

LAB 6: SMALL-SIGNAL AMPLIFIER

1. Goals

- Understand the working principle of a bipolar BJT.
- Build up and analyze a small-signal amplifying circuit using a BJT.

2. Exercises

Exercise 1. Implement and analyze the small-signal common-emitter amplifier as shown in Figure 1.

Requirements:

- Implement the circuit on a breadboard with: $R_1 = 47\text{ k}\Omega$; $R_2 = 12.5\text{ k}\Omega$; $R_C = 1\text{ k}\Omega$; $R_E = 330\text{ }\Omega$; $C_1 = C_2 = 0.1\text{ }\mu\text{F}$, $C_E = 22\text{ nF}$; $\beta = 300$; $V_{BE(\text{on})} = 0.7\text{ V}$.
- Use a pulse generator to provide the input signal $V_{in} = V_0 \sin(2\pi ft)$, with $V_0 = 0.5 \sim 1\text{ V}$ and $f = 1\text{ kHz}$. Use a DC power supply to provide $V_{CC} = 10\text{ V}$.

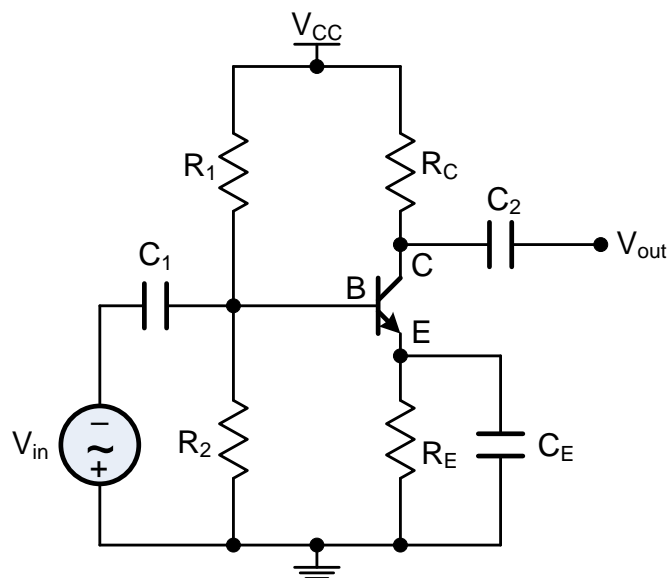


Figure 1. Small-signal common-emitter amplifier.

- Use a multimeter to measure the *Base* (I_B) and *Collector* (I_C) currents of the transistor. Compute the *common-emitter current gain* β of the transistor.
- Use an oscilloscope to display the input voltage (V_{in}) and the output voltage (V_{out}) of the circuit. Based on the input/output voltage waveforms shown on the oscilloscope, determine the *voltage gain* (V_{out}/V_{in}) of the circuit. Compare the measured result with the theoretical calculation.
- Set $R_C = 2\text{ k}\Omega$ and keep the values of the other components unchanged (V_{in} is also unchanged). Use the oscilloscope to observe the output voltage waveform of the circuit. Comment on the waveform of the output voltage.

- With $R_C = 2\text{ k}\Omega$, compute the values of R_1 and R_2 again to make sure that the input voltage waveform and the output voltage waveform are similar, i.e., the input and output voltages have a sinusoidal waveform (no distortion), but they are out of phase. Besides, the voltage gain of the circuit should be aligned with the theoretical calculation.

Components and devices needed for the lab:

Components and Devices	Description	Amount
BJT	2N3904 or 2N2222, 50V-1A	1
Resistor	330 Ω / 2 k Ω / 2.5k Ω / 10 k Ω / 47 k Ω	1/1/1/1/1
Ceramic capacitor	0.1 μ F, 22 nF	3
DC power supply	Aditeg PS-3030DD	1
Pulse generator	UNI-T UTC962E	1
Oscilloscope	OWON SDS1102	1
Breadboard		1
Wire		Few
Multimeter		1