ELECTRICAL ENGINEERING FUNDAMENTAL II

Name: **Test 3** 2024.5.16

Note: Show detailed and organized mathematic works. Make your calculation accuracy to <u>at least</u> the *4th* digit behind the decimal point.

1. (20%) For each of the circuits in Figure 1, Use, assuming the transistor is to have β = 50 and $|V_{BE}|$= 0.7V independent of the current level, derive the node voltages and branch currents.

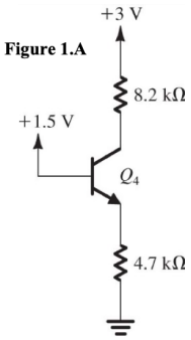


Figure 1.A

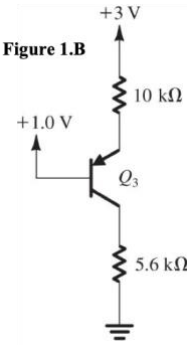


Figure 1.B

2. (20%) For the circuits in Figure 2, assuming the transistor is to have β = 100, $|V_{BE(active)}| = |V_{BE(sat)}| \cong 0.7$ (V), and $|V_{CE(sat)}| \cong 0.2$ (V). Some Measurements have been made on these circuits, with the results indicated in the figure. Find the values of the other labeled voltages and currents (V_1, I_1, V_2, I_2).

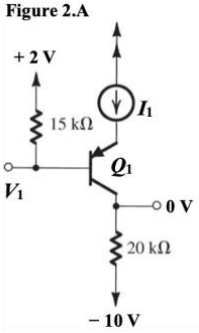


Figure 2.A

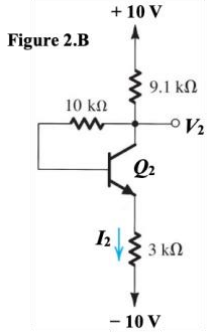


Figure 2.B

3. **(35%)** For the circuit in Figure 3, assuming the transistor is to have β =50, $V_{BE(active)} \cong 0.7$ (V), $V_{BE(sat)} \cong 0.8$ (V), and $V_{CE(sat)} \cong 0.2$ (V), $V_{CE(EOS)} \cong 0.3$ (V).

(A) **(10%)** With $\mathbf{V_B = 4\ V}$, find all branch currents and node voltages.

(B) **(15%)** With $\mathbf{V_B = 8\ V}$, find all branch currents and node voltages, and also $\boldsymbol{\beta_{force}}$ to verify that the transistor is in **saturation**.

(C) **(10%)** Find the $\mathbf{V_{B(min)}}$ and $\mathbf{I_{B(min)}}$ required to drive the transistor into **the edge of saturation**.

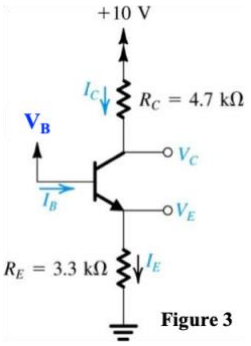
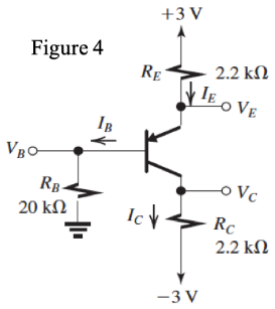


Figure 3

4. **(30%)** In the circuit of Fig. 3, the transistor has $\beta = 40$, $|V_{BE(active)}| = |V_{BE(sat)}| \cong 0.7$ (V), and $|V_{CE(sat)}| \cong 0.2$ (V).
   (A) **(10%)** Find the values of V_B, V_E, and V_C.
   (B) **(10%)** If $\mathbf{R_B}$ is raised to **100 kΩ**, what voltages (V_B, V_E, and V_C) result?
   (C) **(10%)** With $\mathbf{R_B}$**=100 kΩ**, what value of $\boldsymbol{\beta}$ for replaced Q would return the voltages to the values first calculated in (A)?

Figure 4



5. **(30%)** Assume $\beta = 100$, $|V_{BE(active)}| \simeq |V_{BE(sat)}| \simeq 0.7$ (V), and $|V_{CE(sat)}| \simeq 0.2$ (V) for Q_1 and Q_2 in the circuit of Figure 5, based on the defined current directions, evaluate I_B, I_L, I_{C1}, I_{C2}, and V_O with **(A) V_I = 10 V**, **(B) V_I = 0 V**, **(C) V_I = –5 V**.

Figure 5