Transistor Fundamentals

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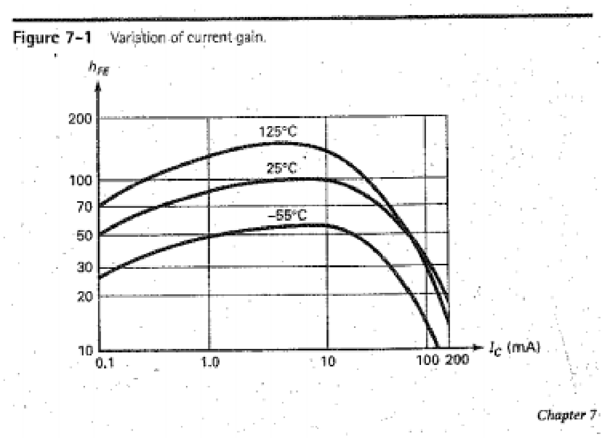
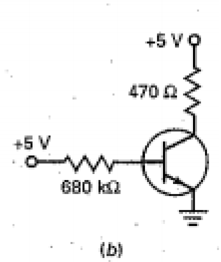
Question 1 Refer to Fig 7-1. What is the current gain of a 2N3904 when the collector current is 100mA and the junction temperature is 125C?



According to Fig 1, For 2N3904, when collector current is 100mA and junction temperature is 125C, current gain is 30

H_{FE} = 30

Question 2. The resistors of Fig. 7-25a have a tolerance of ±5 percent The supply voltages have a tolerance of ±10 percent If the current gain can vary from 50 to 150, what is the minimum possible voltage from collector to ground?



I_B = (V_{BB} - 0.7V)/R_B
V_C = V_{CC} - $I_C * R_C$ = V_{CC} - I_B * β *R_C = V_{CC} -(V_{BB} - 0.7V) / R_B * β *R_C
Thus, $V_C = V_{CC} - (V_{BB} - 0.7V)/R_B * \beta * R_C$

$V_{Cmax} = V_{CC(max)} - (V_{BB(min)} - 0.7V)/R_{B(max)} * \beta_{min} * R_{C(min)}$

$V_{Cmin} = V_{CC(min)} - (V_{BB(max)} - 0.7V)/R_{B(min)} * \beta_{max} * R_{C(max)}$

$V_{CC(min)}$ = 0.90 * V_{CC} = 4.5V
$V_{CC(max)}$ = 1.10 * V_{CC} = 5.5V

$V_{BB(min)}$ = 0.90 * V_{BB} = 4.5V
$V_{BB(max)}$ = 1.10 * V_{BB} = 5.5V

$R_{B(min)}$ = 0.95 * R_B = 646kΩ
$R_{B(max)}$ = 1.05 * R_B = 714kΩ

$R_{C(min)}$ = 0.95 * R_C = 446.5Ω
$R_{C(max)}$ = 1.05 * R_C = 493.5Ω

$\beta_{(min)}$ = 50
$\beta_{(max)}$ = 150

Applying

$V_{C(max)}$ = $V_{CC(max)}$ - ($V_{BB(min)}$ - 0.7V) / $R_{B(max)}$ * $\beta(min)$*$R_{C(min)}$ = 5.38V
$V_{C(min)}$ = $V_{CC(min)}$ - ($V_{BB(max)}$ - 0.7V) / $R_{B(min)}$ * $\beta(max)$*$R_{C(max)}$ = 3.95V

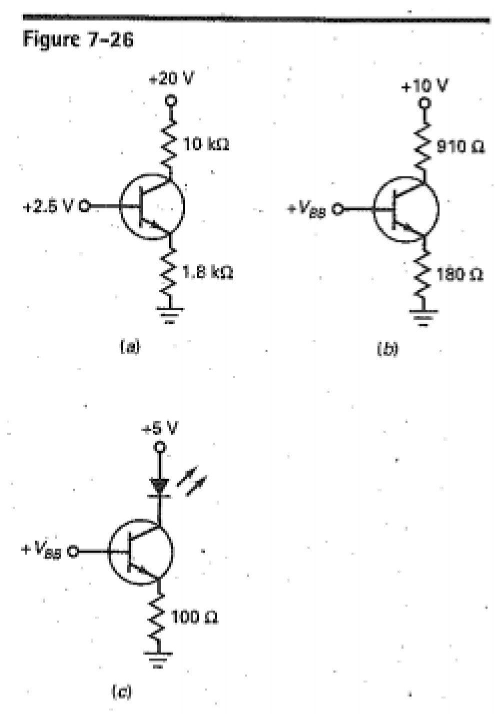
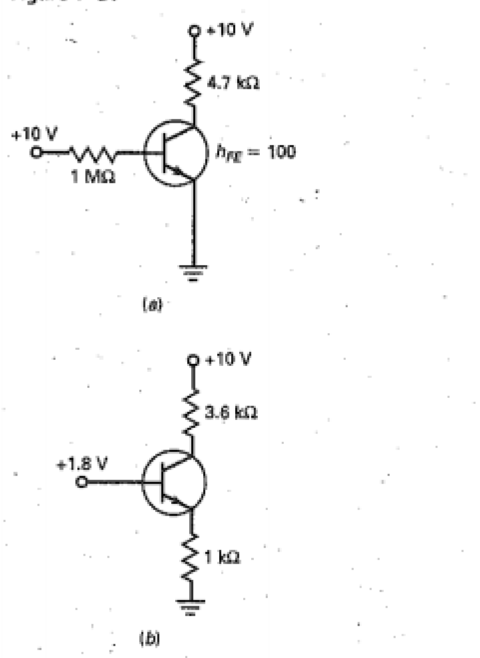
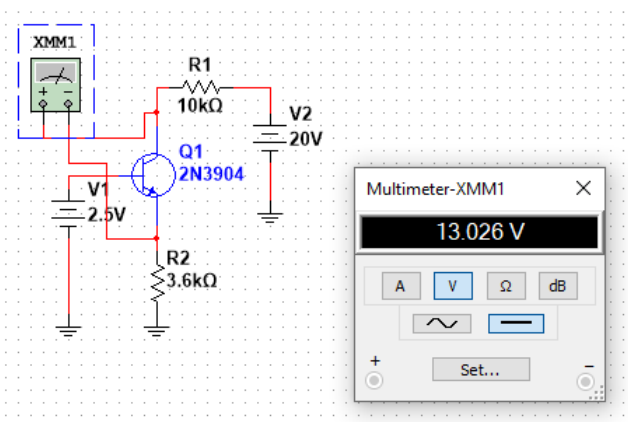


Figure 7-27

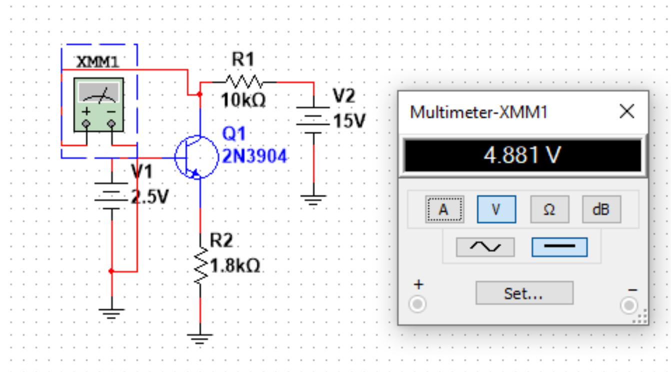


Question 3.(Multisim) If the emitter resistor is doubled in fig 7-26a what is the collector-emitter voltage?



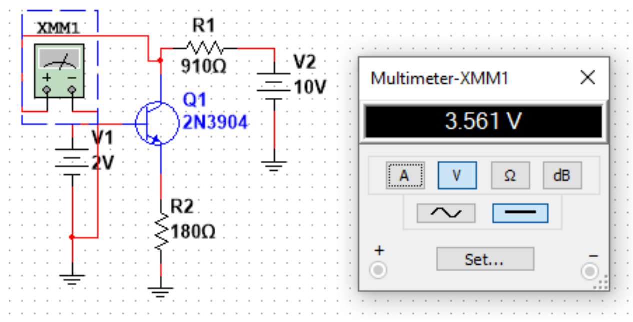
V_{CE} = 13V

Question 4. (Multisim) If the collector supply voltage is decreased to 15V in Fig 7-26a, what is the collector voltage?



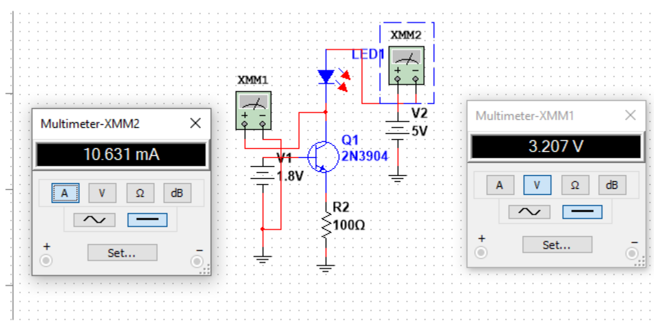
V_C = 4.88V

Question 5. (Multisim)What is the collector voltage in Fig. 7-26b if V_{bb} = 2V?



V_C = 3.56V

Question 6. (Multisim) If V_{BB} = 1.8V in Fig 7-26C, what is the LED current? The appropriate V_C?



I_C = 3.2V
V_C = 10.6mA

Question 7.The base supply voltage of Fig. 7-27a decreases by 10 percent. What happens to the base current, collector current, and collector voltage?

Base current
I_B = (V_{BB} - 0.7V)/R_B
Collector current
I_C = $I_B * \beta$
Collector voltage
V_C = V_{CC} - $I_C * R_C$

Considering V_{BB} = 10V,V_{CC} = 10V

Base current
I_B = (V_{BB} - 0.7V)/R_B = (10V -0.7V)/1MΩ = 9.3μA

Collector current
I_C = $I_B * \beta$ = 9.3μA*100 = 0.93mA

Collector voltage
V_C = V_{CC} - $I_C * R_C$ = 10V - 0.93mA*4.7kΩ = 5.629V

Considering V_{BB} = 9V

Base current
I_B = (V_{BB} - 0.7V)/R_B = (9V - 0.7V)/1MΩ = 8.3μA
Base current decreases as base supply voltage decreases.

Collector current
I_C = $I_B * \beta$ = 8.3μA*100 = 0.83mA
Collector current decreases as base supply voltage decreases.

Collector voltage
V_C = V_{CC} - $I_C * R_C$ = 10V - 0.83mA*4.7kΩ = 6.1V
Collector voltage Increases as base supply voltage decreases.

Question 8. The collector resistance of Fig. 7-27b increases by 10 percent.What happens to the emitter current, collector current, and collector voltage?

Emitter current
I_E = (V_{BB} - 0.7V)/R_E

Collector current
I_C = $I_B * \beta$

Collector voltage
V_C = V_{CC} - $I_C * R_C$

Emitter current
I_E = (V_{BB} - 0.7V)/R_E = (1.8V - 0.7V)/1kΩ = 1.1mA
Collector current
I_C ≈I$_E$ = 1.1mA
Collector voltage
V_C = V_{CC} - $I_C * R_C$ = 10V - 1.1mA*3.6kΩ = 6.04V

Considering Collector resistance increase by 10 percent

R_C = 3.96kΩ

Emitter current
I_E = (V_{BB} - 0.7V)/R_E = (1.8V -0.7V)/1kΩ = 1.1mA
Emitter current remains the same as collector resistance increase
I_C ≈I$_E$ = 1.1mA
Collector current remains the same as collector resistance increase

Collector voltage
V_C = V_{CC} - $I_C * R_C$ = 10V - 1.1mA*3.96kΩ = 5.644V
Collector voltage decreases as collector resistance increase

Question 9.The collector supply voltage of Fig. 7-27b increases by 10 percent.What happens to the emitter current, collector current, and collector voltage?

Emitter current
I_E = (V_{BB} - 0.7V)/R_E
Collector current
I_C = $I_B * \beta$
Collector voltage
V_C = V_{CC} - $I_C * R_C$

Emitter current
I_E = (V_{BB} - 0.7V)/R_E = (1.8V - 0.7V)/1kΩ = 1.1mA

Collector current
I_C ≈I$_E$ = 1.1mA

Collector voltage
V_C = V_{CC} - $I_C * R_C$ = 10V - 1.1mA*3.6kΩ = 6.04V

supply voltage increase by 10 percent
V_{CC} = 11V

Emitter current
I_E = (V_{BB} - 0.7V)/R_E = (1.8V -0.7V)/1kΩ = 1.1mA
Emitter current remains the same as collector supply voltage increase
I_C ≈I$_E$ = 1.1mA
Collector current remains the same as collector supply voltage increase

Collector voltage
V_C = V_{CC} - $I_C * R_C$ = 11V - 1.1mA*3.6kΩ = 7.04V
Collector voltage increases as supply voltage increase

Question 10.What if the ground on the emitter is open in Fig. 7-27a? What will a voltmeter read for the base voltage? For the collector voltage?

If the ground on emitter is open

Base voltage will remain the same because it is sending 10V, Based voltage is 10V Which is V_{BB}

Since there are no current flowing through the circuit. I_C will equal to zero, Using the kirchhoff's voltage law V_C = V_{CC} - $I_C * R_C$, Since I_C is zero, V_C will equal to V_{CC} which is 10V.

Collector voltage = 10V which is V_{CC}