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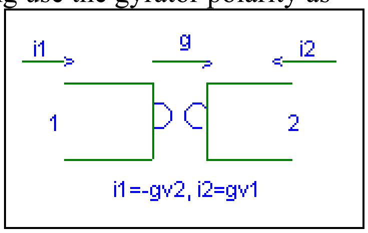
ENEE 610 Fall 2003 Final exam

2 hours (=120minutes), 120 points total, open book, open notes. If stuck on a problem, go on to the next. Show your work for partial credit. Good luck!

For the following use the gyrator polarity as



1. (40points, 30 minutes) [PR and synthesis]

Consider the rational driving point admittance where n and d are finite real parameters:

$$y(s)=\frac{ns^2+3s+1}{ds+1}$$

a) Give the set of n and d such that this y(s) is positive real.

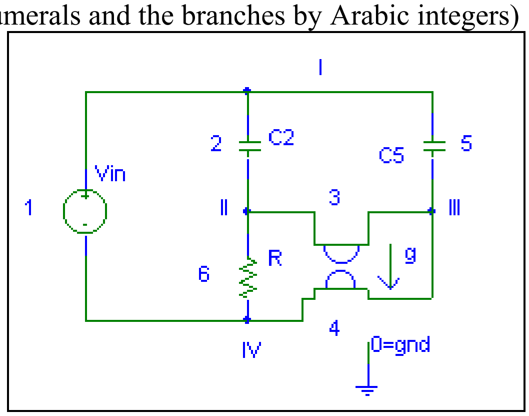
b) Give the set of n and d such that this y(s) is lossless.

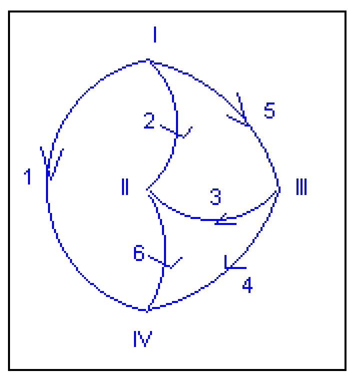
c) Give a synthesis for all y(s) that are positive real.

d) Give a synthesis for all y(s) including those which are not positive real.

2. (40points, 40 minutes) [graph, admittance matrices, transfer function]

For the following bridge circuit and the corresponding given graph (the nodes are numbered by Roman numerals and the branches by Arabic integers) [choose branches 1, 2, 3 as the tree]





a) Give the cut-set matrix.

b) Give the tie-set matrix.

c) Give the indefinite admittance matrix,Yind, for the circuit to the right of Vin.

d) Give the resulting 3-terminal Y matrix when node IV=0=gnd.

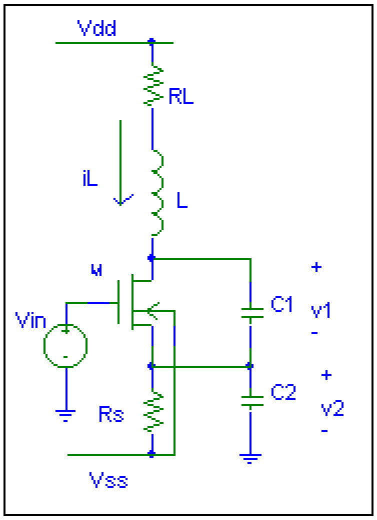
e) Assuming C2=C5=C>0 find the transfer function Vo/Vin where Vo=vIII-vII (with vIV=vgnd=0).

f) Assuming that g can vary find those g and s for which the bridge is balanced, that is Vo=0=i3, and from that state a use for the circuit.

3. (40points, 40 minutes) [from papers presented] Choose one of the following two (I or II)

I. [nonlinear state variables]

For the Colpitts Oscillator chaos generator of M. P. Kennedy, in the paper presented by A. Jaleel, replace the BJT by an NMOS transistor and add an input vin=u as shown below.



Assume that there is some nonlinear function f(.,.) such that the transistor is described by

$$iG = iB = 0$$

$$iD = f(vGS, vDS)$$

a) Using the drain voltage (with respect to ground) as the output, y=v1+v2, set up the state variable equations in the form

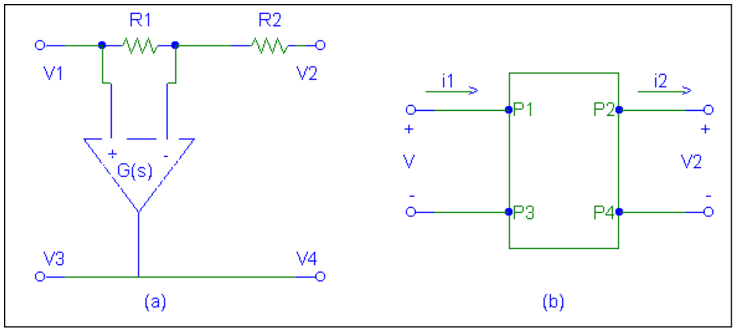
$$\frac{dx}{dt} = Ax + F(x,u) + Bu, \quad x = \begin{bmatrix} iL \\ v1 \\ v2 \end{bmatrix}, u = vin$$

$$y = Cx$$

b) Under the assumptions that the nonlinear transistor is replaced by a linear voltage controlled current source with iG=0, iD=g_mvGS and that vin=0, can the resulting circuit exhibit chaos?

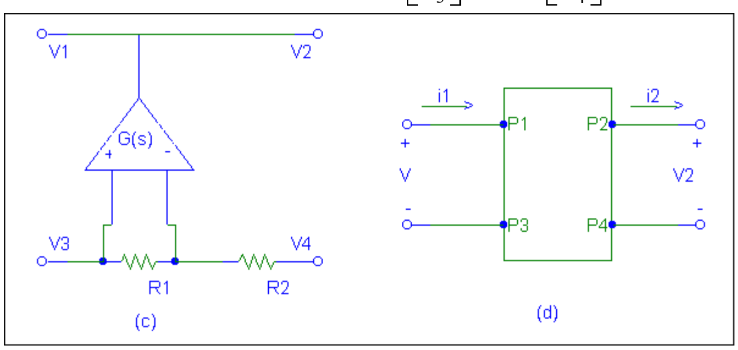
II. [synthesis with op-amps]

a) For the following circuit on the left, find the mixed matrix A_1 for $\begin{bmatrix} V_1 \\ V_3 \end{bmatrix} = A_1 \cdot \begin{bmatrix} V_2 \\ V_4 \end{bmatrix}$. The op-amp has $V_o = G(s) \cdot (V_+ - V_-)$ with $G(s) = \dfrac{G_0}{a \cdot s + 1}$.



b) For the network (b) on the right of the above, if $\begin{bmatrix} V_1 \\ i_1 \end{bmatrix} = A_1 \cdot \begin{bmatrix} V_2 \\ i_2 \end{bmatrix}$ with the matrix A_1 found in a), give an RL synthesis and give the value of each element in terms of the circuit elements in (a). V_1, i_1, V_2, and i_2, have the signs and directions as shown in the right circuit above.

c) For the following circuit find the mixed matrix A_2 $\begin{bmatrix} V_1 \\ V_3 \end{bmatrix} = A_2 \cdot \begin{bmatrix} V_2 \\ V_4 \end{bmatrix}$.



d) For the network in (d) of the last figure, if $\begin{bmatrix} V_1 \\ i_1 \end{bmatrix} = A_2 \cdot \begin{bmatrix} V_2 \\ i_2 \end{bmatrix}$ with the matrix A_2 found in c), give an RC synthesis and the value of each element in terms of the circuit elements in (c).

e) For the following circuit, find the transfer function $T(s) = \dfrac{V_o}{V_{in}}$.