This gives us

$$
\begin{bmatrix}
\gamma_1 & 1 & 0 & 0 & 0 & 0 & \beta_1^2 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & & \\
2k_1 & \gamma_{12} & 2(1+k_1\beta_1\beta) & 0 & 0 & 0 & 0 & \beta_{12} & -2k_1\beta_1\beta & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & & \\
0 & 1 & \gamma_2 & (1+2\beta\beta_2) & 0 & 0 & 0 & 0 & \lambda & -2\beta\beta_2 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & & \\
0 & 0 & 1 & \gamma_2 & (1+2\beta\beta_2) & 0 & 0 & 0 & 0 & \lambda \\
-2\beta\beta_2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & & \\
0 & 0 & 0 & 2k_2(k_2+\beta\beta_3) & \gamma_{23} & 2k_2 & 0 & 0 & 0 & 2k_2\beta_3\beta \\
\beta_{23} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & & \\
0 & 0 & 0 & 0 & 1 & \gamma_3 & 0 & 0 & 0 & 0 \\
0 & \beta_3^2 & 0 & 0 & 0 & 0 & 0 & 0 & & \\
\beta_1^2 & 0 & 0 & 0 & 0 & 0 & \gamma_1 & 1 & 0 & 0 \\
0 & 0 & \beta_1^2 & 0 & 0 & 0 & 0 & 0 & & \\
0 & \beta_{12} & 0 & 0 & 0 & 0 & 2k_1 & \gamma_{12} & 2(1+k_1\beta_1\beta) & 0 \\
0 & 0 & 0 & \beta_{12} & -2k_1\beta_1\beta & 0 & 0 & 0 & & \\
0 & 0 & (\beta^2+1)\beta_2^2 & 0 & 0 & 0 & 0 & 1 & \gamma_2 & (1+2\beta\beta_2) \\
0 & 0 & 0 & 0 & \lambda & -2\beta\beta_2 & 0 & 0 & & \\
0 & 0 & 0 & (\beta^2+1)\beta_2^2 & 0 & 0 & 0 & 0 & 1 & \gamma_2 \\
(1+2\beta\beta_2) & 0 & 0 & 0 & 0 & \lambda & -2\beta\beta_2 & 0 & & \\
0 & 0 & 0 & 0 & \beta_{23}\beta_3^2 & 0 & 0 & 0 & 0 & 2k_2(k_2+\beta\beta_3) \\
\gamma_{23} & 2k_2 & 0 & 0 & 0 & 2k_2\beta_3\beta & \beta_{23} & 0 & & \\
0 & 0 & 0 & 0 & 0 & \beta_3^2 & 0 & 0 & 0 & 0 \\
1 & \gamma_3 & 0 & 0 & 0 & 0 & 0 & \beta_3^2 & & \\
0 & 0 & 0 & 0 & 0 & 0 & \beta_1^2 & 0 & 0 & 0 \\
0 & 0 & \gamma_1 & 1 & 0 & 0 & 0 & 0 & & \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & \beta_{12} & 0 & 0 \\
0 & 0 & 2k_1 & \gamma_{12} & 2(1+k_1\beta_1\beta) & 0 & 0 & 0 & & \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & (\beta^2+1)\beta_2^2 & 0 \\
0 & 0 & 0 & 1 & \gamma_2 & (1+2\beta\beta_2) & 0 & 0 & & \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & (\beta^2+1)\beta_2^2 \\
0 & 0 & 0 & 0 & 1 & \gamma_2 & (1+2\beta\beta_2) & 0 & & \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
\beta_{23}\beta_3^2 & 0 & 0 & 0 & 0 & 2k_2(k_2+\beta\beta_3) & \gamma_{23} & 2k_2 & & \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & \beta_3^2 & 0 & 0 & 0 & 0 & 1 & \gamma_3 & &
\end{bmatrix}
\begin{bmatrix}
u_{1,1} \\ u_{2,1} \\ u_{3,1} \\ u_{4,1} \\ u_{5,1} \\ u_{6,1} \\ u_{1,2} \\ u_{2,2} \\ u_{3,2} \\ u_{4,2} \\ u_{5,2} \\ u_{6,2} \\ u_{1,3} \\ u_{2,3} \\ u_{3,3} \\ u_{4,3} \\ u_{5,3} \\ u_{6,3}
\end{bmatrix}
=
\begin{bmatrix}
-u_{0,1} - \beta_1^2 u_{1,0} \\
-\beta_{12} u_{2,0} \\
-(\beta^2+1)\beta_2^2 u_{3,0} \\
-(\beta^2+1)\beta_2^2 u_{4,0} \\
-\beta_{23}\beta_3^2 u_{5,0} \\
-\beta_3^2 u_{6,0} - u_{7,1} \\
u_{0,2} \\
0 \\
0 \\
0 \\
0 \\
u_{7,2} \\
-u_{0,3} - \beta_1^2 u_{1,4} \\
-\beta_{12} u_{2,4} + 2k_1\beta_1\beta u_{3,4} \\
-\lambda u_{3,4} + 2\beta\beta_2 u_{4,4} \\
-\lambda u_{4,4} + 2\beta\beta_2 u_{5,4} \\
-\beta_{23} u_{5,4} - 2k_2\beta_3\beta u_{4,4} \\
-\beta_3^2 u_{6,4} - u_{7,3}
\end{bmatrix}
$$