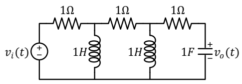
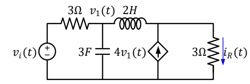
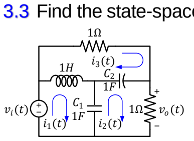
3.1 Represent the electrical network in state space with output v_0



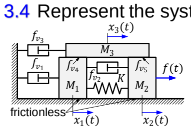
3.2 Represent the electrical network in state space with output i_R



3.3 Find the state-space representation of the network with output v_0



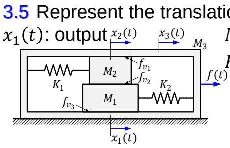
3.4 Represent the system in state space with output $x_3(t)$



$M_1 = 2kg$, $M_2 = M_3 = 1kg$, $K = 2N/m$

$f_{v_1} = f_{v_2} = f_{v_3} = f_{v_4} = f_{v_5} = 1Ns/m$

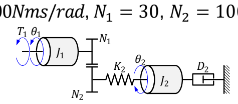
3.5 Represent the translational mechanical system in state space, $x_1(t)$: output



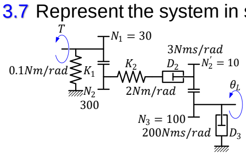
$M_1 = 2kg$, $M_2 = M_3 = 1kg$

$K_1 = K_2 = 1N/m$, $f_{v_1} = f_{v_2} = f_{v_3} = 1Ns/m$

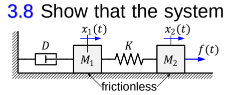
3.6 Represent the rotational mechanical system in state space, $\theta_1(t)$: output, $J_1 = 50kgm^2$, $J_2 = 100kgm^2$, $K_2 = 100Nm/rad$, $D_2 = 100Nms/rad$, $N_1 = 30$, $N_2 = 100$



3.7 Represent the system in state space with output $\theta_L(t)$



3.8 Show that the system yields a fourth-order TF if we relate the displacement of either mass to the applied force, and a third-order one if we relate the velocity of either mass to the applied force



3.9 Find the state-space representation in phase-variable form for

a. $R(s) \rightarrow \boxed{\dfrac{100}{s^4+20s^3+10s^2+7s+100}} \rightarrow C(s)$ b. $R(s) \rightarrow \boxed{\dfrac{30}{s^5+8s^4+9s^3+6s^2+s+30}} \rightarrow C(s)$

3.10 Find the state-space representation in phase-variable form using matlab

a. $R(s) \rightarrow \boxed{\dfrac{100}{s^4+20s^3+10s^2+7s+100}} \rightarrow C(s)$ b. $R(s) \rightarrow \boxed{\dfrac{30}{s^5+8s^4+9s^3+6s^2+s+30}} \rightarrow C(s)$

3.11 For each system write the state equations and the output equation for the phase-variable representation

a. $R(s) \rightarrow \boxed{\dfrac{8s+10}{s^4+5s^3+s^2+5s+13}} \rightarrow C(s)$ b. $R(s) \rightarrow \boxed{\dfrac{s^4+2s^3+12s^2+7s+6}{s^5+9s^4+13s^3+8s^2}} \rightarrow C(s)$

3.12 For each system write the state equations and the output equation for the phase-variable representation using matlab

a. $R(s) \rightarrow \boxed{\dfrac{8s+10}{s^4+5s^3+s^2+5s+13}} \rightarrow C(s)$ b. $R(s) \rightarrow \boxed{\dfrac{s^4+2s^3+12s^2+7s+6}{s^5+9s^4+13s^3+8s^2}} \rightarrow C(s)$

3.13 Represent the following TF in state space. Give your answer in vector-matrix form

$$T(s)=\frac{s^2+3s+8}{(s+1)(s^2+5s+5)}$$

3.14 Find the TF $G(s)=Y(s)/X(s)$ for each of the following systems represented in state space

a. $\dot{\boldsymbol{x}}=\begin{bmatrix}0&1&0\\0&0&1\\-3&-2&-5\end{bmatrix}\boldsymbol{x}+\begin{bmatrix}0\\0\\10\end{bmatrix}r,\quad y=\begin{bmatrix}1&0&0\end{bmatrix}\boldsymbol{x}$

b. $\dot{\boldsymbol{x}}=\begin{bmatrix}2&-3&-8\\0&5&3\\-3&-5&-4\end{bmatrix}\boldsymbol{x}+\begin{bmatrix}1\\4\\6\end{bmatrix}r,\quad y=\begin{bmatrix}1&3&6\end{bmatrix}\boldsymbol{x}$

c. $\dot{\boldsymbol{x}}=\begin{bmatrix}3&-5&2\\1&-8&7\\-3&-6&-2\end{bmatrix}\boldsymbol{x}+\begin{bmatrix}5\\-3\\2\end{bmatrix}r,\quad y=\begin{bmatrix}1&-4&3\end{bmatrix}\boldsymbol{x}$

3.15 Use matlab to find the TF $G(s)=Y(s)/X(s)$ for each of the following systems represented in state space

a. $\dot{\boldsymbol{x}}=\begin{bmatrix}0&1&5&0\\0&0&1&0\\0&0&0&1\\-7&-9&-2&-3\end{bmatrix}\boldsymbol{x}+\begin{bmatrix}0\\5\\8\\2\end{bmatrix}r,\quad y=\begin{bmatrix}1&3&6&6\end{bmatrix}\boldsymbol{x}$

b. $\dot{\boldsymbol{x}}=\begin{bmatrix}3&1&0&4&-2\\-3&5&-5&2&-1\\0&1&-1&2&8\\-7&6&-3&-4&0\\-6&0&4&-3&1\end{bmatrix}\boldsymbol{x}+\begin{bmatrix}2\\7\\8\\5\\4\end{bmatrix}r,\ y=\begin{bmatrix}1&-2&-9&7&6\end{bmatrix}\boldsymbol{x}$

3.16 Use matlab, the Symbolic Math Toolbox, and Eq.3.73 to find the TF $G(s)=Y(s)/X(s)$ for each of the following systems

a. $\dot{\boldsymbol{x}}=\begin{bmatrix}0&1&5&0\\0&0&1&0\\0&0&0&1\\-7&-9&-2&-3\end{bmatrix}\boldsymbol{x}+\begin{bmatrix}0\\5\\8\\2\end{bmatrix}r,\quad y=\begin{bmatrix}1&3&6&6\end{bmatrix}\boldsymbol{x}$

b. $\dot{\boldsymbol{x}}=\begin{bmatrix}3&1&0&4&-2\\-3&5&-5&2&-1\\0&1&-1&2&8\\-7&6&-3&-4&0\\-6&0&4&-3&1\end{bmatrix}\boldsymbol{x}+\begin{bmatrix}2\\7\\8\\5\\4\end{bmatrix}r,\ y=\begin{bmatrix}1&-2&-9&7&6\end{bmatrix}\boldsymbol{x}$