Solution T4P1

For link 2:

$$F_{12_x} + F_{32_x} = m_2 a_{G_{2x}}$$

$$F_{12_y} + F_{32_y} = m_2 a_{G_{2y}}$$

$$T_{12} + \left(R_{12_x} F_{12_y} - R_{12_y} F_{12_x}\right) + \left(R_{32_x} F_{32_y} - R_{32_y} F_{32_x}\right) = I_{G_2} \alpha_2$$

For link 3:

$$F_{43_x} - F_{32_x} = m_3 a_{G_{3x}}$$

$$F_{43_y} - F_{32_y} = m_3 a_{G_{3y}}$$

$$\left(R_{43_x} F_{43_y} - R_{43_y} F_{43_x}\right) - \left(R_{23_x} F_{32_y} - R_{23_y} F_{32_x}\right) = I_{G_3} \alpha_3$$

For Link 4:

$$F_{14_x} - F_{43_x} + F_{P_x} = m_4 a_{G_{4x}}$$

$$F_{14_y} - F_{43_y} + F_{P_y} = m_4 a_{G_{4y}}$$

$$\left(R_{14_x} F_{14_y} - R_{14_y} F_{14_x}\right) - \left(R_{34_x} F_{43_y} - R_{34_y} F_{43_x}\right) + \left(R_{P_x} F_{P_y} - R_{P_y} F_{P_x}\right) = I_{G_4} \alpha_4 \quad ($$

$$\alpha_4 = 0, \qquad\qquad a_{G_{4y}} = 0$$

The third equation for link 4 is essentially 0=0 and is not needed.

$$F_{14_x} = \pm \mu F_{14_y}$$

This friction force has to be substituted to be zero in the equations for link 4 given below

$$\pm \mu F_{14_y} - F_{43_x} + F_{P_x} = m_4 a_{G_{4x}}$$

$$F_{14_y} - F_{43_y} + F_{P_y} = 0$$

Finally you will get 8 equations in 8 unknowns

$$
\begin{bmatrix}
1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 \\
-R_{12_y} & R_{12_x} & -R_{32_y} & R_{32_x} & 0 & 0 & 0 & 1 \\
0 & 0 & -1 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & -1 & 0 & 1 & 0 & 0 \\
0 & 0 & R_{23_y} & -R_{23_x} & -R_{43_y} & R_{43_x} & 0 & 0 \\
0 & 0 & 0 & 0 & -1 & 0 & \pm\mu & 0 \\
0 & 0 & 0 & 0 & 0 & -1 & 1 & 0
\end{bmatrix}
\times
\begin{bmatrix}
F_{12_x} \\
F_{12_y} \\
F_{32_x} \\
F_{32_y} \\
F_{43_x} \\
F_{43_y} \\
F_{14_y} \\
T_{12}
\end{bmatrix}
=
$$

$$
\begin{bmatrix}
m_2 a_{G2_x} \\
m_2 a_{G2_y} \\
I_{G_2}\alpha_2 \\
m_3 a_{G3_x} \\
m_3 a_{G3_y} \\
I_{G_3}\alpha_3 \\
m_4 a_{G4_x} - F_{P_x} \\
-F_{P_y}
\end{bmatrix}
$$

This is just as outline of the solution. Students need to put in appropriate values wherever needed (e.g. fiction coefficient is given to be zero etc.)