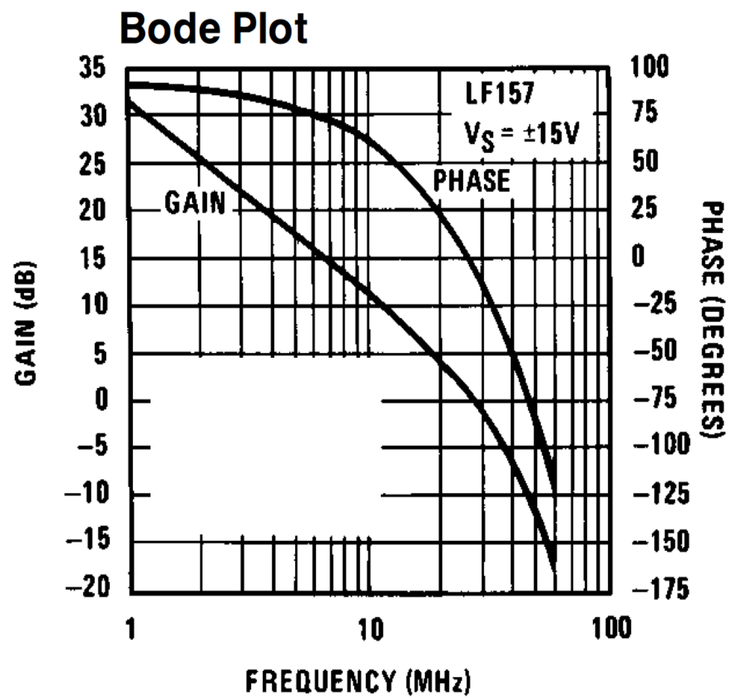
Physics 623 — Problem Set 4



1. The open-loop gain curve for an LF157/357 op-amp is shown at the right. This is a detailed view of the high frequency end of the curve, and explicitly shows the phase as well as the magnitude of the gain. The reference for the phase at low frequencies for this plot is +180° instead of the usual 0°, so you'll need to subtract 180° from the values given here.

a) What is the gain-bandwidth product for this op-amp?

b) If you use it as a unity-gain buffer ($\beta = -1$), what is the phase margin? Is this a useable amplifier circuit?

c) What is the minimum closed-loop gain ($-\beta^{-1}$) that will provide a reasonably safe 45° phase margin?

d) What is the approximate bandwidth of the amplifier at this gain? The nominal gain-bandwidth product? (Don't try to calculate these exactly. The neat result that the closed loop gain curve is a simple single-pole response with gain-bandwidth product independent of gain only holds for a 90° phase margin. At smaller margins, the gain actually rises at high frequencies and has a peak at $|\beta A| = 1$. The simple equations you have used are still exact, but when more than one pole is involved the complex algebra gets messy. See H&H.)

e) Suppose your circuit in part c) is a conventional non-inverting amplifier with a voltage divider on the output connecting a fraction β of the output back to the negative input. We usually assume this β is entirely real, but suppose there is a significant stray capacitance between the wiring to the negative input and ground. Explain the qualitative effect on your phase margin. If the bottom resistor in the divider is 10 K ohms (the gain then determines the top one) and the stray capacitance is 5 pF, at what frequency do you get an additional 45° phase shift? What will happen?