EE2019–Analog Systems and Lab: Tutorial 6

Nagendra Krishnapura, Shanthi Pavan

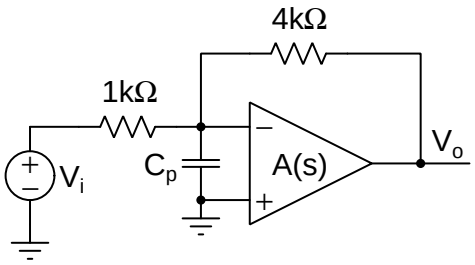

Figure 1: Circuit for problem 1

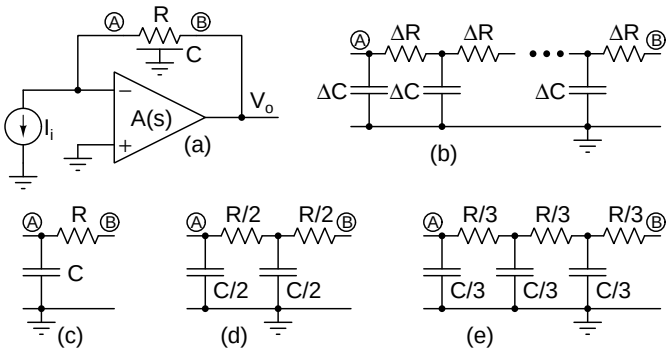

Figure 2: Circuit for problem 2

1. Fig. 1 shows an inverting amplifier. The opamp has a gain $A(s) = A_0/(1 + s/p_1)(1 + s/p_2)$ where $A_0 = 20000$, $p_1 = 1$ krad/s, $p_2 = 10$ Mrad/s. C_p is a parasitic capacitor.

   - What is the phase margin of the system with $C_p = 0$?
   - What is the closed loop bandwidth of the system? (Calculate this from (a) Unity loop gain frequency, (b) Natural frequency of the second order system, and (c) Exact calculation-computing the frequency at which the gain magnitude drops to $1/\sqrt{2}$ times the dc gain.; Compare the estimates so obtained)
   - What is the value of C_p for which the circuit becomes unstable?
   - With C_p being the value calculated in the previous part, can you change the circuit so that the phase margin is 60° without changing the opamp or the closed-loop dc gain V_o/V_i?

2. Fig. 2 shows a transimpedance amplifier. The opamp has a frequency independent gain A_0. The feedback resistor R has a parasitic capacitor C. C is distributed across the length of the resistor and should be modeled as shown in Fig. 2(b) where the infinite number of infinitesimal ΔR and ΔC sum up to R and C respectively. This cannot be analyzed easily, so we model it as shown in Fig. 2(c), (d), or (e). Analyze each case and comment on the effect of A_0 on stability or damping. (In addition to stability, this problem also tells you something about oversimplified models).

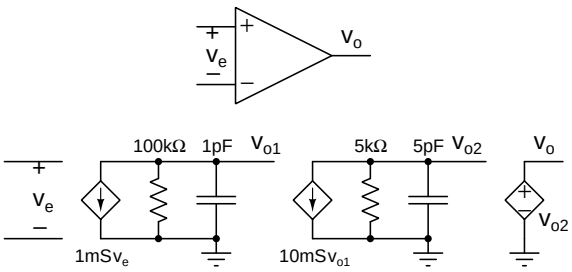

Figure 3: Circuit for problem 3

3. Fig. 3 shows the internal schematic of an opamp. This opamp is used to realize a unity gain, non-inverting amplifier.

   - What is the phase margin?
   - Connect a capacitor across one of the existing capacitors inside the opamp so that the phase margin is 60°.

Repeat the above if the opamp is used to realize an inverting amplifier of gain -4.