BJT amplifier DC Operating Point

Consider the circuit below with the assumption that the transistor is in the active forward region and $\beta = 100$. Lets solve for the voltage V_{out}.

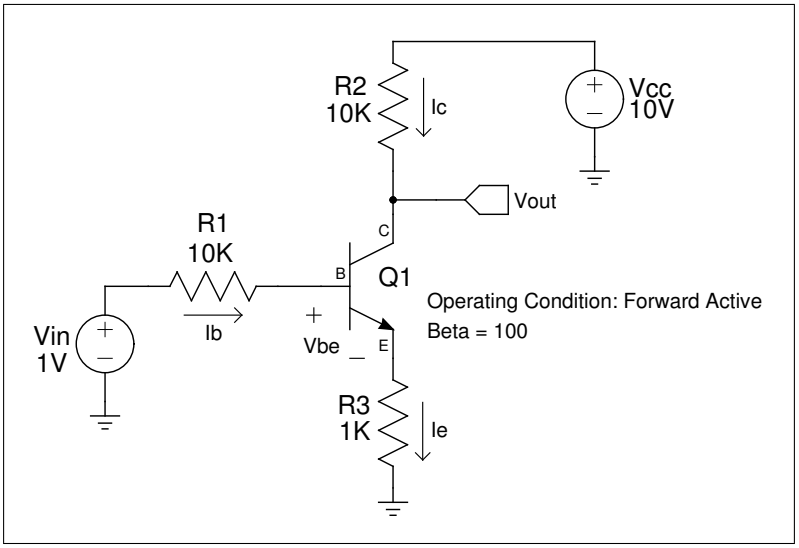

Figure 1: BJT Amplifier Circuit

To analyze this circuit, first write the KVL loop equation around the base-emitter circuit.

$$-1 + 10000I_b + 0.7 + 1000I_e = 0$$

however, we know that

$$I_c = \beta I_b, \text{ thus } I_e = (I_b + \beta I_b) = (\beta + 1)I_b$$

Now, rewriting the KVL loop equation, we get:

$$-1 + 10000I_b + 0.7 + 1000(\beta + 1)I_b = 0$$

$$-1 + 10000I_b + 0.7 + 101000I_b = 0$$

$$111000I_b = 0.3$$

$$I_b = 2.7\mu A$$

Now, knowing I_b, we can calculate I_c and thus the voltage drop across the collector resistor.

$$I_c = 100(2.7\mu A) = 270\mu A;$$

thus the voltage drop across the collector resistor is:

$$10000(270\mu A) = 2.7V$$

and therefore,

V_{out} is $10 - 2.7 = 7.3V$.

As a check to our assumption that the transistor is not in saturation, we can see that:

$$V_{ce} = 10 - 10000I_c - 1000I_e$$

where; $I_e = 101 * 2.7\mu A = .273mA$, and

$I_c = 100 * 2.7\mu A = .27mA$,therefore

$$V_{ce} = 10 - 10000(.00027) - 1000(.000273) = 10 - 2.7 - .273$$

$V_{ce} = \underline{7.07V}$ (not in saturation)