Purposes
Get familiar with circuits containing BJT-type and FET-type transistor.

1 Transistor versus diode
1. Take a 1N914 Si diode and measure its resistance (in both directions by flipping the polarity of the digital multimeter leads).
2. Take a 2N3904 transistor and measure the resistance for each pairs of terminals for both polarity (so you should perform six measurements).
3. Can you conclude that the transistor acts as two diodes?

2 BJT transistor characteristics curves
Connect the variable power supply, the 2N3904 transistor (npn) and a digital multimeter (DMM) as shown in Figure 1. Use a 1.5 V battery for $V_{BB}$ and a variable power for $V_{CC}$. Take $R_B = 470 \, \text{k\Omega}$ and set $V_{CC}$ to 0.1 V.

![Circuit diagram](image)

Figure 1: Circuit for parts 2 and 3.

1. Measure the voltage drop across $R_B$ to infer $I_B$.
2. Measure the voltage drop across the 100 $\Omega$ resistor, this gives $V_E$.
3. Compute $V_{CE}$ and $I_C$ for this value of $I_B$.
4. Repeat the measurement of $V_E$ for $V_{CC} = 0.2, 0.5, 1, 2,$ and 5 V.
5. Plot $I_C$ versus $V_{CE}$.

6. Change $R_B$ to 200 kΩ and then to 110 kΩ and repeat the measurement/plot of the $I_C$ versus $V_{CE}$ curve.

7. Estimate the value of $\beta$ for this transistor.

3 BJT transistor characteristics curves: simpler measurement

Modify the circuit of the previous section to measure the voltage across $V_{CC}$ on channel 1 and the voltage across the 100 Ω resistor on channel 2. Replace the $V_{CC}$ power supply by the function generator setup to produce triangular signals.

1. Set the O-scope to “X-Y” mode. This means the x-axis will now read volts from channel 1 input and the y axis will read volts channel two input.

2. Sketch the curve you observe on the scope and compare them with the one you measure in Section 2.

4 FET transistor characteristics

Use a power supply set to 5 V for $V_{GS}$ and a 10 kΩ potentiometer for $R_G$ to set the voltage at the gate $V_{GS}$. Use the variable power supply for $V_{DD}$.

1. Set $V_{GS}$ to 0 V
   
   (a) set $V_{DD}=0.5$ V.
      i. Measure $V_{DS}$ with a digital multimeter.
      ii. Subtract $V_{DS}$ from $V_{DD}$ to get the voltage drop across $R_D$
      iii. Use this value to infer the current $I_D$.
   
   (b) Repeat the measurement of $V_{DS}$ versus $I_D$ for $V_{DD} = 1.0, 2.0, 3.0, 4.0, 6.0, 10.0,$ and 15.0 V.
   
   (c) Graph $I_D$ versus $V_{DS}$.

2. Redo all the previous measurements for the values $V_{GS} =-0.5$ and -1.0 V.

3. Estimate the transconductance of the FET transistor used.
Figure 2: Circuits for part 4.