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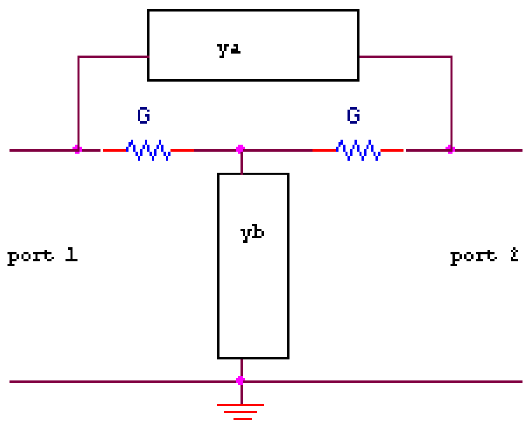
EE 610 Final Exam Fall 2008

Take Home. Open Book Open Notes 200 points total

Due in Room AVW 1364 at the final period W 12/17/08

along with your notebook. Your signature certifies that the work is your own.

1. (50 points) [Y matrix & constant-R 2-port]



For the above circuit ya(s). yb(s) and G are 1-port admittances and conductance with constant G>0,

a) Give the 3x3 nodal admittance matrix and from it obtain the 2-port Y(s) matrix by eliminating the internal node (which should be numbered 3).
b) When a load of conductance G is placed on port 2 find the relationship between ya(s) and yb(s) such that the input admittance is G (the 2-port is then called a constant-R 2-port)
c) For the constant-R 2-port loaded in conductance G, find the voltage transfer function V2(s)/V1(s) [express it in terms of G and ya(s)].
d) Given that it is desired to synthesize $V2(s)/V1(s)=ks/(s^2+s+1)$ by this constant-R circuit, give ya(s) and the range of real k and G such that ya(s) is PR.

2. (50 points) [even parts]

a) Find the zeros of the even part, Ev[y(s)], of

a1) $y(s)=[s^2+3s+4]/[s^2+6]$

a2) $y(s)=[s^2-3s+4]/[s^2+6]$

b) Comment upon uniqueness of a PR y(s) if only given its Ev[y(s)].

c) Show that if k is a zero of the even part of y(s) it is also a zero of the even part of z(s)=1/y(s) with some exceptions. Consider y(s)=s/(s+1) and discuss exceptions.

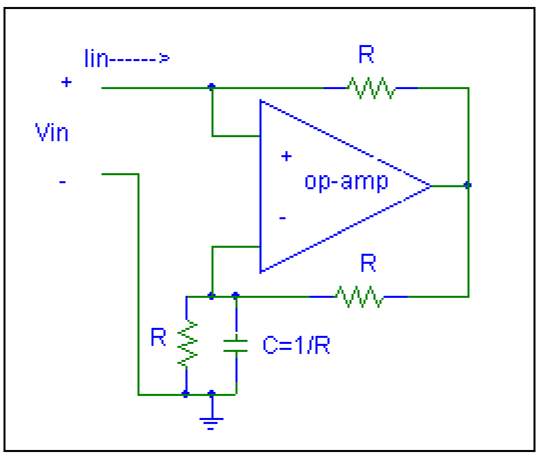
d) It is possible that there are no zeros of the even part of y(s). Give necessary and sufficient conditions for this to occur when y(s) is PR.

3. (50 points) [Richards' function problem]

Assume that the even part of a PR admittance y(s) is a positive constant, G (independent of s). This y(s) can be relatively easily synthesized.

   a) Give the partial fraction expansions of y(s) and of z(s) and the resulting syntheses.
   b) Discuss why there is no good choice of k for synthesis of y(s) directly via the Richards' function. How about using z(s)=1/y(s) instead.
   c) In view of b) and your result of a) show how the Richards' function can be used on y(s) after an initial parallel resistor extraction.

4. (50 points) [Op-Amp]



In this circuit the op=amp is ideal (zero input current and voltage).

a) Give semi-state equations governing this circuit for Vin as the input and Iin as the output and the first component of the semi-state being the capacitor voltage. If possible reduce these to state-variable form with the state being the capacitor voltage.
b) Give the input admittance y(s).
c) This circuit requires the input admittance to be taken with one terminal at ground. If the same admittance is needed to be for a floating 1-port discuss how you might modify this circuit to obtain such.
d) Discuss how you would proceed if the op-amp saturates at Vdd and Vss=-Vdd.