Analog Electronic Circuits Lab (EC2.103, Spring 2024)

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Instructions:

1. Systematically record all your observations in the lab book (mandatory)
2. Save results in USB or take pictures
3. Make meaningful tables to summarize your findings and show it to the instructor(s) during the lab session only
4. Bring your calculators and DMM (if available)
5. Handle equipment carefully and report in case of any incidence
6. Enjoy your time in lab and strengthen your understanding about circuits

Experiment-4
BJT characterization

1. **BJT Characterization**
   Consider the common emitter (CE) configuration shown in Fig. 1. It is given that $R_B = 10\ k\Omega$, $R_C = 1\ k\Omega$ and $V_{CC} = 12\ V$.

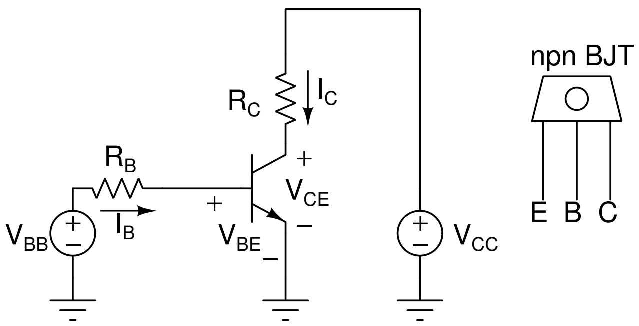

Figure 1

   (a) V_{BE} vs I_B plot
   With the oscilloscope available in lab you can only plot voltage quantities. However, you can find the value of current by KVL and ohm's law. For example, in Fig. 1, base and collector currents (I_B & I_C) can be calculated as follows:

$$I_B = \frac{V_{BB} - V_{BE}}{R_B},\ I_C = \frac{V_{CC} - V_{CE}}{R_C}$$

   Connect the circuit as shown in Fig. 1 and by using xy-mode in oscilloscope plot V_{BE} (CH2) (Y-axis) vs V_{BB} (CH1) (X-ais) for $V_{BB} = 0\ V$ to $V_{BB} = 4\ V$. For sweeping V_{BB}, use a sinusoidal signal from 'Wavegen' ($V_{PP} = 4\ V$ and offset = 2 V). From the measurement results, tabulate (see Table 1) and calculate values of V_{BE} and I_B for $V_{BB} = \{0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 1.2, 1.4, 1.6, 1.8, 2, 3 \text{ and } 4\}$ V. **(Attach plots)**

   (b) Now for the same experimental setup, plot V_{CE} (CH-2) with respect to V_{BB} (CH1). Tabulate and calculate V_{CE} and I_C for same set of V_{BB} used in the previous part. **(Attach plots)**

V_{BB}	V_{BE}	I_B	V_{CE}	I_C	$\beta = \frac{I_C}{I_B}$	Mode

Table 1

(c) Calculate common emitter current gain $\beta = \frac{I_C}{I_B}$ and tabulate as shown in Table 1. Also report the mode of operation of BJT for each row in the table 1.

2. **BJT Output Characteristics (I_C vs V_{CE})**
As shown in Fig. 2, in this experiment we will use operational amplifier to plot the required BJT characteristics. It is known that $V_2 = V_{CE}$ and $V_0 = -I_2 \times R_0 = -I_E \times R_0 \approx -I_C \times R_0$, where $R_0 = 1\ k\Omega$ (between node 2 and 6). Therefore plot of I_C will be proportional to V_0. We will sweep $V_2 = V_{CE}$ using the function generator and plot V_0 ($\propto -I_C$).

(a) Connect the BJT and other components in the configuration as shown in Fig. 2. The internal configuration of the BJT block is also shown in Fig. 3(a). The PIN diagram of the operational amplifier IC used is as shown in Fig. 3(b). Verify the potentiometer output using the multimeter or DSO and observe that the output voltage varies between -4 V and 4V. Please note that potentiometer is a variable resistor, which is used here to vary the base current. Also note that opamp uses dual supply ($\pm 12\ V$).

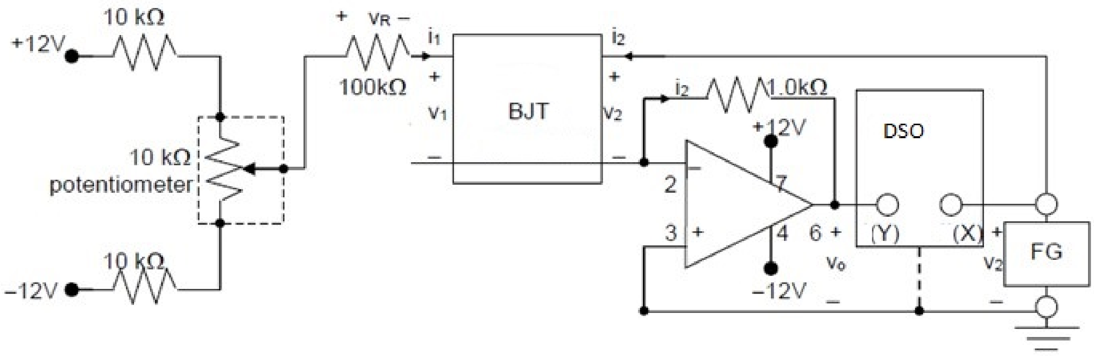

Figure 2: Circuit for displaying the output i-v characteristics of BJT/MOSFET

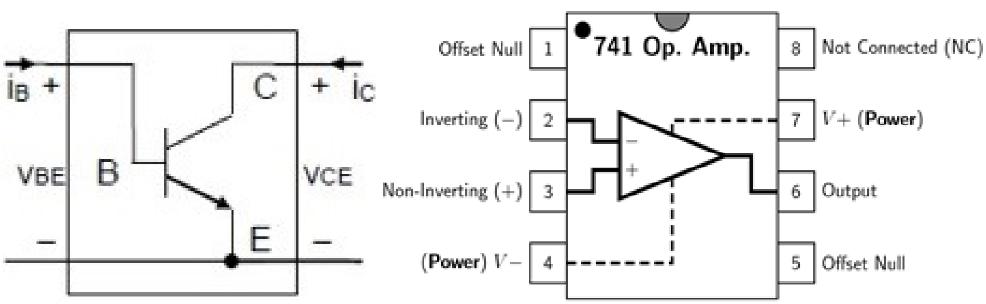

Figure 3: (a) NPN BJT, (b) opamp pin configuration

(b) Provide a 100 Hz sine wave input with peak to peak voltage of 8 V and offset of 4 V at the C terminal of the BJT using the function generator. Channel 1 of the DSO is also connected to C terminal and channel 2 is connected at the output of the opamp (V_0). Observe the characteristic waveform obtained using the acquire function of the DSO by varying the base current (potentiometer resistance) and report parameters shown in Table 2 from the measured results for $V_{BB} = \{0.2, 0.3, 0.4, 0.5, 0.6,\ 0.7, 0.8, 0.9, 1, 1.2, 1.4, 1.6, 1.8, 2, 3$ and $4\}$, where V_{BB} is the voltage at potentiometer output.

V_{BB}	V_{BE}	I_B	V_{CE}	V_o	I_C	I_B	β

Table 2
