Name ______________________
Date ______________________
Instructor ______________________

EXPERIMENT 24

Current Source and Current Mirror Circuits

OBJECTIVE

To calculate and measure DC voltages in current source and current mirror circuits.

EQUIPMENT REQUIRED

Instruments

Oscilloscope
DMM
Function generator
DC supply

Components

Resistors

(1) 20-Ω
(1) 51-Ω
(1) 82-Ω
(1) 100-Ω
(1) 150-Ω
(2) 1.2-kΩ
(1) 4.3-kΩ
(1) 5.1-kΩ
(1) 7.5-kΩ
(1) 10-kΩ

Transistors

(3) 2N3904, or equivalent npn transistor
(1) 2N3823, or equivalent JFET n-channel transistor

EQUIPMENT ISSUED

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

RÉSUMÉ OF THEORY

Current source and current mirror circuits are part of many types of linear integrated circuits. This experiment will provide building and testing a few types of each circuit.

Current Source: Fig. 24.1 shows a simple form of current source using a JFET biased to operate at its drain-source saturation current. Regardless of the load R_L (within practical limits) the current through load R_L will be set by the JFET device:

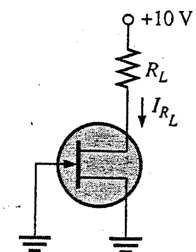

Figure 24-1

$$I_L = I_{DSS} \tag{24.1}$$

A BJT current source circuit is shown in Fig. 24.2. The base voltage is approximately set by

$$V_B = \frac{R_1}{R_1 + R_2}(-V_{EE})$$

The emitter voltage is then

$$V_E = V_B - 0.7 \text{ V}$$

with the emitter current then

$$I_{R_E} = \frac{V_E - V_{EE}}{R_E} = I_{R_L} \tag{24.2}$$

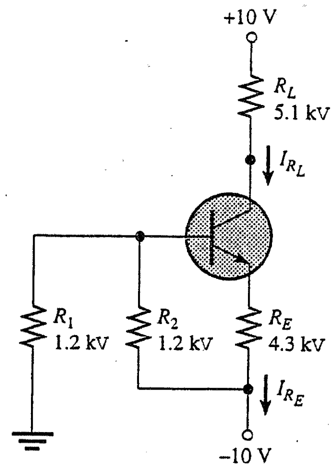

Figure 24-2

Current Mirror: The circuit of a Fig. 24.3 is a current mirror, in which the current set through resistor R_x is mirrored through the load

$$I_x = \frac{V_{CC} - V_{BE}}{R_x} = I_{R_L} \tag{24.3}$$

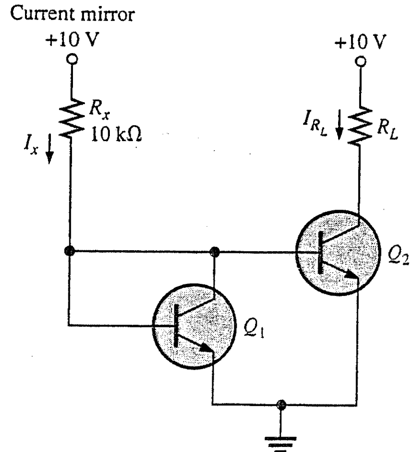

Figure 24-3

The circuit of Fig. 24.4 shows how a current mirror can provide the same current to a number of loads. The mirrored current set through resistor R_x and mirrored through both loads is

$$I_{R_x} = \frac{V_{CC} - V_{BE}}{R_X} = I_{R_2} = I_{R_3} \tag{24.4}$$

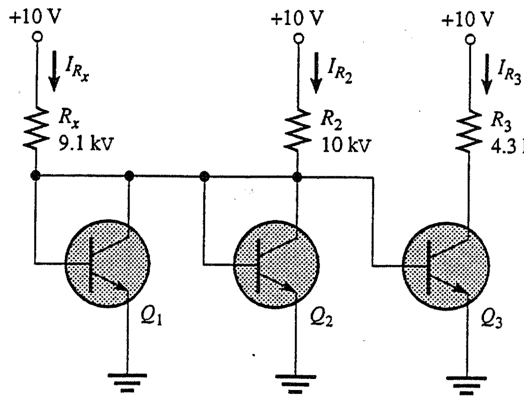

Figure 24-4

PROCEDURE

Part 1. JFET Current Source

a. Wire up the circuit of Fig. 24.1. Use $R_L = 51$. Measure and record the drain-source voltage.

V_{DS} (measured) = __________

b. Using the voltage measured in step 1(**a**), calculate the load current.

$$I_{R_L} = \frac{V_{DD} - V_{DS}}{R_L}$$

I_{R_L} = __________

c. Replace R_L with resistors as listed in Table 24.1, and repeat steps 1(**a**) and 1(**b**).

TABLE 24.1

R_L	20 Ω	51 Ω	82 Ω	100 Ω	150 Ω
V_{DS}					
I_{R_L}					

Part 2. BJT Current Source

a. Calculate the current I_{R_L} through the load in the circuit of Fig. 24.2.

I_{R_L} (calculated) = __________

b. Wire up the circuit of Fig. 24.2. Measure and record the following voltages.

V_E (measured) = __________
V_C (measured) = __________

c. Calculate the emitter current and the current through the load.

I_{R_E} = __________
I_{R_L} = __________

d. Replace R_L with resistors listed in Table 24.2 and repeat steps 2(**a**) through 2(**c**).

TABLE 24.2

R_L	3.6 kΩ	4.3 kΩ	5.1 kΩ	7.5 kΩ
V_E				
V_C				
I_{R_E}				
I_{R_L}				

Part 3. Current Mirror

a. Calculate the mirror current in the circuit of Fig. 24.3.

I_x (calculated) = __________

b. Wire up the circuit of Fig. 24.3 and measure:

V_{B_1}(measured) = ________
V_{C_2} (measured) = ________
I_x = ________
I_{R_L} = ________

c. Change R_L to 3.6 kΩ and repeat steps 3(**a**) and 3(**b**).

I_x (calculated) = ________
V_{B_1} (measured) = ________
V_{C_2}(measured) = ________
I_x = ________
I_{R_L} = ________

Part 4. Multiple Current Mirrors

a. Calculate the mirror current in the circuit of Fig. 24.4.

I_{R_x} (calculated) = ________

b. Wire up the circuit of Fig. 24.4 and measure:

V_{B_1} (measured) = ________
V_{C_2} (measured) = ________
V_{C_3} (measured) = ________
I_{R_x} = ________
I_{R_2} = ________
I_{R_3} = ________

c. Change R_L to 3.6 kΩ and repeat steps 4(**a**) and 4(**b**).

I_{R_x} (calculated) = ____________
V_{B_1} (measured) = ____________
V_{C_2} (measured) = ____________
V_{C_3} (measured) = ____________
I_{R_x} = ____________
I_{R_2} = ____________
I_{R_3} = ____________