$$[K^2] = 10^9 \begin{bmatrix} 0.126 & 0.000 & -0.126 & 0.000 \\ 0.000 & 0.000 & 0.000 & 0.000 \\ -0.126 & 0.000 & 0.126 & 0.000 \\ 0.000 & 0.000 & 0.000 & 0.000 \end{bmatrix}$$

$$[K^3] = 0.63 \times 10^8 \begin{bmatrix} 1.0 & 1.0 & -1.0 & -1.0 \\ 1.0 & 1.0 & -1.0 & -1.0 \\ -1.0 & -1.0 & 1.0 & 1.0 \\ -1.0 & -1.0 & 1.0 & 1.0 \end{bmatrix}$$

The assembled equations before including the constraint conditions are

−0.63

$$10^8 \begin{bmatrix} 0.63 & 0.63 & 0.00 & 0.00 & -0.63 & -0.63 \\ 0.63 & 1.89 & 0.00 & -1.26 & -0.63 & -0.63 \\ 0.00 & 0.00 & 1.26 & 0.00 & -1.26 & 0.00 \\ 0.00 & -1.26 & 0.00 & 1.26 & 0.00 & 0.00 \\ \cancel{0.00} & -0.63 & -1.26 & 0.00 & 1.89 & 0.63 \\ -0.63 & -0.63 & 0.00 & 0.00 & 0.63 & 0.63 \end{bmatrix} \begin{Bmatrix} U_1 \\ U_2 \\ U_3 \\ U_4 \\ U_5 \\ U_6 \end{Bmatrix} = \begin{Bmatrix} Q_1^1 + Q_1^3 \\ Q_2^1 + Q_2^3 \\ Q_3^1 + Q_1^2 \\ Q_4^1 + Q_2^2 \\ Q_3^2 + Q_3^3 \\ Q_4^2 + Q_4^3 \end{Bmatrix} \tag{4.6.50}$$

The constraint condition at node 3 is

$$u_n \equiv -u \sin\alpha + v \cos\alpha = 0 \rightarrow -0.7071u + 0.7071v = 0$$

Comparing this constraint equation to the general constraint equation (4.6.37), we find that $\beta_1 = -0.7071$, $\beta_2 = 0.7071$, and $\beta_{12} = 0$.

The value of the penalty parameter is selected to be $\gamma = (1.89 \times 10^8)10^4$. The stiffness additions due to the constraint are

$$\begin{array}{cc} & \begin{array}{cc} 5 & 6 \end{array} \\ \begin{array}{c} 5 \\ 6 \end{array} & \gamma \begin{bmatrix} (-0.7071)^2 & -(0.7071)^2 \\ -(0.7071)^2 & (0.7071)^2 \end{bmatrix} \end{array} = 1.89 \times 10^{12} \begin{bmatrix} 0.5 & -0.5 \\ -0.5 & 0.5 \end{bmatrix}$$

The assembled equations after including the constraint conditions are (the numbers shown are truncated but more accurate numbers are used in actual computation in a computer)

−0.63

$$10^8 \begin{bmatrix} 0.63 & 0.63 & 0.00 & 0.00 & -0.63 & -0.63 \\ 0.63 & 1.89 & 0.00 & -1.26 & -0.63 & -0.63 \\ 0.00 & 0.00 & 1.26 & 0.00 & -1.26 & 0.00 \\ 0.00 & -1.26 & 0.00 & 1.26 & 0.00 & 0.00 \\ \cancel{0.00} & -0.63 & -1.26 & 0.00 & 6301.8 & 6299.2 \\ -0.63 & -0.63 & 0.00 & 0.00 & 6299.2 & 6300.5 \end{bmatrix} \begin{Bmatrix} U_1 \\ U_2 \\ U_3 \\ U_4 \\ U_5 \\ U_6 \end{Bmatrix} = \begin{Bmatrix} Q_1^1 + Q_1^3 \\ Q_2^1 + Q_2^3 \\ Q_3^1 + Q_1^2 \\ Q_4^1 + Q_2^2 \\ Q_3^2 + Q_3^3 \\ Q_4^2 + Q_4^3 \end{Bmatrix}$$

Imposing the boundary and force equilibrium conditions $U_1 = U_2 = U_4 = 0$ and $Q_3^1 + Q_1^2 = P$, we obtain the condensed equations

$$10^8 \begin{bmatrix} 1.26 & -1.26 & 0.00 \\ -1.26 & 6301.8 & 6299.2 \\ 0.00 & 6299.2 & 6300.5 \end{bmatrix} \begin{Bmatrix} U_3 \\ U_5 \\ U_6 \end{Bmatrix} = \begin{Bmatrix} P \\ 0 \\ 0 \end{Bmatrix}$$