

EE105 Lab Experiments

Prelab 7: Frequency Response

Name:

Lab Section:

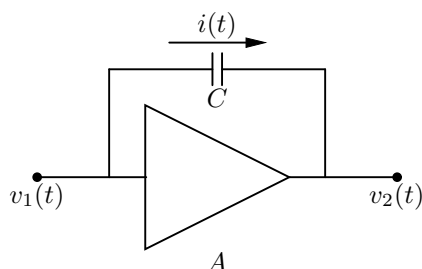


Figure 1: Amplifier with a “Miller” capacitor

The Miller effect plays an important role in determining the poles of an amplifier. If there is a gain A across the capacitor C as shown in Figure 1, the current across C can be written as:

$$i(t) = C \frac{d}{dt}(v_1(t) - v_2(t)) = C \frac{d}{dt}(v_1(t) - Av_1(t))$$

By distributing the derivative, this simplifies to:

$$i(t) = C(1 - A) \frac{d}{dt}v_1(t)$$

Therefore, the equivalent capacitance looking into $v_1(t)$ is the capacitance C multiplied by $(1 - A)$. If the gain A is large enough, this Miller effect can make the capacitor dominate and contribute to the dominant pole of the amplifier. Using this same method, you can derive the equivalent capacitance looking into $v_2(t)$, which is $C(1 - 1/A)$.

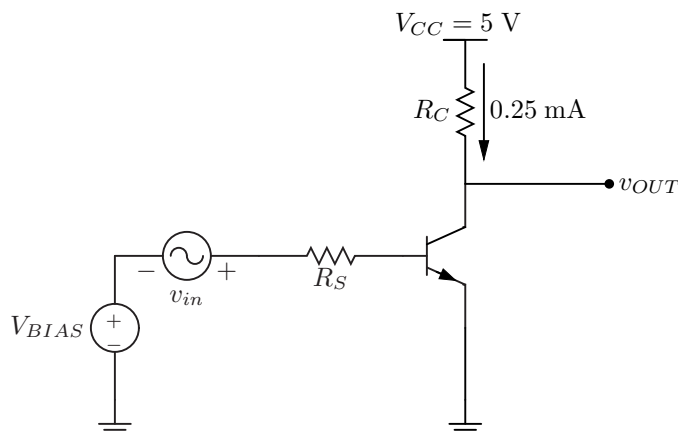


Figure 2: Common emitter amplifier

1. For the common emitter amplifier shown in Figure 2, use the Miller approximation to derive the expressions for the two poles of v_{out}/v_{in} in terms of C_μ , C_π , g_m , R_S , r_π , and r_o . These expressions will help you predict and understand the results of the lab.

$\omega_{p1} =$
$\omega_{p2} =$

2. If $R_S = 51 \, \Omega$, $R_C = 10 \, \text{k}\Omega$, $C_\mu = 11 \, \text{pF}$, $C_\pi = 25 \, \text{pF}$, $g_m = 3 \, \text{mS}$, $r_\pi = 10 \, \text{k}\Omega$, and $r_o = 100 \, \text{k}\Omega$, what are the poles of this amplifier?

$\omega_{p1} =$
$\omega_{p2} =$

3. What will happen to the poles if a capacitor C_M is added across the base collector junction?

4. SPICE

- Construct the common emitter amplifier circuit shown in Figure 2 in SPICE. Use $V_{BIAS} = 0.58 \, \text{V}$, $R_S = 51 \, \Omega$, and $R_C = 10 \, \text{k}\Omega$.
- Use the 2N4401 SPICE model provided on the course website.
- Perform an AC analysis of the circuit from 100 Hz to 10 GHz in HSPICE.
- Use Awaves to generate Bode plots (both magnitude and phase) for the circuit for v_{out}/v_{in} . Attach the Bode plots to this prelab worksheet. Do the results agree with your hand calculations (check the pole frequencies)?