Experiment 8

Bipolar Junction Transistor

Pre-Lab Report

BJT Characteristics

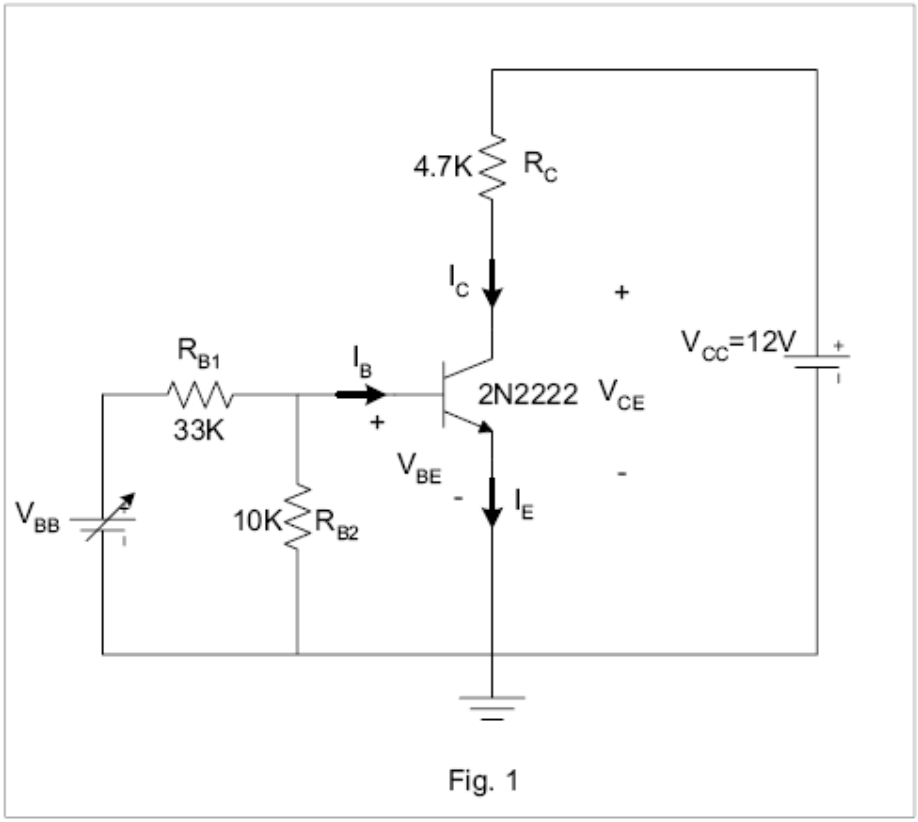

Fig. 1

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 V, V_{BB} is increased to 8 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	µA	Volts		Volts
Vbb	Ic	Ib	Ic/Ib	Vbe	Vce
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 VBB where the transistor is in the active region.

The value of saturation current Ic (sat) is 2.550 mA. To be in the active region Ic must be between 0.01Ic(sat) and 0.99Ic(sat) this corresponds to 1.4 V <Vbb<3.5 V

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?

Edge of conduction : 0.280 V
Edge of saturation : 0.640 V
Then the range is between 0.28<Vbe<0.64
V(be) changes according to the change in current supplied but becomes constant at a value of 0.6 V for Vbb higher than 2 V

Q3. Consdier the ratio I_C/I_B *in the active region*. This ratio is β (beta) of the BJT. β is usually assumed cons tant in the active regi on. Is this assumption justified? If so, what constant value would you use for the BJT in this experiment?

Yes because the graph of Ib vs Ic is somehow a straight line passing through the origin in the active .region
B= 148

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?

In the saturation region V(be) is constant at about 0.65 V while V(ce) is about 0.07 V. So the .assumption is correct

BJT As A Switch

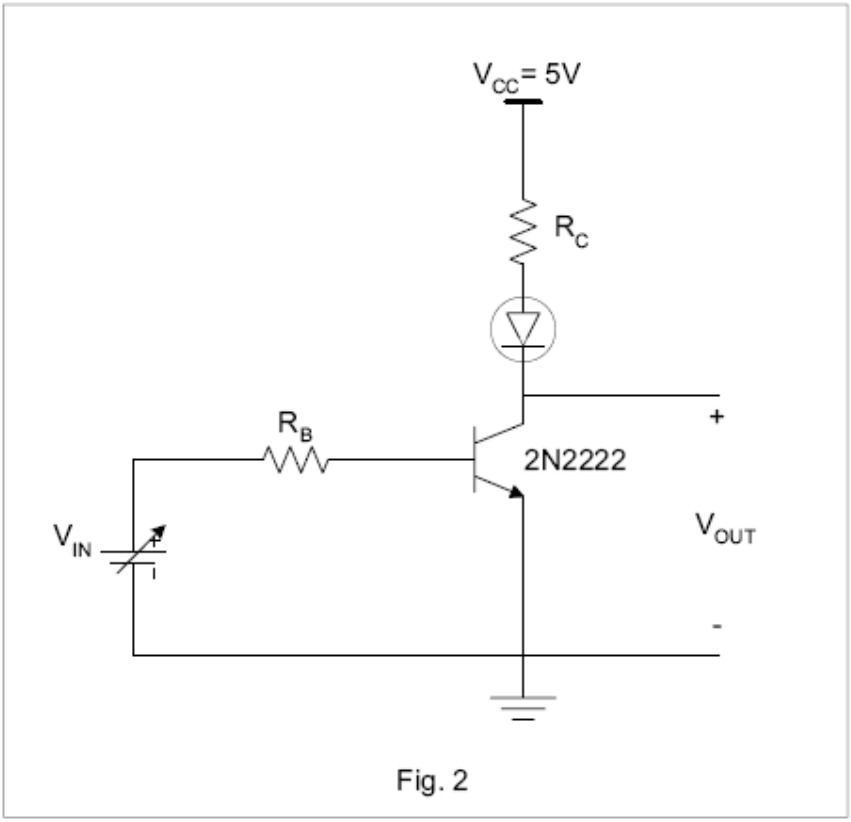

Fig. 2

Q5. Given the average value of β for the BJT of the previous step, design the circuit in Fig. 2 (fnd 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= β/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.

Ib = B*Ic/10 14.8*10mA = 148 mA
using V(be)= 0.65 V and V(ce) 0.07 V , -5 +0.65 Rb*0.148=0; by KVL
thus Rb= 30 ohms
Rc +2 +0.07=0*0.01 + -5
thus Rc = 293 ohms