Analog Electronics

Laboratory work

Three Bias Circuits

Key objective

Construct and analyze three types of transistor bias circuits: base bias, voltage-divider bias, and collector-feedback bias.

Components needed

- Resistors: 560 Ω,100 Ω, 1.2 kΩ, 2.0 kΩ, 6.8 kΩ, 33 kΩ, 330 kΩ, two 470 kΩ
- Three small *npn* transistor BC140, BC550

Fixed bias

1. Fixed base bias will be investigated first, but it is the most sensitive to differences in β_{DC}. Transistors of the same type can have widely different values of β_{DC}, which generally restricts the fixed base bias to more specialized applications such as switching circuits such as you used in the last experiment. In step 4, you will modify the fixed base bias with an emitter resistor, which will add stability to this type of circuit. (R_E is not used in the first circuit.)

   The manufacturer's specification sheet for the BC140 shows β_{DC} can range from 100 to 250, a factor of 2.5, which implies that the collector current can also vary by a factor of 2.5 with base bias! Assuming the β_{DC} for a BC140 is in the middle of its specified range (160), compute the parameters listed in Table 1 for the fixed base bias circuit shown in Figure 1. Start by computing the voltage across the base resistor, V_{RB}, and the current in this resistor, I_B. Using β_{DC}, find the collector current, I_C, the voltage across the collector resistor, V_{RC}, and the voltage from collector to ground, V_C.

DC Parameter	Computed value		Measured value	
			Q_1	Q_2
V_{RB}				
I_B				
I_C				
V_{RC}				
V_C				

Table 1

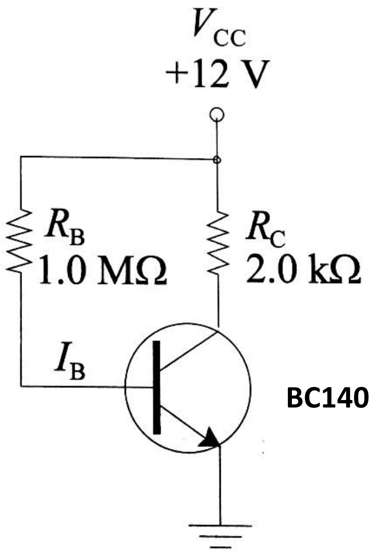

Figure 1

2. Label each of three *npn* transistors as Q_1, and Q_2 in a manner that allows you to keep track of each transistor. Construct the circuit shown in Figure 1 using Q_1. Measure the voltages listed in Table 1 for Q_1. Then remove Q_1 from circuit and test the other two transistors in the same circuit. Record the data in Table 1.

Emitter-Feedback bias

3. Emitter-feedback bias is a form of base bias but with increased stability due to the addition of an emitter resistor. Add the emitter resistor to the base bias circuit and observe the results. Calculate the parameters in Table 2 for the circuit in Figure 2 and enter the calculations in the table. Use the method described in the text. Use β_{DC} as 160 for the calculated value.

4. Construct the circuit and measure the parameters in Table 2 for each of the two transistors you tested.

DC Parameter	Computed value		Measured value Q_1	Measured value Q_2
V_{RB}				
I_B				
I_C				
V_{RC}				
V_C				

Table 2

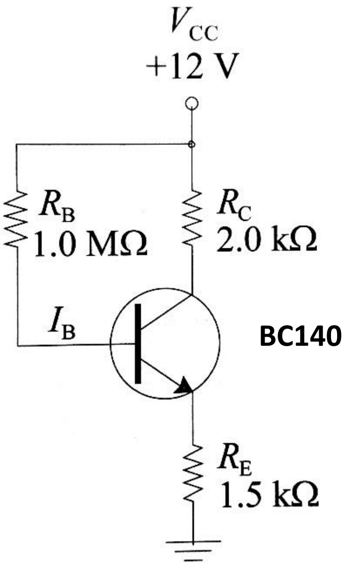

Figure 2

Voltage-Divider Bias

5. Although the emitter-stabilized base bias you tested in step 5 has better stability than fixed base bias, you may have noticed that parameters still vary between transistors. A more stable form of bias is voltage-divider bias, which you will test next using the same three transistors. The circuit meets the condition that $\beta R_E \geq 10\ R_2$, so the approximate analysis method, given in Section 2 of the text, can be used.

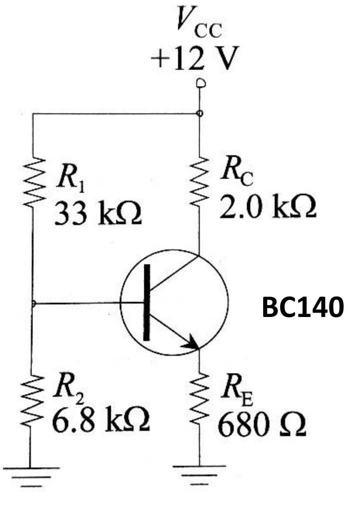

Figure 3

6. Compute the parameters listed in Table 3 for the circuit shown in Figure 3 using the approximate method for all calculations.

DC Parameter	Computed value		Measured value Q_1	Q_2
V_B				
I_E				
$I_E \approx I_C$				
V_{RC}				
V_C				

Table 3

7. Substitute the same three transistors into the voltage-divider circuit and measure the parameters listed in Table 3. Record your data in the table.

Collector-Feedback Bias

8. Compute the parameters listed in Table 5 for the circuit shown in Figure 4. Notice there is no emitter resistor. Assume β_{DC} is 160 for the calculation. Calculate the voltage across the collector resistor, V_{RC}, and the collector voltage, V_C based on this assumption.
9. Construct the circuit shown in Figure 4 using transistor Q_1. Measure the voltages listed in Table 4 for Q_1. Then remove Q_1 from the circuit and test the other two transistors in the same circuit. Record all measurements in Table 4.

DC Parameter	Computed value		Measured value Q_1	Q_2
I_C				
V_{RC}				
V_C				

Table 4

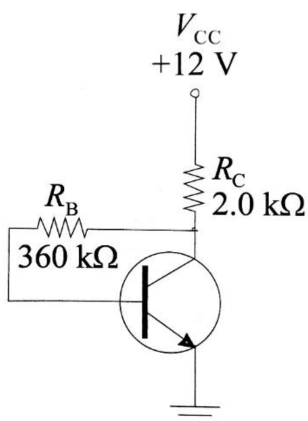

Figure 4