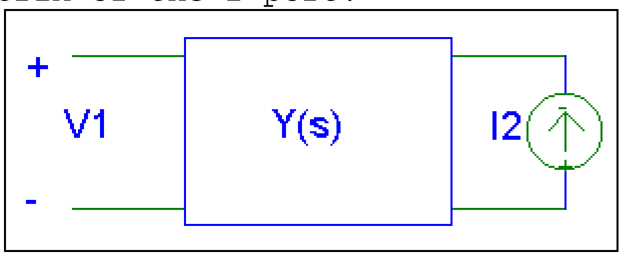
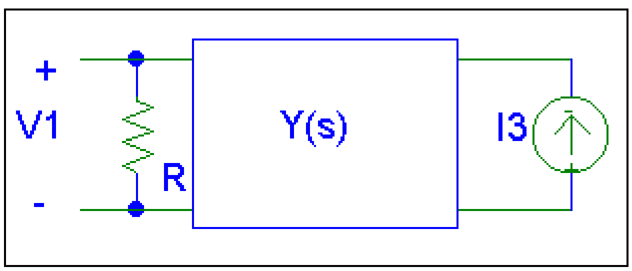
file: 610_F02_probs5.doc RWN 10/07/02

ENEE 610 Fall 2002
Problems to consider #5

1. For the terminated circuit shown find V1/I2 in terms of the Y(s) matrix of the 2-port.



2. Repeat 1. for the following circuit.



3. Give the conditions on the transfer function T(s)=V1/I2 for it to be realizable when the 2-port for Y(s) is a lossless ladder and when R>0. What changes if the 2-port is lossless but not restricted to be a ladder? What if R<0 is allowed?

4. If possible synthesize T(s)=V1/I2 by one or both of the above two structures:

a) $$T(s)=\frac{20}{s^5+5s^4+3s^3+2s^2+5s+3}$$

b) $$T(s)=\frac{20s^3+10s}{s^5+5s^4+3s^3+2s^2+5s+3}$$

5. Consider all of the above in the case where Y(s) is RC.

6. Show that for a positive real nxn matrix Y(s) the ith pole on the jω axis is simple with a residue matrix H_i which is Hermitian positive semi-definite. Thus the contribution of the pole and its conjugate take the form:

a) if at infinity: $sH_\infty \Rightarrow H_\infty$ positive semidefinite

b) if at zero: $\frac{1}{s}H_0 \Rightarrow H_0$ positive semidefinite

c) if finite and non-zero:

$$\frac{1}{s-j\omega_i}H_i + \frac{1}{s+j\omega_i}H_i^* = \frac{s(H_i + H_i^T) + j(H_i - H_i^T)}{2(s^2+\omega_i^2)}$$

where

$$\frac{1}{2}(H_i + H_i^T) = \text{Real\_part}(H_i) = \text{Symmetric\_part}(H_i) \Rightarrow \text{positive semisdefinite}$$

and

$$\frac{1}{2j}(H_i - H_i^T) = \text{Imaginary\_part}(H_i) = \text{Skew\_part}(\frac{1}{j}H_i)$$

hint: to do this consider a small circle around the pole and check the angle as a vector moves from -90 degrees to +90 degrees in the right half plane where the real part of $V^{T*}Y(s)V$ needs to be non-negative for all complex vectors V.

5. Following up on 4. give the partial fraction expansion for

$$Y(s) = \begin{bmatrix} \frac{(3s^2+2)(5s^2+10)}{s(s^2+1)(s^2+9)} & \frac{(3s^2+2)(5s^2-10)}{s(s^2+1)(s^2+9)} \\ \frac{(3s^2+2)(5s^2+10)}{s(s^2+1)(s^2+9)} & \frac{(3s^2+2)(5s^2+10)(6s^2+60)}{s(s^2+1)(s^2+9)} \end{bmatrix}$$

Is this admittance matrix positive real? Lossless? Find the corresponding scattering matrix.