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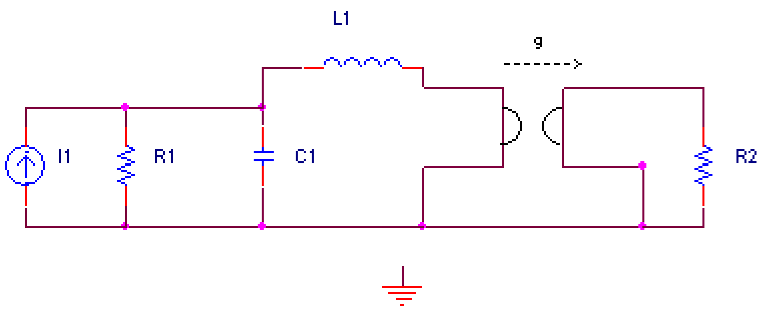
610 Fall 2008 – Homework 2

C in 2. corrected to [1 0 0] 10/27/08

1. For the following circuit set up the indefinite admittance matrix (excluding the current source). Then ground the bottom line of the circuit after which eliminate the two right-most (upper) nodes to get the input admittance Y(s) seen by the current source.



2. Consider the state equations

$$\frac{dx}{dt} = \begin{bmatrix} -(2\zeta\omega_o + \lambda) & 1 & 0 \\ -(2\zeta\omega_o\lambda + \omega_o{}^2) & 0 & 1 \\ -\lambda\omega_o{}^2 & 0 & 0 \end{bmatrix} x + \begin{bmatrix} k \\ 2k\xi\rho \\ k\rho^2 \end{bmatrix} u = Ax + Bu$$

$$y = [1 \quad 0 \quad 0]x = Cx$$

$\zeta, \xi, \lambda, \rho, \omega_o, k$ all real and positive;

$x = x(t)$, a real-valued 3-vector function

a. Find $(sI-A)^{-1}$

b. Find the (scalar) transfer function $T(s)=C(sI-A)^{-1}B$ and give its poles and zeros (note that $s+\lambda$ is a denominator factor).

c. Assume that T(s)=Vout/Vin=Y(s)/U(s) and draw an op-amp-RC circuit to realize this.

d. Find a transformation P such that $A_p=PAP^{-1}$ is of the form

$A_p = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -a_0 & -a_1 & -a_2 \end{bmatrix}$. Give the new B and C matrices, B_p and C_p.