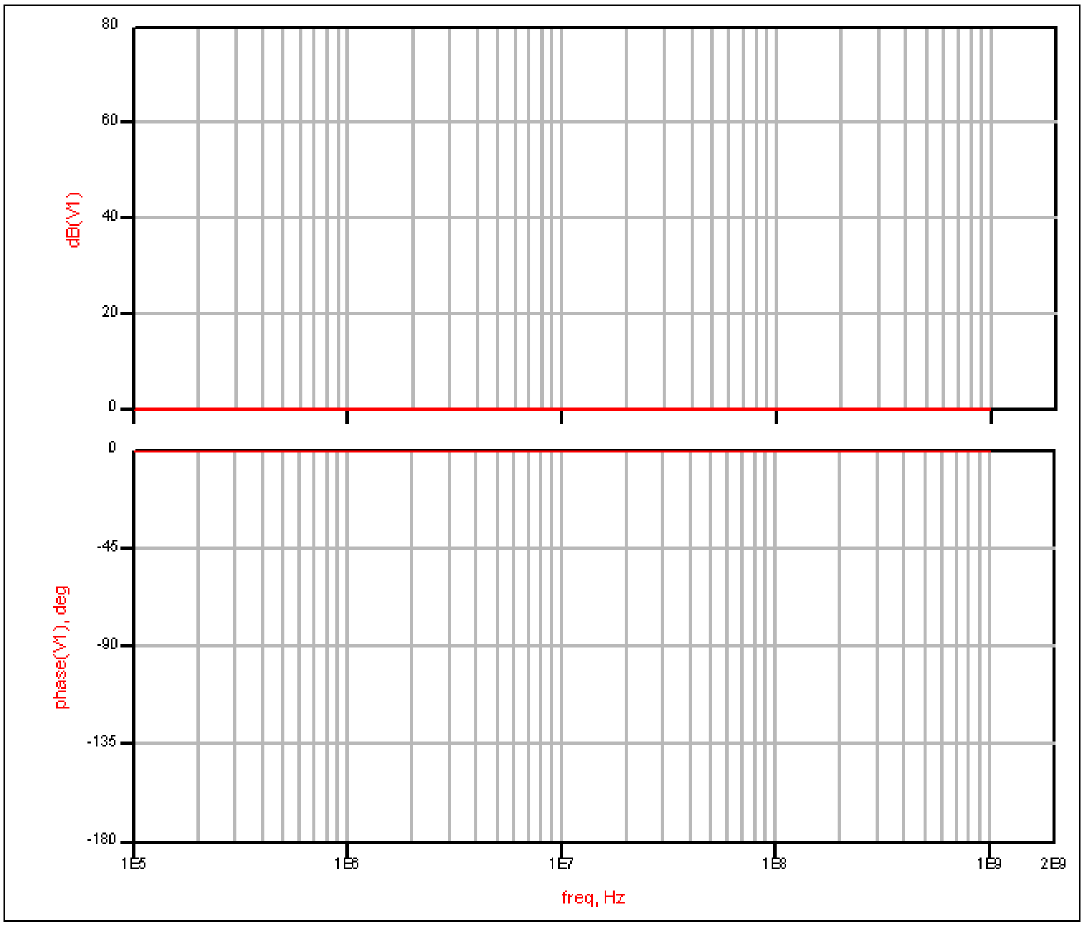
ECE145B/ECE218B Homework #4 Winter 2011
Due 2/25/2011 at homework box, 3rd floor

1. Feedback A feedback amplifier has an open loop gain, $a_o = 1\times10^4$ and feedback transfer function f = 0.0316.

a. Calculate the exact closed loop gain. How much in error is the first order estimate of closed loop gain in this case? In dB?

b. The amplifier has two poles, 10 MHz and 50 MHz. Sketch the Bode plot. Estimate the crossover frequency and phase margin.



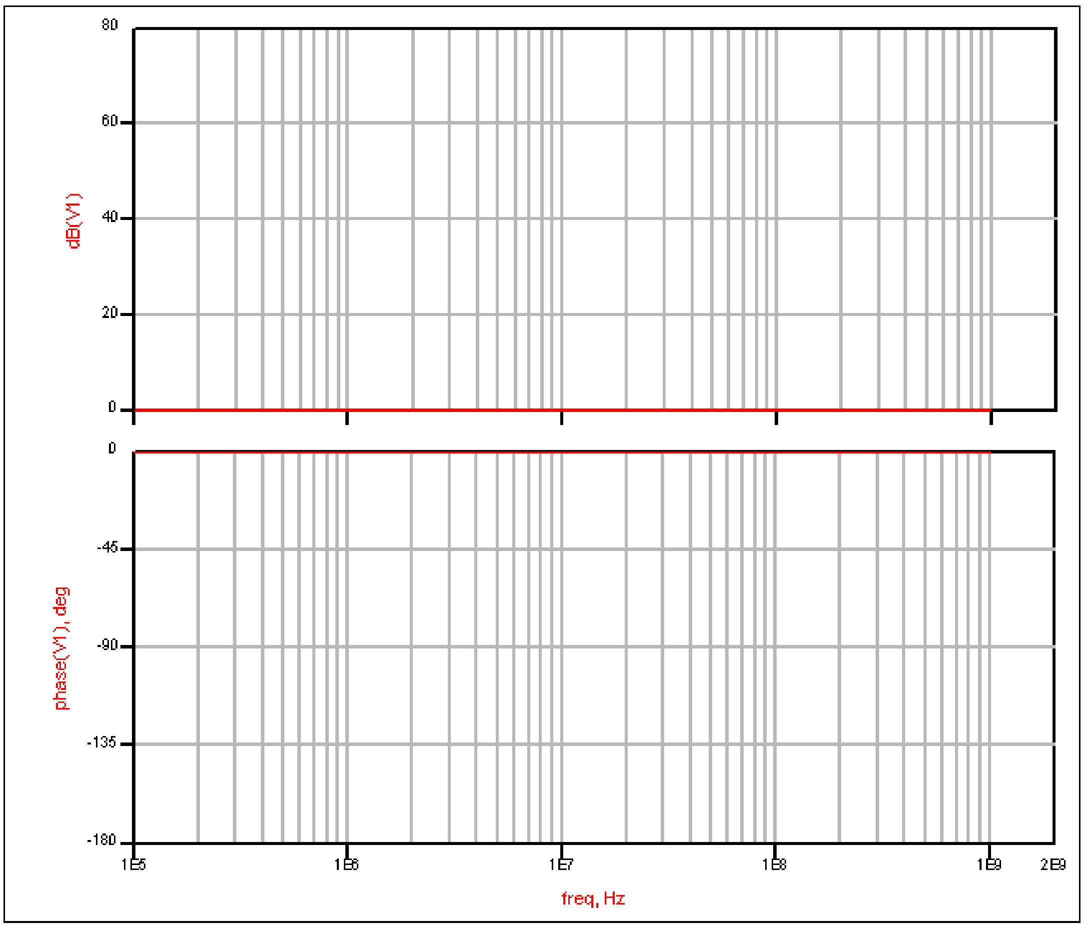
c. Calculate ωn and ζ from the closed loop transfer function. Sketch the root-locus plot.

d. Use ωn and ζ to estimate the following properties of this amplifier:

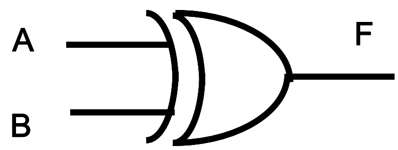
Overshoot in the step response
1% settling time
Ringing frequency
Gain peaking (dB)
Frequency of gain peak
3 dB frequency.

Sketch what the closed loop frequency response might look like on the Bode plot

e. Now, use dominant pole compensation to provide a 45 degree phase margin. At what frequency is the dominant pole? What is the new crossover frequency?
Repeat parts c. and d. for this compensated case. (why is it valid to consider this a two pole amplifier?)

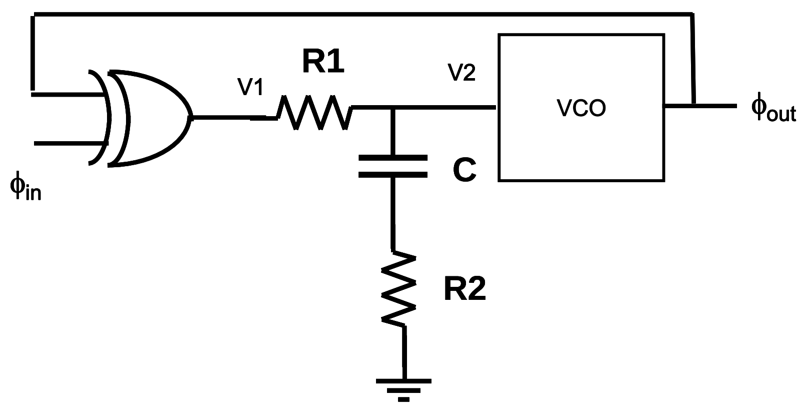


2. a. The exclusive OR gate below can be used as a phase detector. Assume that its output range is 0 to 5V. If two inputs, A and B, are considered square waves, draw a plot of the average phase detector output voltage for phase differences between 0 and π radians.
Determine K_D in the useful region of this phase detector.



A	B	F
0	0	0
0	1	1
1	0	1
1	1	0

b.

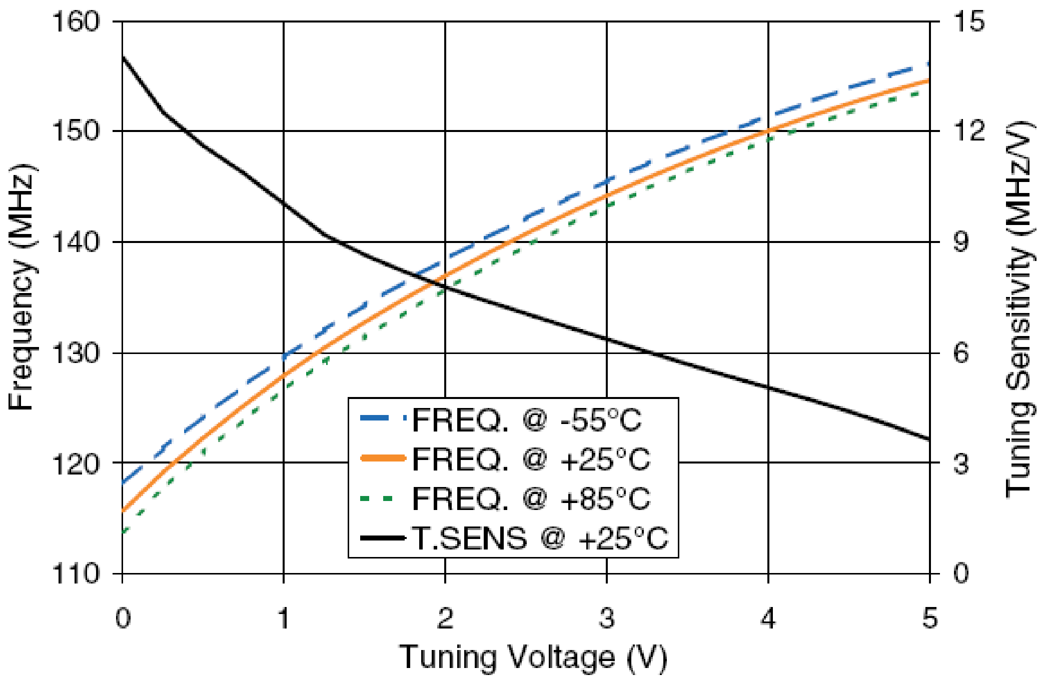


The phase detector is combined with the loop filter and VCO. The VCO tuning characteristic is given by the plot from Mini-circuits on the next page and the step response of a Type 1 second-order loop is also provided. You are given R1 = 10k.

Design the loop filter so that the overshoot to a phase step is a maximum of 10% and the 1% settling time is 10 us at the 5 volt end of the tuning range.

c. Determine the overshoot and settling time at the 1 volt end of the tuning range.

ZX95-148+
Frequency and Tuning Sensitivity



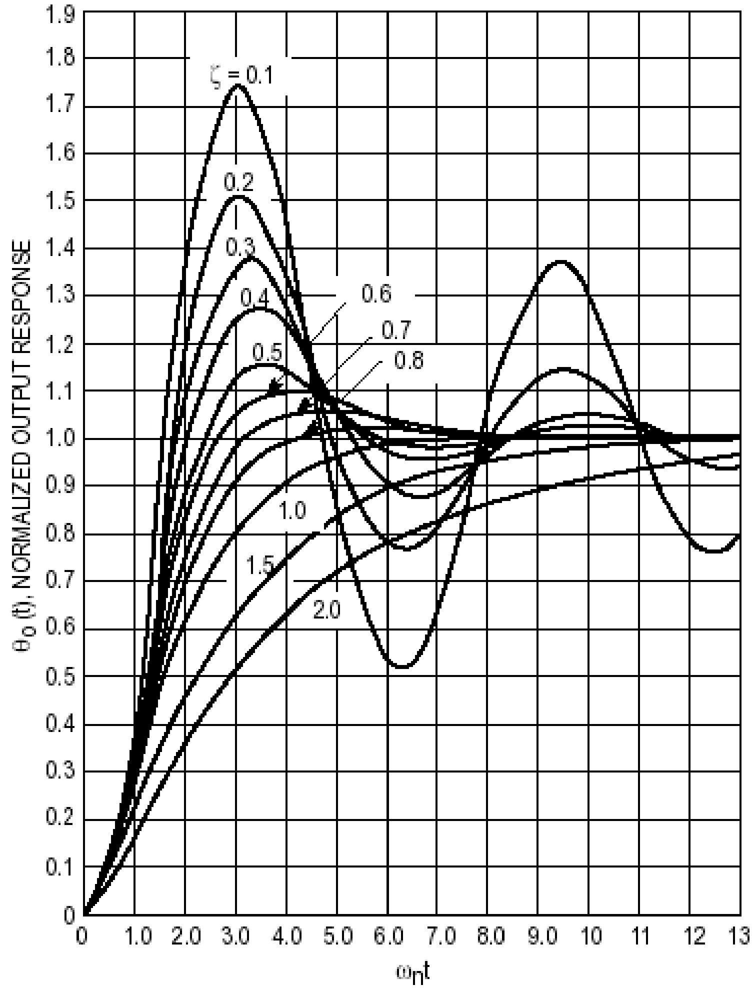


Figure 4. Type 1 Second Order Step Response