)$ and $(-1 + 12(\frac{5}{6}), 7 + (-6)(\frac{5}{6})) = (9, 2)$.