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EE 610 Final Exam Fall 2010

Take Home. Open Book Open Notes 200 points total

Due in Room AVW 1364 at the final period F 12/17/09 [1:30-3:30pm] along with your notebook. Your signature certifies that the work is your own.

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

   Synthesize $z(s) = \frac{s(s^2+8)}{s^2+4}$ by 5 methods (1st & 2nd Foster & Cauer & via Richards' function sections with k=2)

2. (40 points) [even part zeros]

   Given the even part of a function, Ev(y), one can create a function, y, by adding an odd part. For

   $$2\text{Ev}(y(s)) = \frac{(s+1)(-s+1)}{(s+2)(s+3)(-s+2)(-s+3)}$$

   add 2 times an odd part with a degree three numerator and the same finite poles and from that find y(s) with only left hand finite poles. Is this y(s) PR?

3. (40 points = 10 points per part) [positive-real of positive-real]

   Given two positive-real functions f(s) and g(s), possibly not rational, it is known that f(g(s)) is positive-real.

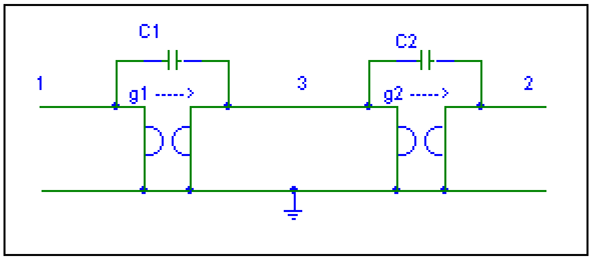
   a) Show mathematically that this is the case.
   b) In the rational, PR, case, if a circuit is known for each of f(s) and g(s) explain how a circuit for f(g(s)) can be obtained. Assume that both f(.) and g(.) are admittances.
   c) Let $f(s) = \frac{s+1}{2s+3}$, $g(s) = \frac{s^2+5}{4s}$ be given admittances. Give a circuit for the admittance y1(s)=f(g(s)) and one for y2(s)=g(f(s)) and discuss important points learned from this example.
   d) Give conditions for f(g(s)) = g(f(s))

4. (50 points = 25 points per part) [semistate equations]

   The following circuit (on next page) represents the extraction of two Richards' sections at positive k's for an input admittance $y_{in}(s)$ seen looking into port 1 (on the left). Assume a resistive load of resistance r>0 at port 2 (on the right). Use the voltages at nodes 1, 2, 3 with respect to ground as semistate variables.

   a) Write the semistate equations $\begin{aligned} E\frac{dx}{dt} &= Ax + Bu \\ y &= Cx \end{aligned}$ for $y_{in}(s)$ as the transfer function.

   b) Find $y_{in}(s)$ from these semistate equations in terms of the element values.



5. (40 points = 13+ points per part) [graph and 2-port admittance]
For the following circuit there are three nodes as numbered (plus the ground = 0) and 5 branches which are numbered by the components (the transistor M has two branches, 2 and 3).
   a) Draw the graph for the circuit with directions from lower to higher numbers.
   b) Choose branches 1, 3, 4 for the tree and give the cut set and tie set matrices.
   c) Assuming linear operation of the transistor (with gm, go as the only parameters of interest), give the 2-port admittance matrix with port 1 seen by V1 and port 2 as seen at Vout.