Name _____

Date _____

Instructor _____

EXPERIMENT

27

Differential Amplifier Circuits

OBJECTIVE

To calculate and measure DC and AC voltages in differential amplifier circuits.

EQUIPMENT REQUIRED

Instruments

Oscilloscope
DMM
Function generator
DC power supply

Components

Resistors

(1) 4.3-kΩ
(4) 10-kΩ
(2) 20-kΩ

Transistors

(3) 2N3823, or equivalent

EQUIPMENT ISSUED

Item	*Laboratory serial no.*
DC power supply	
Function generator	
Oscilloscope	
DMM	

RÉSUMÉ OF THEORY

BJT Differential Amplifier

A differential amplifier is a circuit with plus (+) or minus (–) inputs. In typical operation, inputs that are opposite in-phase are amplified greatly, while inputs that are in-phase are canceled at the output. Figure 27.1 is the circuit of a simple BJT differential amplifier with plus (V_i^+) input and minus (V_i^-) input, and opposite outputs, V_{o1} and V_{o2}. Typically no capacitor is needed, the input signals being DC coupled, and the positive (V_{CC}) and negative (V_{EE}) supplies providing DC bias. Using the value of r_e assumed in this experiment to be the same for both transistors, the differential voltage gain is of magnitude

$$A_v = \frac{R_C}{2r_e} \tag{27.1}$$

The gain for signals which are common at both inputs is of magnitude

$$A_v = \frac{R_C}{2R_E} \tag{27.2}$$

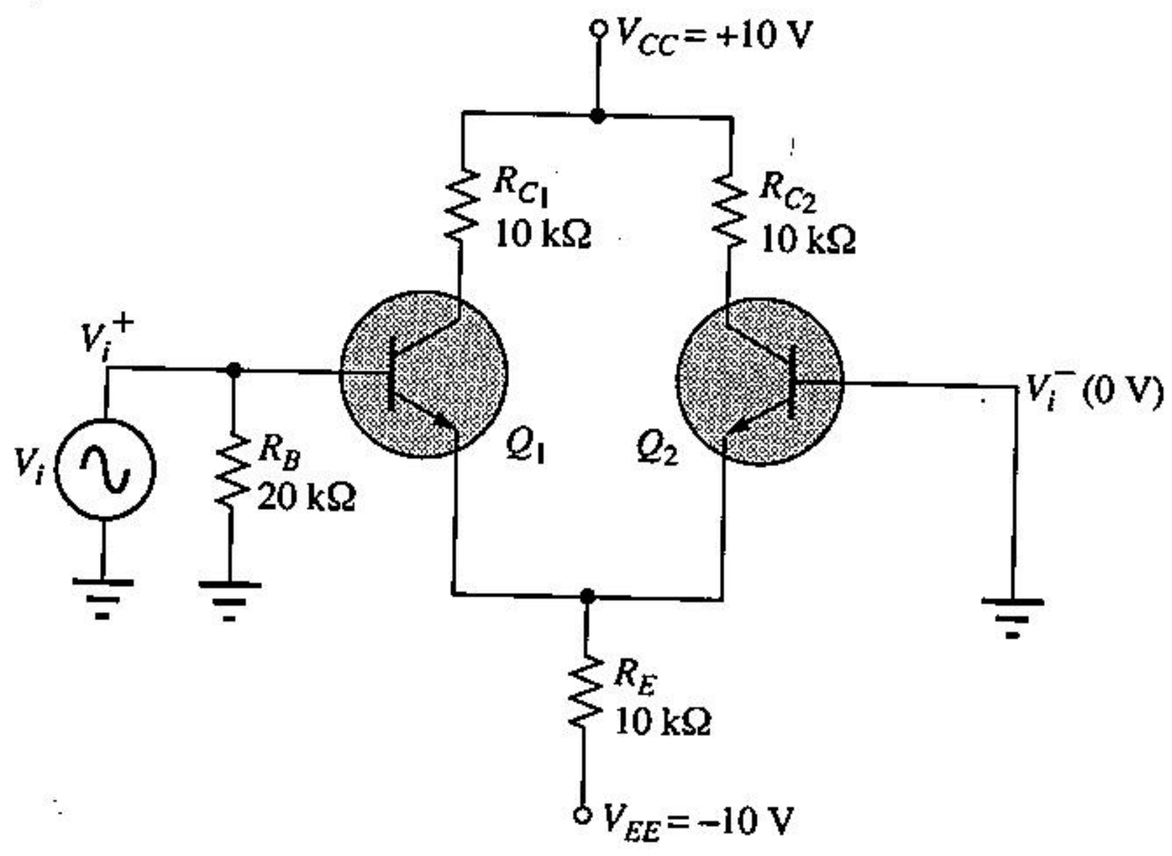

Figure 27-1

FET Differential Amplifier

For an FET differential amplifier the magnitude of the differential voltage gain can be calculated as

$$A_v = \frac{g_m R_D}{2} \tag{27.3}$$

PROCEDURE

Part 1. DC Bias of BJT Differential Amplifier

a. For the circuit of Fig. 27.1 calculate DC bias voltages and currents for one transistor.

V_B (calculated) = _____
V_E (calculated) = _____
V_C (calculated) = _____
I_E (calculated) = _____
r_e (calculated) = _____

b. Construct the circuit of Fig. 27.1. (Record measured value for all resistors in Fig. 27.1.) Set both supplies, V_{CC} = 10 V and V_{EE} = 10 V. Measure and record DC bias voltages for each transistor.

	Q_1	Q_2
V_B (measured) =	_____	V_B = _____
V_E (measured) =	_____	V_E = _____
V_C (measured) =	_____	V_C = _____

Using measured values determine

I_E =	_____	I_E = _____
r_e =	_____	r_e = _____

Compare values for each transistor to determine if they are well matched. Compare the values calculated in step 1(**a**) with those measured in step 1(**b**).

c. Apply common inputs of $V_i = 1$ V, peak to both input terminals in the circuit of Fig. 27.1. Measure and record the output from one side of the circuit.

V_{v_c} (measured) = _____

Calculate the common voltage gain.

$$A_{v_c} = \frac{V_{o_c}}{V_i}$$

A_{v_c} (measured) = _____

Compare the voltage gains calculated in step 2(**a**) with those measured in steps 2(**b**) and 2(**c**).

Part 3. DC Bias of BJT Differential Amplifier with Current Source

a. Calculate DC bias voltages and currents for the amplifier of Fig. 27.2.

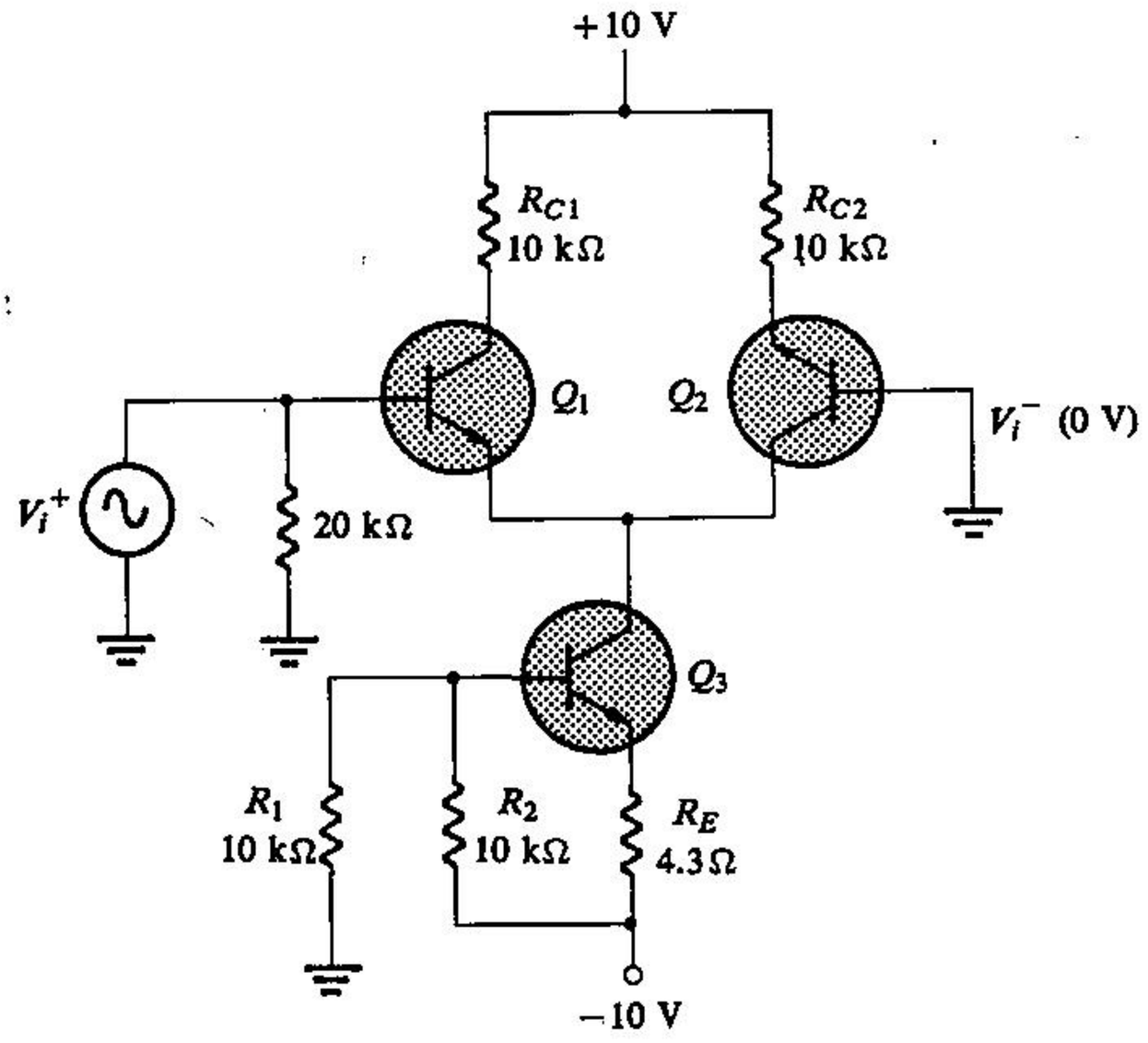

Figure 27-2

Part 2. AC Operation of BJT Differential Amplifier

a. Using Eqs. 27.1 and 27.2 calculate the differential and common-mode gain of the circuit in Fig. 27.1.

A_{v_d} (calculated) = _____

A_{v_c} (calculated) = _____

b. Apply input of V_i = 20 mV, rms at frequency f = 10 kHz to the plus (+) input and 0 V to the minus (–) input in the circuit of Fig. 27.1. Using a DMM measure, record output voltages.

V_{o_1} (measured) = _____

V_{o_2} (measured) = _____

Calculate an average value of $V_{o,\,d}$.

$$V_{o_d} = \frac{V_{o_1} + V_{o_2}}{2}$$

$V_{o,d}$ = _____

Calculate differential voltage gain.

$$A_{v_d} = \frac{V_{o_d}}{V_i}$$

A_{v_d} (measured) = _____