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EE 610 Final Exam Fall 2014

Open Book Open Notes 150 points, 2 hours.

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

1. (60 points, 40 minutes)

   Consider the input admittance $y(s) = s(s^2+a)/[(s^2+1)(s^2+9)]$

   a) For what values of a is this a lossless PR function?
   b) Choose a=4 (for which y(s) is PR lossless) and give a 2nd Foster synthesis.
   c) For your synthesis feed by a current source and draw the resulting graph having a branch for every circuit component. Indicate a tree with as many branches as possible connected to the bottom of the current source; direct the tree branches downward and number them sequentially with lowest numbers from left to right (direct links left to right or down and numbered sequentially after the tree branches). Give the resulting cut set and tie set matrices.

2. (40 points, 20 minutes)

   Given the zeroes of the even part of a PR y(s), show how the zeroes of the even part of z(s)=1/y(s) are related.

3. (20 points, 20 minutes)

   a) An OTA is a 2-port voltage controlled current source with the law $I_1=0$, and $1_2=-g_mV_1$ with non-zero real g_m. Show that the OTA is not passive.
   b) A gyrator can be constructed by two back to back OTAs of g_{m1} and $-g_{m2}$. Draw the circuit diagram for this type of gyrator.
   c) Explain why this gyrator (for which $g_{m1}=g_{m2}$) is passive even though the devices from which it is made are not.
   d) If $g_{m1}\neq g_{m2}$ evaluate the power into the above back to back OTA construction expressed in terms of port voltages.

4. (30 points 20 minutes)

   Assume a synthesis of a lossless y(s) occurs but when constructed it is found that each inductor of inductance L has a resistor of resistance $R_L=aL$ in series and each C has a resistor of conductance $G_C=aC$ in parallel where a is a positive constant.

   a) Give the actual Y(s) in terms of y(s) and a.
   b) How are the actual poles and zeros found from the ones of y(s).