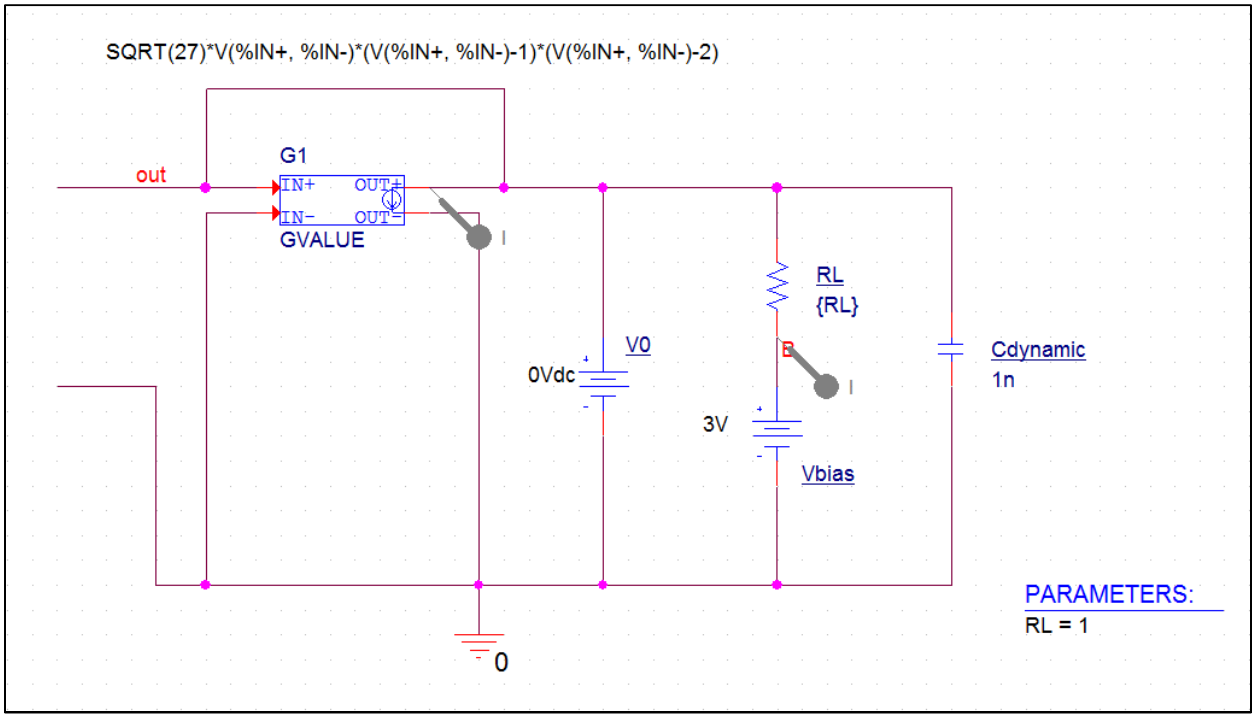
ENEE610
Fall 2013

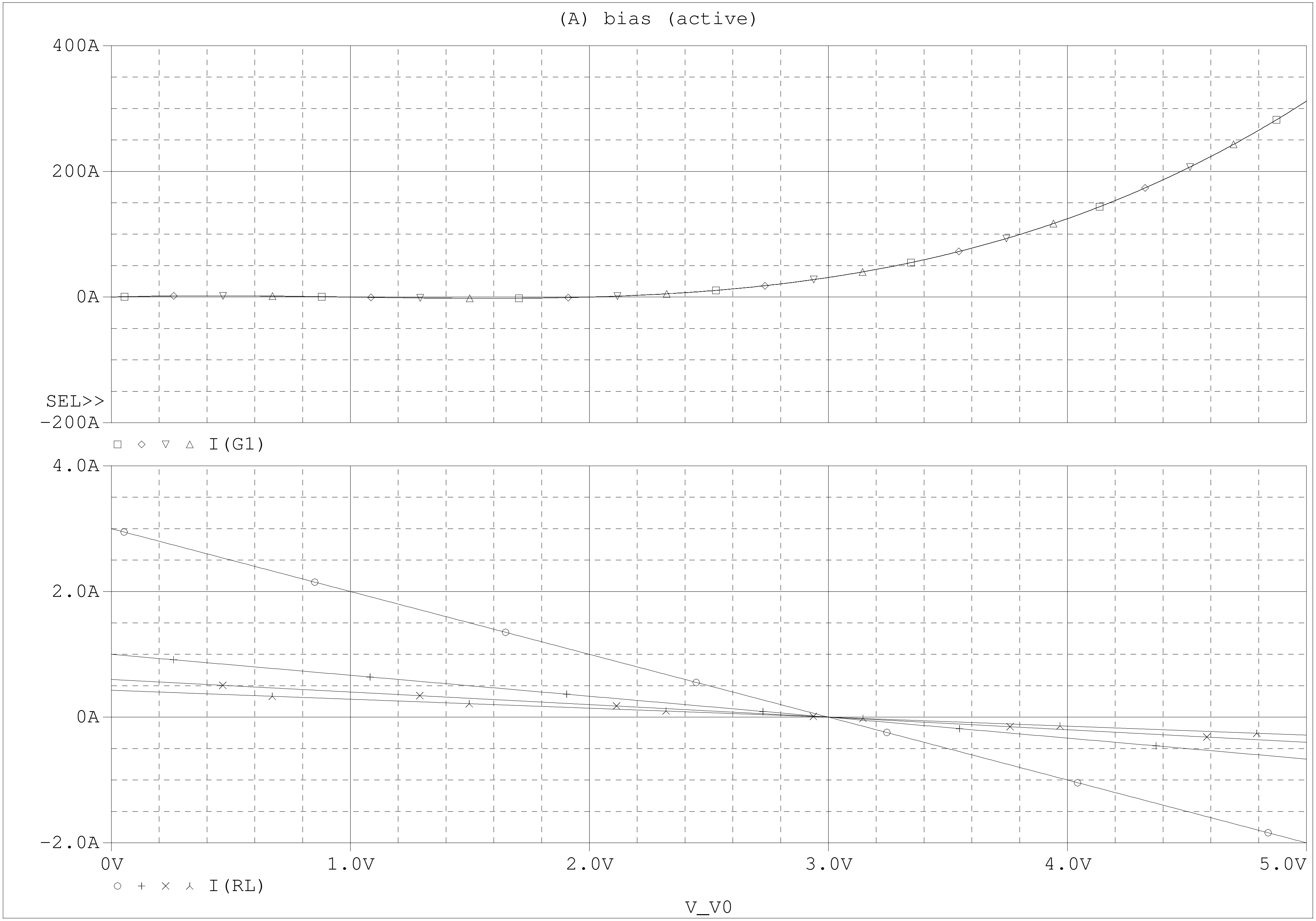
Homework 1 Solutions

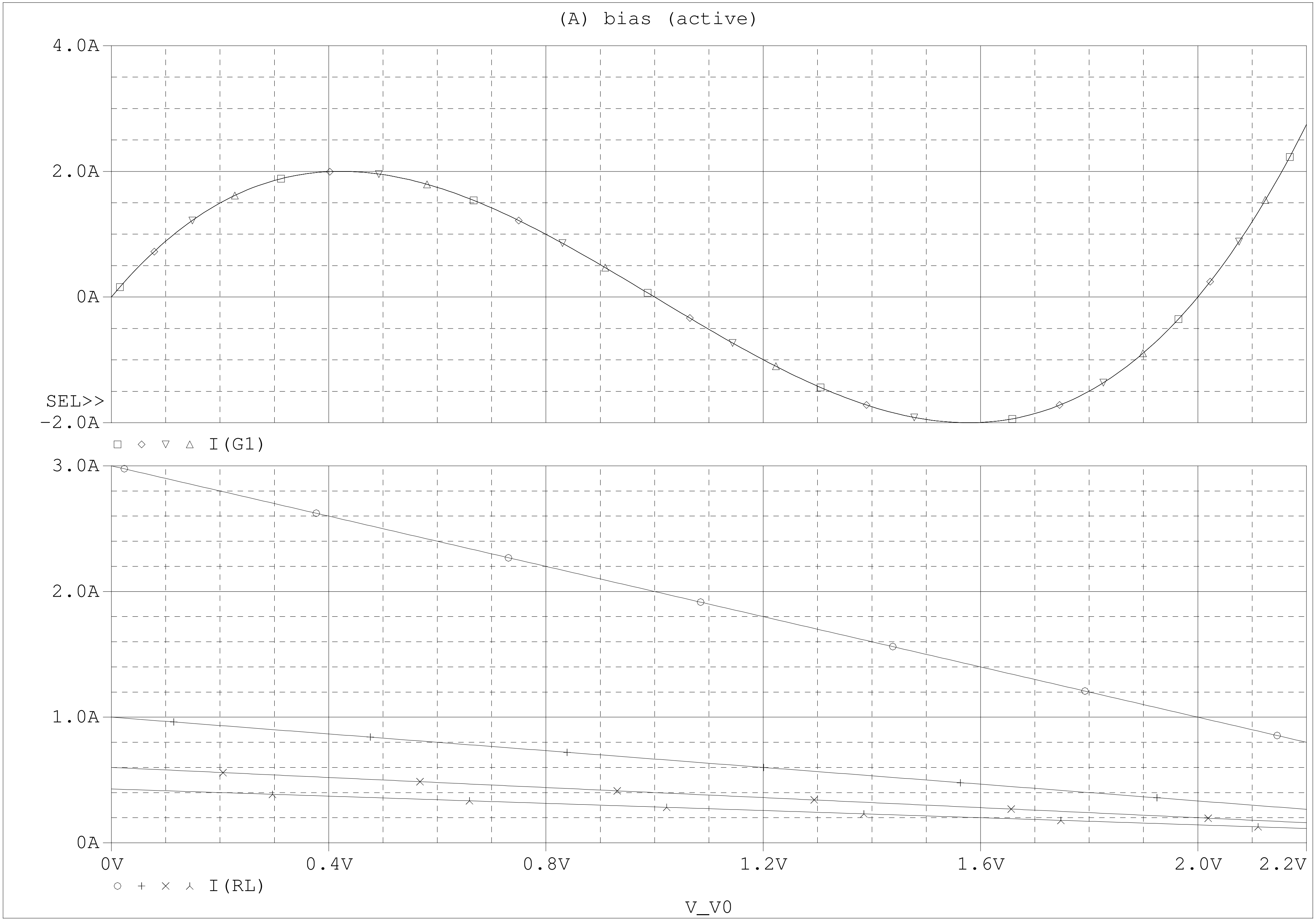
Problem#1

Circuit Schematic

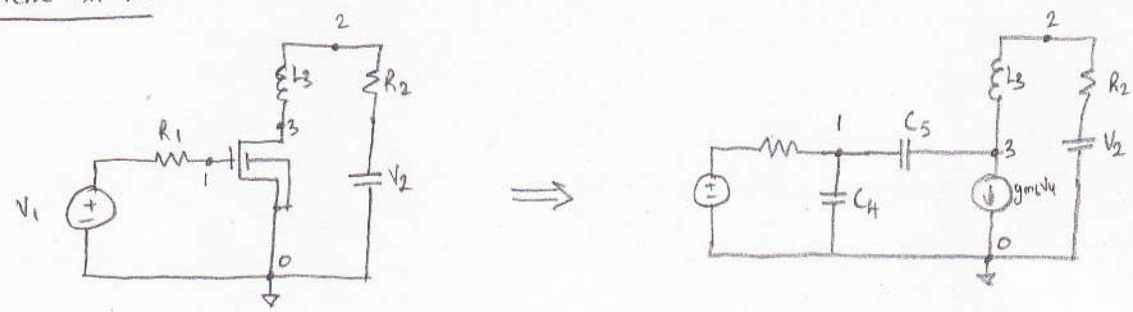


** Profile: "SCHEMATIC1-bias" [H:_F13_ENEE610_F13\601_hwk1-pspicefiles\schematic1\bias.sim]
Date/Time run: 09/24/13 11:55:34 Temperature: 27.0

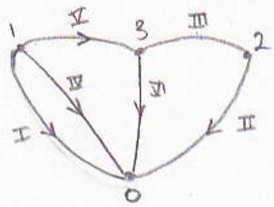



(A) bias (active)
4.0A
2.0A
0A
SEL>>
-2.0A
I(G1)
3.0A
2.0A
1.0A
0A
0V
0.4V
0.8V
1.2V
1.6V
2.0V
2.2V
I(RL)
V_V0

Problem # 2

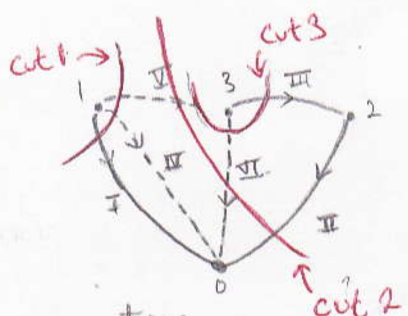


a)



oriented graph

b)



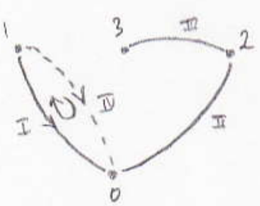
tree

—— = tree branches

- - - = link branches

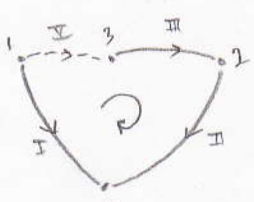
$$\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & -1 & 1 \\ 0 & 0 & 1 & 0 & -1 & 1 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \\ i_5 \\ i_6 \end{bmatrix}$$

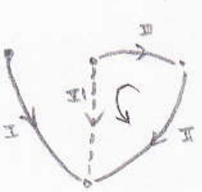
C = Cut-set



$$\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} -1 & 0 & 0 & 1 & 0 & 0 \\ -1 & 1 & 1 & 0 & 1 & 0 \\ 0 & -1 & -1 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \\ v_5 \\ v_6 \end{bmatrix}$$

T = tie set





c) <u>from circuit:</u>

$$\left.\begin{aligned} v_1 &= i_1 R_1 \\ v_2 &= i_2 R_2 \\ v_3 &= sL_3 i_3 \\ sC_4 v_4 &= i_4 \\ sC_5 v_5 &= i_5 \\ i_6 &= g_{m6} v_4 \end{aligned}\right\}$$

$$\begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \\ i_5 \\ i_6 \end{bmatrix} = \underbrace{\begin{bmatrix} 1/R_1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1/R_2 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1/sL_3 & 0 & 0 & 0 \\ 0 & 0 & 0 & sC_4 & 0 & 0 \\ 0 & 0 & 0 & 0 & sC_5 & 0 \\ 0 & 0 & 0 & g_{m6} & 0 & 0 \end{bmatrix}}_{\text{Admittance Matrix}} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \\ v_5 \\ v_6 \end{bmatrix} \qquad \underbrace{\begin{bmatrix} V1 \\ V2 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}}_{\text{source vector}}$$

$$Av = Bi$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & sC_4 & 0 & 0 \\ 0 & 0 & 0 & 0 & sC_5 & 0 \\ 0 & 0 & 0 & g_{m6} & 0 & 0 \end{bmatrix} v = \begin{bmatrix} R_1 & 0 & 0 & 0 & 0 & 0 \\ 0 & R_2 & 0 & 0 & 0 & 0 \\ 0 & 0 & sL_3 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} i$$

$$AC^T = A \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \\ 1 & -1 & -1 \\ 0 & 1 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ sC_4 & 0 & 0 \\ sC_5 & -sC_5 & -sC_5 \\ g_{m6} & 0 & 0 \end{bmatrix} \qquad BT^T = B \begin{bmatrix} -1 & -1 & 0 \\ 0 & 1 & -1 \\ 0 & 1 & -1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} -R_1 & -R_1 & 0 \\ 0 & R_2 & -R_2 \\ 0 & sL_3 & -sL_3 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\left[AC^T \,|\, -BT^T\right] = \begin{bmatrix} 1 & 0 & 0 & R_1 & R_1 & 0 \\ 0 & 1 & 0 & 0 & -R_2 & R_2 \\ 0 & 0 & 1 & 0 & -sL_3 & sL_3 \\ sC_4 & 0 & 0 & -1 & 0 & 0 \\ sC_5 & -sC_5 & -sC_5 & 0 & -1 & 0 \\ g_{m6} & 0 & 0 & 0 & 0 & -1 \end{bmatrix}$$

$$sEx = \bar{A}x + \bar{B}u$$

$$s\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -L_3 & L_3 \\ C_4 & 0 & 0 & 0 & 0 & 0 \\ C_5 & -C_5 & -C_5 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} x = \begin{bmatrix} -1 & 0 & 0 & -R & -R_1 & 0 \\ 0 & -1 & 0 & 0 & R_2 & -R_2 \\ 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ -g_{m6} & 0 & 0 & 0 & 0 & 1 \end{bmatrix} x + \begin{bmatrix} V1 \\ V2 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$