

ENEE 610

Homework Problems for Grading, Set 3 (200 points)

Due at class ~~W 10/11/06~~ M 10/23/06

All-pass lattice, transistorized all-pass & indefinite admittance

1. (50 points)

For the all-pass function

$$T(s) = \left(\frac{2-s}{2+s} \right)^3$$

With $G=3$ Mho realize this as a voltage transfer function in three different ways:

1. As the cascade of three constant R lattices
2. As the cascade of two constant R lattices
3. As one constant R lattice

2. (50 points)

For $R=2\text{Kohm}$ and $C=20\text{nanoFd}$ realize the degree one all-pass using the transistor circuit of the lecture of 09/27/06. Using MOSIS AMI 1.2u transistors (with level 4 models), set this up in Spice and run a frequency response (over decades from at least 10Hz up to at least 10GHz), submitting your circuit diagram along with the phase and amplitude (using a DB scale) responses. Repeat when all substrates are tied together (at the lowest potential in the circuit) and discuss any changes over the original circuit.

To plot phase in an AC run using the PSpice probe, from Add Trace the function $P()$ from the functions in the right panel give continuous phase while $ATAN(\text{IMG}()/\text{R}())$ and $ARCTAN(\text{IMG}()/\text{R}())$ give discontinuous phase only between $-\pi/2$ and $+\pi/2$. You can set white backgrounds for plots by editing the Probe Colors section of the msim.ini file (through version 8 of PSpice) or the pspice.ini file (of later versions).

3. (100 points)

For the first transistor circuit of problem 2 (the circuit given in the 09/27/06 lecture), assume node 1 at the top of v_{in} , node 2 at the top of v_o , node 3 at the top of C, node 4 at x, node 5 at y and node 6 as ground. Assume that all transistors are equal and biased to give the same bias drain current. Include C_{gs} , C_{gd} , g_o and g_m and under small signal conditions (to simplify use $C_{gs}=C_{gd}$)

- a. set up the indefinite admittance matrix (note that V_b is a constant so that g_m for M1 does not enter)
- b. Move the ground to node 6 by scratching out row and column 6 to get Y_{def} .
- c. Eliminate the internal nodes to get the 2-port Y matrix. You can do this one at a time by inverting a scalar three times or all at once by inverting the 3x3 matrix in the last 3x3 position of Y_{def} .
- d. Find the (open circuit) transfer function and compare with the result of Problem 2; briefly discuss the result.