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EE 610 Final Exam Fall 2009

Take Home. Open Book Open Notes 200 points total

Due in Room AVW 1364 at the final period Tu 12/15/09 [08-10am]

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

1. (6 points/synthesis=30 points) [lossless synthesis]

   Synthesize $y(s) = \frac{s(s^2+6)}{s^2+3}$ by 5 methods (1^{st} & 2^{nd} Foster & Cauer & via Richards' function sections with k=1)

2. (10 points/part=40 points) [even part zeros]

   Assume that k1 & k2 ≠ ±k1 are two zeros of the even part of a rational y(s). Note that if a Richards' section is extracted at k1 then also –k1 is also eliminated from the load admittance yL(s).

   a) Since –k1 is also a zero of the even part, a Richards' function extraction can occur by choosing k = -k1 in the Richards' function extraction. Draw the (gyrator, capacitor) Richards' section that results.

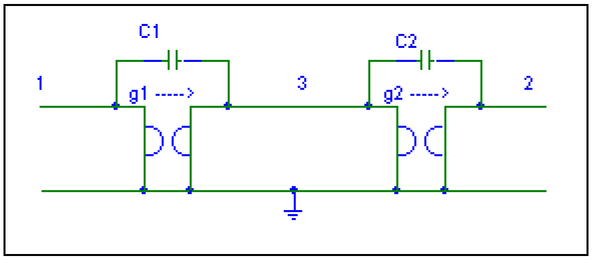
   b) Determine, in terms of the degree $\delta[y(s)]$, what is the minimum number of zeros of the even part of a rational y(s) that can be removed in a synthesis of a rational y(s). In what cases is there no maximum of the number of zeros of this even part?

   c) Show that Richards' functions can be used for synthesis of y(s) which are not positive-real by synthesizing $y(s)=s(s^2+3)$ via three Richards' sections all using k=+1.

3. (30 points) [RL circuits]

   The necessary and sufficient conditions that a positive-real rational y(s) by synthesizable by an LC circuit (with all L's & C's positive) is that y(s)=-y(-s). Give (and prove) similar necessary and sufficient conditions that a positive-real rational y(s) be synthesizable by an LR circuit (with all L's & R's positive).

4. (50 points) [nodal admittance]
   The following represents the extraction of two Richards' sections at positive k's for a PR y(s). Find the nodal admittance matrix and eliminate node three to obtain the 2-port Y(s) matrix. By considering Y(s) as a sum of matrices discuss why it can be synthesized by a passive circuit using only one gyrator, one capacitor, one inductor and one resistor with possible transformer combinations..



5. (50 points) [semistate equations]
   For the following circuit
   a) choose branches 1, 2, 3 for the tree and give the cut set and tie set matrices.
   b) set up the semistate equations with $u=[V1\ V2]^T$ as input voltages, $y=[-I1\ -I2]^T$ as output currents [going up through the voltage sources], and tree voltages & link currents for the semistate x.