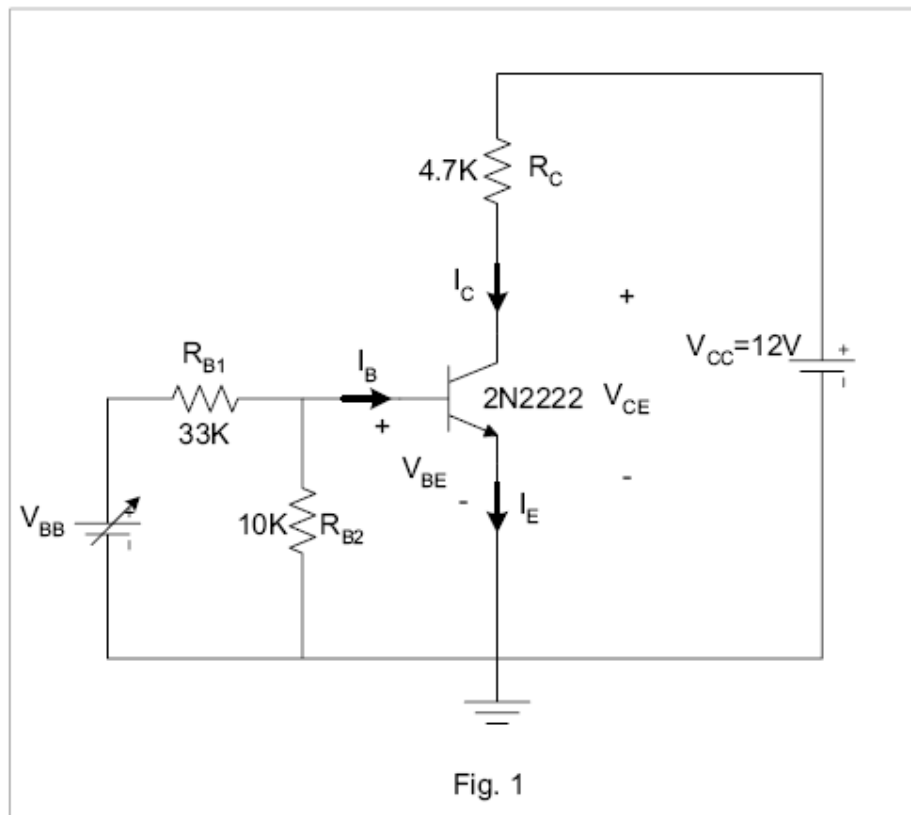


# Experiment 8

## Bipolar Junction Transistor

### Pre-Lab Report

## BJT Characteristics



For the circuit shown in Fig. 1, we will study the characteristics of the 2N2222 bipolar junction transistor and its different regions of operation.

Starting with  $V_{BB} = 1\text{ V}$ ,  $V_{BB}$  is increased to  $8\text{ V}$ , while measuring the collector current  $I_C$ , the base current  $I_B$ , the collector-to-emitter voltage  $V_{CE}$ , and the base-to-emitter voltage  $V_{BE}$ . The values are recorded in Table 1.

TABLE 1

Volts	mA	$\mu\text{A}$	Volts	Volts	Volts
V <sub>bb</sub>	I <sub>c</sub>	I <sub>b</sub>	I <sub>c</sub> /I <sub>b</sub>	V <sub>be</sub>	V <sub>ce</sub>
1.0	0.001	0.1	10.00	0.200	12.000
1.2	0.001	0.1	10.00	0.240	12.000
1.4	0.002	0.1	20.00	0.280	12.000
1.6	0.003	0.2	15.00	0.340	11.950
1.8	0.004	0.3	13.33	0.370	11.950
2.0	0.008	0.4	20.00	0.440	11.930
2.2	0.013	0.5	26.00	0.470	11.910
2.4	0.048	1	48.00	0.530	11.750
2.6	0.227	2	113.50	0.570	10.870
2.8	0.507	3	169.00	0.590	9.600
2.9	0.796	5	159.20	0.610	8.230
3.0	1.200	7	171.43	0.620	6.300
3.1	1.500	9	166.67	0.620	5.000
3.2	2.010	12	167.50	0.630	2.690
3.3	2.300	14	164.29	0.630	1.420
3.4	2.520	17	148.24	0.640	0.320
3.5	2.550	20	127.50	0.640	0.180
3.6	2.560	22	116.36	0.640	0.160
3.8	2.567	30	85.57	0.640	0.130
4	2.570	34	75.59	0.650	0.120
4.2	2.570	42	61.19	0.650	0.110
4.4	2.570	48	53.54	0.650	0.104
4.6	2.572	53	48.53	0.650	0.100
4.8	2.573	59	43.61	0.650	0.096
5	2.574	66	39.00	0.650	0.092
5.2	2.575	72	35.76	0.650	0.089
5.4	2.576	79	32.61	0.650	0.086
5.6	2.576	84	30.67	0.650	0.084
5.8	2.576	90	28.62	0.650	0.082
6	2.577	96	26.84	0.650	0.080
6.2	2.577	102	25.26	0.651	0.078
6.4	2.578	109	23.65	0.651	0.076
6.6	2.578	116	22.22	0.651	0.075
6.8	2.578	122	21.13	0.651	0.073
7	2.579	129	19.99	0.652	0.072
7.2	2.579	133	19.39	0.652	0.071
7.4	2.579	141	18.29	0.652	0.069
7.6	2.579	145	17.79	0.652	0.068
7.8	2.579	151	17.08	0.652	0.067
8	2.580	157	16.43	0.652	0.066

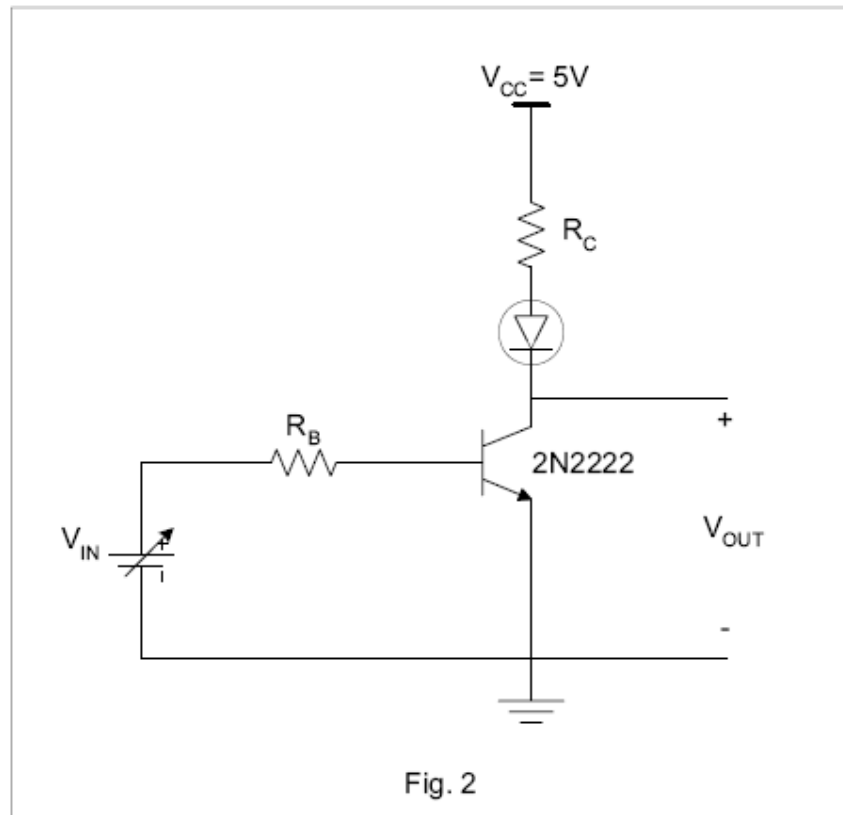
Q1. At what value does the collector current saturate? We will refer to this value as  $I_{C(SAT)}$ . This value of collector current will be used to define the boundaries of the different regions of operation of the BJT: cutoff, active, and saturation. We will assume that the transistor is practically OFF (in the cutoff region) when its collector current is less than  $I_{C(SAT)}/100 = 0.01I_{C(SAT)}$ , and that it is at the edge of saturation when the collector current reaches  $0.99I_{C(SAT)}$ . Between these two points, the BJT is in the active region. Write in the space below the value of  $I_{C(SAT)}$  and the range of values for  $V_{BE}$  where the transistor is in the active region.

Q2. Find the two values of  $V_{BE}$  that correspond to the edge of conduction ( $I_C$  is  $0.01I_{C(SAT)}$ ) and the edge of saturation ( $I_C = 0.99I_{C(SAT)}$ ). What is the range of values of  $V_{BE}$  in the active region?  $V_{BE}$  is usually assumed constant in the active region. Is this assumption justified? If so, what constant value would you use for the BJT in this experiment?

Q3. Consider the ratio  $I_C/I_B$  in the active region. This ratio is  $\beta$  (beta) of the BJT.  $\beta$  is usually assumed constant in the active region. Is this assumption justified? If so, what constant value would you use for the BJT in this experiment?

Q4. Find the range of values of  $V_{BE}$  and  $V_{CE}$  in the saturation region.  $V_{BE}$  and  $V_{CE}$  are usually assumed constant in the saturation region. Is this assumption justified? If so, what constant values would you use for the BJT in this experiment?

## BJT As A Switch



Q5. Given the average value of  $\beta$  for the BJT of the previous step, design the circuit in Fig. 2 (find the values of  $R_C$  and  $R_B$ ) in order to meet the following specification:

When  $V_{IN}$  is 5 V, the transistor is fully saturated with  $I_C/I_B = \beta/10$  and the LED current is 10 mA. Assume that the LED forward voltage is 2 V.

Show in the space below the steps and assumptions of your design and the obtained values of  $R_C$  and  $R_B$ .