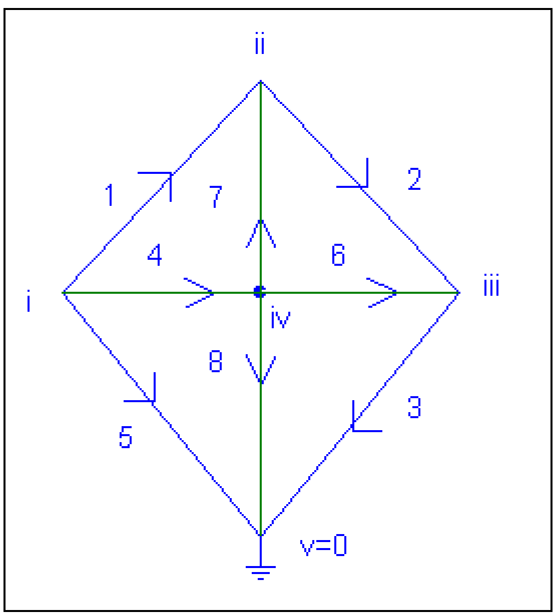
File: c:\temp\courses\fall2005\610\hmwrk1.doc RWN 09/05/05 corrected 09/08-13/05

ENEE 610
Homework Problems for Grading, Set 1 (100 points)
Due at class W 09/14/05
Graphs and setting up equations

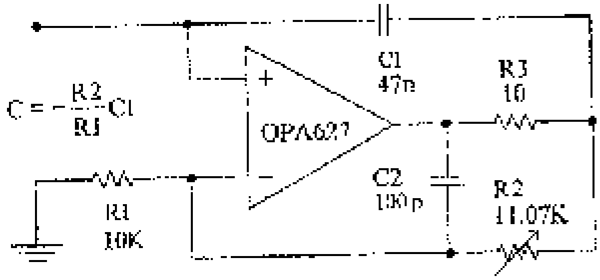
1.(50 points)
For the following graph

a) Find the cut set matrix C and the tie set matrix T for the tree of branches 1,2,3,4
b) Find $\det(CC^T)$
c) Find the augmented incidence matrix, A_a as defined on p, 96, and the incidence matrix A found by deleting the row corresponding to the ground node (node v).
d) Explain why $\det(A_aA_a^T)=0$ and hence that the result of problem 3.12 of p. 124 is incorrect.
e) Find $\det(AA^T)$ and compare with the result of part b) above; with this give what you think is a correction to the result of problem 3.12. Check your version of the "theorem"on a three branch three node graph.

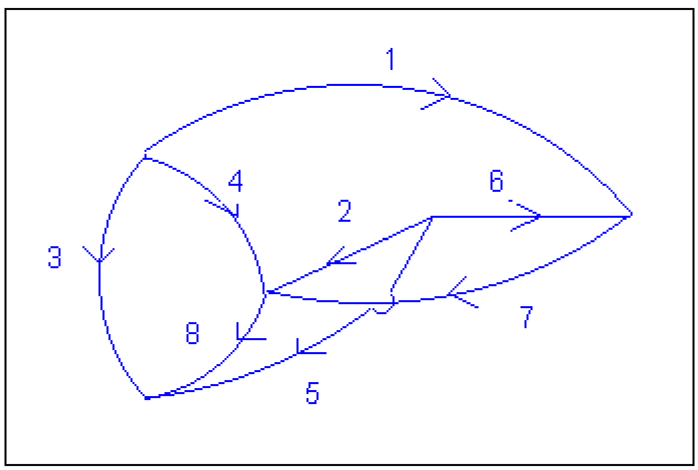


2. (50) points

In the August 2005 IEEE Transactions on Circuits and Systems -II the following circuit is claimed to be equivalent to a negative capacitor.



a) Insert a voltage sourceVs across the left terminals (feeding a current, i, into the top terminal) and use graph theory to set up the describing state variable type equations. For grading, choose the capacitors in the first two and the voltage source in the third tree branches; as the (final) fourth tree branch use the input (+ to -) of the op-amp. Let branch 5 be the op-amp output (to ground), branch 6 be for R3, branch 7 for R2 and branch 8 for R1, all oriented as per the following graph.



b) Give the cut set and tie set matrices along with the device equations, assuming the op-amp is linear of voltage gain K (to be later chosen very large) and keeping literal resistances and capacitances.

c) Eliminate the link voltages and tree branch currents, giving the resulting equations in terms of tree branch voltages and link currents.

d) From the equations of part c) eliminate all variables but the two capacitor tree branch voltages writing the results as dx/dt=Ax+BVs, i=Cx+DVs+F(dVs/dt)

e) Eliminate x from the result of d) to get the transfer function with finite K as a function of s, using d/dt=s.

f) Take the limit as K goes to infinity in the result of e) and compare with the result shown above from the IEEE Transactions on Circuits and Systems.

g) Comment upon the results and the technique used to get them.