Analog Electronic Circuits (EC2.103) : Assignment-2

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Instructions:

1. Circuits of all questions mentioned at the end of the assignment.
2. Submit your assignment as a single pdf (Name_RollNo.pdf) at moodle on or before the due date
3. Hand-written/typed (notion/latex/word) submissions are allowed
4. Report should be self explanatory and must carry complete solution - Answers with schematics, SPICE directives, annotated waveforms, inference/discussion on results as asked in the questions.
5. Use BC547B for circuits with BJTs.
6. Post your queries on moodle. Discussions are highly encouraged on moodle
7. Any form of copying/cheating will result in immediate F grade

1. BJT formula based

(1.1) Measurement of an npn BJT in a particular circuit shows the base current to be $14.46\mu A$, the emitter current to be $1.460mA$, and the base-emitter voltage to be 0.7V. For these conditions, calculate α, β and I_s .

(1.2) A transistor for which $I_s = 10^{-16}A$ and $\beta = 100$ is conducting a collector current of $1mA$. Find v_{BE}. Also, find I_{SE} and I_{SB} for this transistor.

(1.3) For the circuit in Figure.1 , it is given that $\beta = 100$ and $V_a = \infty$. Design the circuit such that $I_{CQ} = 0.25mA$ and $V_{CEQ} = 3V$. Find the small-signal voltage gain A_v and the input resistance as seen from the source v_s.

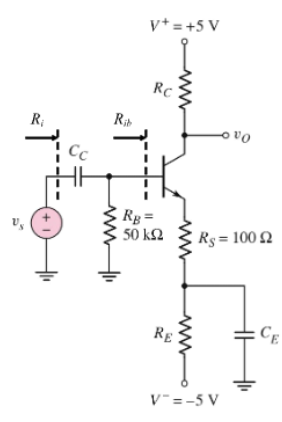

Figure 1: Figure corresponding to Question 1.3

2. BJT circuits at DC

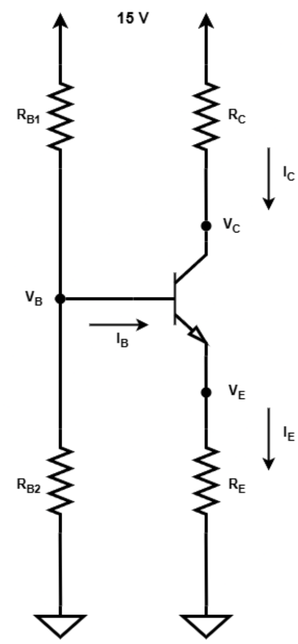

Figure 2: Figure corresponding to Question 2

(2.1) Determine the voltages at all nodes and the currents through all branches in the circuit given in Fig.2. Assume $\beta = 100$. Given, $R_{B_1} = 100k\Omega$, $R_{B_2} = 50k\Omega$, $R_C = 5k\Omega$, $R_E = 3k\Omega$.

(2.2) If the transistor in the circuit of Fig.2 is replaced with another having half the value of β (i.e., $\beta = 50$), find the new value of all node voltages and currents, and express the change in the values as a percentage. Tabulate all the results as follows:

	I_C	I_B	I_E	V_C	V_B	V_E
$\beta = 100$						
$\beta = 50$						
%						

Table 1: Currents and Voltages for Different β Values

(2.3) Comment about region of operation of BJT in both cases. Explain your observations.

3. BJT characterization

(3.1) Take BC547B npn transistor from the LTSPICE library and make a circuit as shown in Fig. 3(a). Use VCC = 12 V, sweep IB from 0μA to 100 μA in step size of 10μA and plot V_{BE} with respect to I_B. What is the forward bias emitter-base junction (EBJ) voltage obtained from the plot? Repeat experiment for $V_{CC} = 0$ to 12 V in step size of 2 V and give superimposed plots for different V_{CC} on same graph. (Hint: .dc IB 0 100u 10u V_{CC} 0 12 2)

(3.2) Use the schematic shown in Fig. 3 in LTSPICE and plot I_C vs V_{BE} for $V_{CC} = 12$ V at 20° C, 30° C, 40° C, 50° C by sweeping V_{BE} from 0 to 0.7 V in step size of 0.01 V. All plots should overlay on same graphical axis. (Hint: .dc VBE 0 0.7 0.01, .step TEMP 20 50 10 or .step TEMP LIST 20 30 40 50)

(3.3) For Fig. 3(a), plot I_C vs V_{CE} by sweeping V_{CC} from 0 to 12 V in step size of 0.01 V and sweeping $I_B = 0\mu$A to 100μA in step size of 10μA. Clearly mark cut-off, saturation and active modes in your characteristic plot. Find and tabulate incremental current gain $\beta = \frac{\Delta I_C}{\Delta I_B}$ in saturation (at $V_{CE} = 100$ mV) and active (at $V_{CE} = 600$ mV) modes for $I_{B1} = 50\mu$A to $I_{B1} = 60\mu$A. Comment on the reason for the difference observed. Tabulate the current gain $\beta = \frac{I_C}{I_B}$ at $V_{CE} = 1$V for different values of I_B. Do you observe Early effect. Estimate the value of early voltage (V_A) from your simulations. (Hint: slope at a point = y/x = $I_C/(V_A + V_{CE})$)

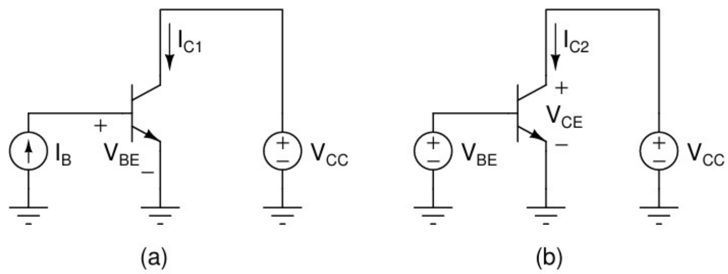

Figure 3: Figure corresponding to Question 3