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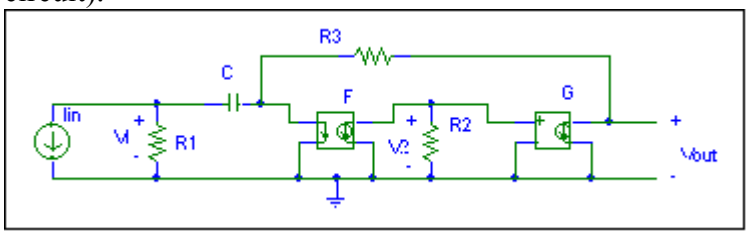
ENEE 610 To Consider #6

1. Read chapter 3, pp. 91 - 122, on network graph theory for setting up equations.

2. For the following circuit where F and G are the Spice components (CCCS and VCCS, respectively) of gains also called F and G, find the sensitivity of Vout/Iin to any R and to F and to G, in two ways (through direct differentiation and through use of the adjoint circuit).



3. If all circuit parameters vary with respect to some other parameter k (for example temperature) show how to find the sensitivity of the transfer function with respect to k if the sensitivity with respect to all circuit parameters are known. Carry out an example to check your theory (for example on the circuit of problem 2. above).

4. Given the state variable equations [equations (5.4-1) & (5.4.3) of page 217 of the text]

$$\frac{dx}{dt} = Ax + Bu$$

$$y = Cx + Du$$

find the sensitivity of the transfer function T(s), Y(s)=T(s)U(s), with respect to any entry in A, B, C, or D.

5. If T(s)=N(s)/D(s) with N(s) and D(s) polynomial in s, find $S_k^{T(s)}$ in terms of $S_k^{N(s)}$ and $S_k^{D(s)}$. Express $S_{1/k}^{T(s)}$ in terms of $S_k^{T(s)}$. Consider also $|S_k^{T(s)}|$ and $S_k^{|T(s)|}$. Carry out some numerical examples.

6. Set up the state variable equations, as in problem 4. above, for the transfer function

$$\frac{Vout}{Vin}(s) = T(s) = \frac{5(s^2+3s+4)}{(s+3)(2s^2+3s+4)}$$

From these state variable equations synthesize this transfer function in two different ways, one using VCCSs and capacitors and one using op-amps, resistors and capacitors.

Repeat if T(s) is Iout/Iin.

7. (harder problems)

a) Using the adjoint circuit set up a means to calculate the sensitivity of a driving point admittance. Carry this out on some examples such as for V1/Iin of problem 2. above.

b) For a circuit described by state variable equations, as in problem 3. above, set up the adjoint circuit and show how to use that to calculate the derivative of y with respect to a circuit parameter.