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ENEE 610 Fall 2001 Final exam
2 hours, 100 points total, open book open notes. If stuck on a problem go on to the next.
Shoe your work for partial credit. Good luck!

1. (33points, 30 minutes)
Assume that for the following function F(s), m=n-1 and $0 \le \sigma_1 < \sigma_2 < \ldots < \sigma_m < \sigma_n$.

$$F(s) = \frac{(s+\sigma_1)(s+\sigma_3)\ldots(s+\sigma_m)}{(s+\sigma_2)(s+\sigma_4)\ldots(s+\sigma_n)} = \prod_{k=1}^{n/2} \left(\frac{s+\sigma_{2k-1}}{s+\sigma_{2k}}\right)$$

a) Show that the function can be expanded into a partial fraction expansion as

$$F(s) = K_1 + \frac{K_2}{s+\sigma_2} + \frac{K_4}{s+\sigma_4} + \ldots + \frac{K_n}{s+\sigma_n}$$

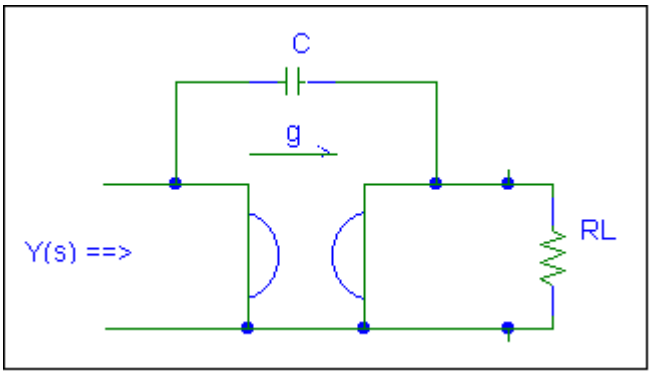
b) Determine which of the coefficients K_i in this partial fraction expansion are real and positive.
c) Synthesize the following function $F_1(s)$ as an impedance and as an admittance of a network, respectively.

$$F_1(s) = \frac{s(s+5)}{(s+3)(s+8)}$$

2. (35 points, 30 minutes)
Consider the admittance function

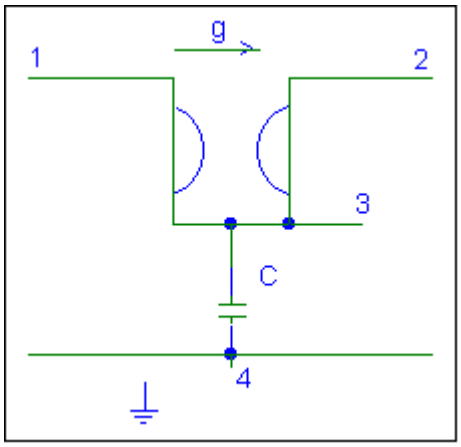
$$Y(s) = \frac{s+a}{s+b}$$

where a and b are complex parameters.
a) Determine for which a and b this admittance is positive real.
b) Find the zeros of the even part of Y(s).
c) For $0 < a \le b$ synthesize Y(s) by using the Richards' function and the following circuit giving passive element values where possible in terms of the parameters a and b.
d) Discuss any anomalies.



3. (32 points, 30 minutes)

For the following circuit all node voltages are measured positive with respect to ground and all external currents enter the numbered nodes.



a) Set up the indefinite admittance. Then from it

b) Find the admittance matrix when node 4 is grounded.

c) With node 4 grounded set up semistate equations using the results of b) along with

$$x = \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} = \text{semistate}, \quad u = \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = \text{input}, \quad y = \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \text{output},$$

where all voltages are measured with respect to the ground node and the input currents enter the correspondingly numbered nodes. (note that in this case $i_3 = 0$)

d) By any means find the 2-port admittance Y(s), y=Y(s)u, for u and y as in c).