EE315 - Electronics Laboratory

Experiment - 4 Simulation
BJT Small Signal Analysis

Preliminary Work

1.a) Calculate $\mathbf{A_V}$, $\mathbf{A_i}$, $\mathbf{R_{in}}$, and $\mathbf{R_{out}}$ on the circuit given in Figure **1**. Assume that $\mathbf{C_{Ci}}$ and $\mathbf{C_{Co}}$ behave as open circuit for DC signals and as short circuit for AC signals.

1.b) Determine limits of the signal source, v_S, for the transistor to remain in forward-active region.

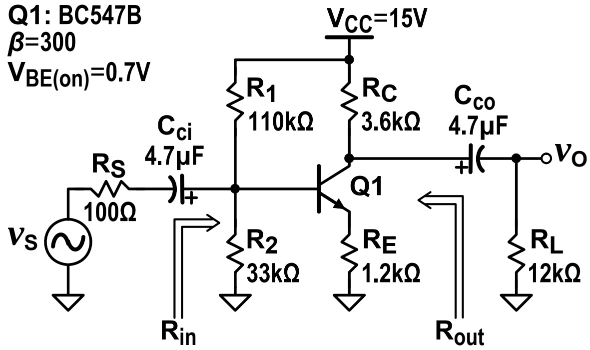

Figure 1. Common-emitter amplifier

2.a) Calculate $\mathbf{A_V}$, $\mathbf{A_i}$, $\mathbf{R_{in}}$, and $\mathbf{R_{out}}$ on the circuit given in Figure **2**. Assume that the coupling capacitors, $\mathbf{C_{Ci}}$ and $\mathbf{C_{Co}}$, behave as open circuit for DC signals and as short circuit for AC signals.

2.b) Determine limits of the signal source, v_S, for the transistor to remain in forward-active region. (Hint: AC current on $\mathbf{R_L}$ will be added onto the quiescent emitter current.)

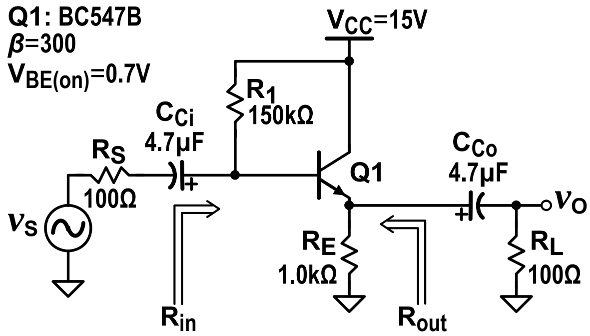

Figure 2. Common-collector amplifier (emitter follower)

Procedure

1. Build the circuit given in Figure **1** and select **BC547B** as the transistor model. Set the ***value*** of the voltage source v_S to obtain **1 kHz** sine wave, with **2 Vp-p** amplitude. Select a **4.7 µF Al electrolytic** capacitor model (right-click on the capacitor figure and click on "Select Capacitor"). Note the polarity of the capacitors on the circuit diagram.

1.a) Measure the voltage gain, A_V.

$V_{Sp\text{-}p}$ = $V_{Op\text{-}p}$ = A_V =

1.b) Determine the current gain, A_i, by measuring the current through R_S and R_L.

$I_{Sp\text{-}p}$ = $I_{Lp\text{-}p}$ = A_i =

1.c) Disconnect R_L and measure the input resistance, R_{in}.

$V_{Sp\text{-}p}$ = $I_{Sp\text{-}p}$ = R_{in} =

1.d) Measure peak-to-peak output voltage while R_L is disconnected. Connect R_L and change its value to obtain half the output voltage measured without any load that will give the R_{out} of the amplifier.

$V_{Op\text{-}p(NoLoad)}$ = R_{out} =

1.e) Find the maximum peak v_S amplitudes before the transistor goes into cut-off or saturation. Compare the results with your calculations in the preliminary work.

$V_{Speak(cut\text{-}off)}$ = $V_{Speak(sat)}$ =

1.f) Connect a **4.7 µF** capacitor in parallel to R_E. Make sure that the polarity of the capacitor matches the DC voltage polarity on R_E. Measure the voltage gain, A_V, again as described in step **1.a**.

$V_{Sp\text{-}p}$ = $V_{Op\text{-}p}$ = A_V =

1.g) Draw the small signal model of the common-emitter amplifier with the capacitor in parallel to R_E, and calculate the voltage gain, A_V, based on your model.

2. Build the emitter-follower circuit given in Figure **2**. Verify that the voltage source output is set to **1 Vp-p**, **1 kHz**, and repeat the steps **1.a**, **1.b**, and **1.c** for this circuit

2.a) Measure the voltage gain, $\mathbf{A_V}$.

$V_{Sp\text{-}p}$ = $V_{Op\text{-}p}$ = A_V =

2.b) Determine the current gain, $\mathbf{A_i}$.

$I_{Sp\text{-}p}$ = $I_{Lp\text{-}p}$ = A_i =

2.c) Disconnect $\mathbf{R_L}$ and measure the input resistance, $\mathbf{R_{in}}$.

$V_{Sp\text{-}p}$ = $I_{Sp\text{-}p}$ = R_{in} =

2.d) Increase v_S amplitude to **2.0 Vp-p** and observe v_O waveform. How do you explain the distortion in the v_O waveform?

2.e) Find a way to restore the v_O waveform while keeping v_S amplitude at **2.0 Vp-p**, and $\mathbf{R_L = 100\ \Omega}$. Explain how you can restore the v_O waveform.

2.f) Measure the output resistance, $\mathbf{R_{out}}$ using the method discribed in step **1.d**. Make sure that the output waveform is not distorted while you measure $\mathbf{R_{out}}$.

$V_{Op\text{-}p(NoLoad)}$ = R_{out} =