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EE 610 Final Exam Fall 2018 Take Home due prior to end of scheduled exam
Open Book Open Notes 100 points, 2 hours.

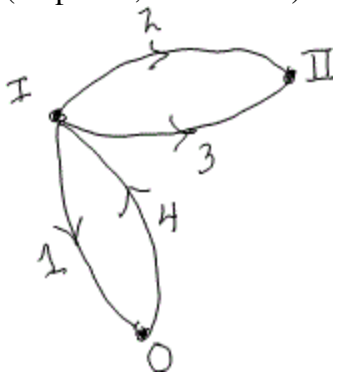
Notebooks are due at the end of the exam. Good luck and have a good semester break.

1. (10 points, 10 minutes)
   Give the 2nd Foster circuit for all real constant a and b for which the following input admittance is Lossless PR
   $$y(s) = [(s^2+1)(s^2+a)] /s[(s^2+2)(s^2+b)]$$

2. (10 points, 10 minutes)
   Using the 1st Cauer test determine if the following polynomial is Hurwitz, strictly Hurwitz, or neither
   $$P(s)=s^7+2s^6+6s^5+9s^4+12s^3+12s^2+8s+4$$

3. (25 points, 25 minutes)
   A 2-port is described by
   $$v_2=n_v \cdot v_1 \text{ and } i_2=n_i \cdot i_1$$
   where n_v and n_i are real constants (which can be negative, zero, or positive)
   a) Give the Av=Bi description and from it the 2-port Y, Z, and S matrices and when they exist give the n_v & n_i .
   b) Give the cases when this 2-port is passive.
   c) Load this 2-port in an admittance y_L (1-port) and give the corresponding (1-port) input y_{in}. Interpret the results when n_v and n_i are both positive. [remember that 2-port polarities have i_2 entering the 2nd port upper lead]
   d) Discuss how you would build this 2-port given that all types of controlled sources are available in VLSI circuits (that is, available are: VCCS=Voltage Controlled Current Sources, CCVS, VCVS, CCCS).

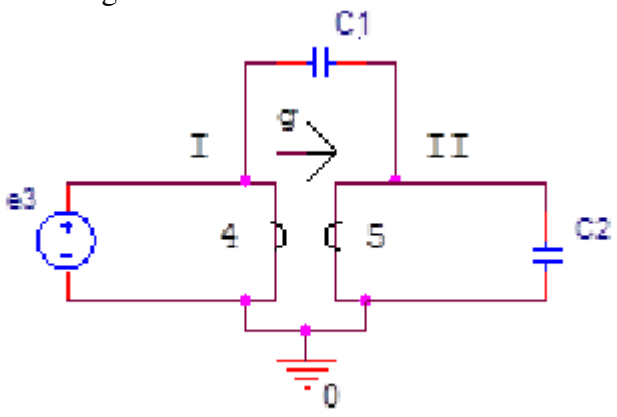
4. (20 points, 20 minutes)



   For the above circuit graph
   a) Using branches 1 and 2 as a tree, give the cut-set, C_1, and tie-set, T_1, matrices.
   b) Using the same numbering, repeat using branches 3 and 4 as a tree to give cut-set, C_2, and tie-set, T_2, matrices.

   c)Find a relationship (=transformation) matrix R such that the cut-set matrices are related by $C_2=R \cdot C_1$ and give the relation between the tie-set matrices T_1 and T_2.

5. (35 points, 35 minutes)
For the following circuit



a) Set up the semi-state equations, $sEx=A(t)x+Be3$, $v_{c2}=Cx$, using graph branches pointing down or to the right and numbered as the components. Choose branches 1 and 2 as the tree, the input as e3 and output as the voltage of node II with respect to ground (which is $v_{C2}=x_2$). Use x as tree branch voltages followed by link currents.
b) Using the middle 2-port (comprised of the gyrator and C1) give its 2-port Y and from it give the input admittance, yin(s), seen by the voltage source and the voltage gain, $v_{C2}/e3$.
c) Compare the calculations which would be involved between using the two methods to give the voltage gain.