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610 Fall 2015 – Homework 4 Due Tu 10/06/15

1. (50 points, degree one state-variable design)

   For the driving point admittance

   $$y(s) = [as+b]/[cs+d]$$

   a) Set up state-variable equations. Interpret the state as voltage on capacitors and from that give a synthesis using a constant coupling admittance matrix, Yc, loaded with a capacitor..
   b) Show that y(s) is PR for all real non-negative a, b, c, d. Then determine if the Yc found in part a) is positive semi-definite to see if it can be made with only passive elements. {note: a sufficient condition for a matrix to be positive semi-definite is that all principle minors are non-negative; the condition for a matrix to be positive-definite is that all of the nested set of principle minors be positive}.
   c) For a=1, b=1, and c=-1 y(s) is not PR. Prove that and discuss how this shows up in Yc.

2. (20 points, $V_2/V_1$ design from state variables)

   Given a voltage transfer function $A_v(s)=V_1/V_2=N(s)/D(s)$ where N(s) and D(s) are polynomials with real coefficients and with $A_v(s)$ having no pole at infinity, discuss design via state-variable equations using the fact that N(s) and D(s) can be factored into products of degree two or one polynomials with real coefficients. Will this work if D(s) has zeros in the right half plane (meaning that $A_v(s)$ is unstable)

3. (30 points, Sensitivity via adjoint)

   For the gyrator-capacitor circuit of Problem 1 of Homework set 3 use the adjoint method to find the sensitivity of Vo/Vi with respect to the capacitance $C_1$ and again to the gyrator conductance g.