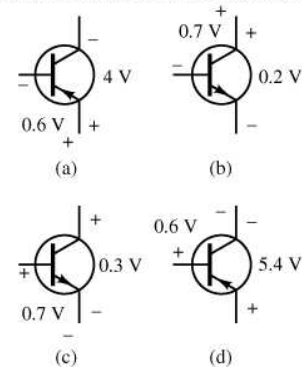


Block C: Bipolar Junction Transistor

Q1. Problem P10.1

For each transistor shown in Figure P10.1, determine whether the BE and BC junctions are forward-or reverse-biased, and determine the operating region. For simplicity, you may assume BE and BC junctions have no forward offset voltage, i.e. $V_{\gamma} = 0$

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Answers:

- a) Forward, reverse, active
- b) Reverse, reverse, cut-off
- c) Forward, forward, saturation
- d) Forward, reverse, active

Figure P10.1

Q2. Problem P10.2

Determine the region of operation for the following transistors. For simplicity, you may assume BE and BC junctions have no forward offset voltage, i.e. $V_{\gamma} = 0$

- a. *n*pn, $V_{BE} = 0.8 \text{ V}$, $V_{CE} = 0.4 \text{ V}$
- b. *n*pn, $V_{CB} = 1.4 \text{ V}$, $V_{CE} = 2.1 \text{ V}$
- c. *p*np, $V_{CB} = 0.9 \text{ V}$, $V_{CE} = 0.4 \text{ V}$
- d. *n*pn, $V_{BE} = -1.2 \text{ V}$, $V_{CB} = 0.6 \text{ V}$

Answers:

- a) Saturation
- b) Active
- c) Saturation
- d) Cutoff

Q3. Problem P10.3

Given the circuit of Figure P10.3, determine the operation point of the silicon device with $\beta = 100$. In what region is the transistor? ($V_\gamma = 0.6 \text{ V}$.)

Answer:

$I_C = 1.25 \text{ mA}$; $V_{CE} = 8.101 \text{ V}$; active region

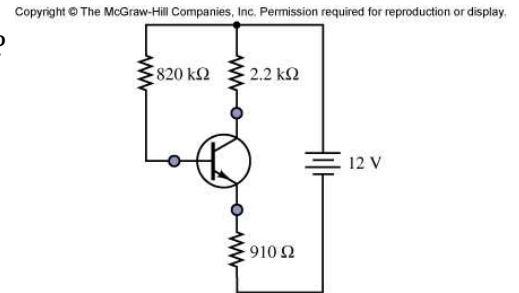


Figure P10.3

Q4. Problem P10.5

Given the circuit of Figure P10.5, determine the emitter current and the collector-base voltage. Assume the BJT has $V_\gamma = 0.6 \text{ V}$.

Answers:

$I_E = 0 \text{ A}$; $V_{CB} = 10 \text{ V}$

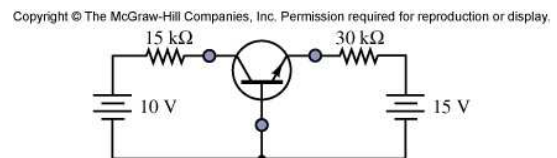


Figure P10.5

Q5. Problem P10.6

Given the circuit of Figure P10.6, determine the operating point of the transistor. Assume a 0.6-V offset voltage and $\beta = 150$. In what region is the transistor?

Answers:

$I_C = 2.25 \text{ mA}$; $V_{CE} = 7.857 \text{ V}$; active region

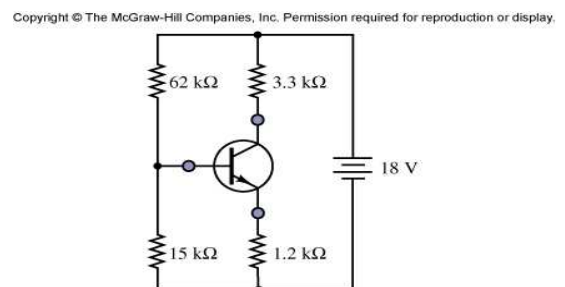


Figure P10.6

Q6. Problem P10.7

Given the circuit of Figure P10.7, determine the emitter current and the collector-base voltage. Assume the BJT has a 0.6-V offset voltage at the BE junction.

Answers:

$$I_E = 497.4 \mu\text{A}; V_{CB} = -10.05\text{V}$$

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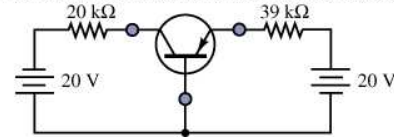


Figure P10.7

Q7. Problem P10.9

The collector characteristics for a certain transistor are shown in Figure P10.9.

- Find the ratio I_C / I_B for $V_{CE} = 10\text{V}$ and $I_B = 100, 200,$ and $600\text{ }\mu\text{A}$.
- The maximum allowable collector power dissipation is 0.5 W for $I_B = 500\text{ }\mu\text{A}$. Find V_{CE} .

Hint: A reasonable approximation for the power dissipated at the collector is the product of the collector voltage and current $P = I_C V_{CE}$, where P is the permissible power dissipation, I_C is the quiescent collector current, and V_{CE} is the operating point collector-emitter voltage.

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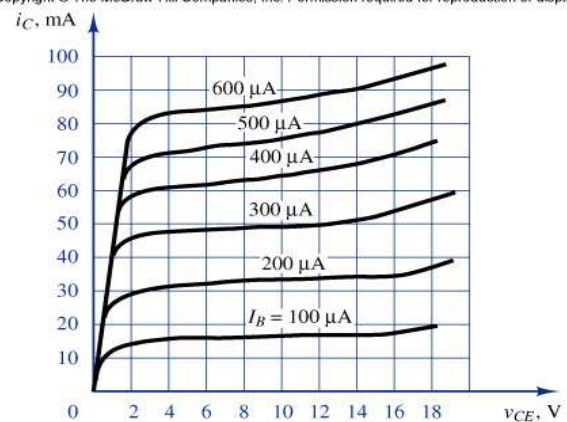


Figure P10.9

Answers:

- 170; 165; 143;
- $\sim 6.8\text{V}$

Q8. Problem P10.10

Given the circuit of Figure P10.10, assume both transistors are silicon-based with $\beta = 100$. Determine: ($V_\gamma = 0.7\text{ V}$)

- I_{C1} , V_{C1} , V_{CE1}
- I_{C2} , V_{C2} , V_{CE2}

Answers:

- $I_{C1} = 3.907\text{mA}$; $V_{C1} = 5.777\text{V}$; $V_{CE1} = 5.777\text{V}$
- $I_{C2} = 1.07\text{mA}$; $V_{C2} = 8.6\text{V}$; $V_{CE2} = 3.571\text{V}$

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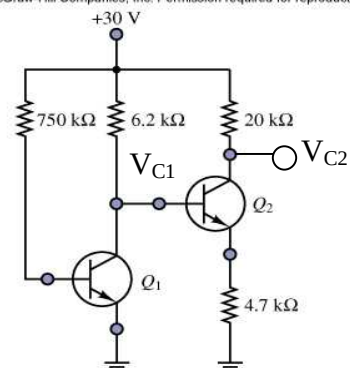


Figure P10.10