(b) The DE for disk J_1 is given by

$$J_1\ddot{\theta}_1 + c\dot{\theta}_1 - c\dot{\theta}_2 + (k_1 + k_2)\theta_1 - k_2\theta_2 = T_1(t)\,.$$

(c) The matrices of the 2nd-order form: $\mathbf{M} = \begin{bmatrix} J_1 & 0 \\ 0 & J_2 \end{bmatrix}, \mathbf{C} = \begin{bmatrix} c & -c \\ -c & c \end{bmatrix},\ \mathbf{K} = \begin{bmatrix} k_1 + k_2 & -k_2 \\ -k_2 & k_2 \end{bmatrix}.$

(d)

$$\frac{\theta_2}{T_2}(s) = \frac{J_1 s^2 + cs + k_1 + k_2}{J_1 J_2 s^4 + (J_1 + J_2)cs^3 + [k_2 J_1 + (k_1 + k_2)J_2]s^2 + k_1 cs + k_1 k_2}\,.$$

(e) One possible solution is given by

$$\dot{\mathbf{x}} = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -{}^{(k_1+k_2)}\!/\!_{J_1} & {}^{k_2}\!/\!_{J_1} & -{}^{c}\!/\!_{J_1} & {}^{c}\!/\!_{J_1} \\ {}^{k_2}\!/\!_{J_2} & -{}^{k_2}\!/\!_{J_2} & {}^{c}\!/\!_{J_2} & -{}^{c}\!/\!_{J_2} \end{bmatrix}\mathbf{x} + \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ {}^{1}\!/\!_{J_1} & 0 \\ 0 & {}^{1}\!/\!_{J_2} \end{bmatrix}\mathbf{u}$$

$$\mathbf{y} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix}\mathbf{x} + \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}\mathbf{u}$$

The exact arrangement of these elements depends on your selection of state variables.