POSTAL Book Package 2021

Instrumentation Engineering

Objective Practice Sets

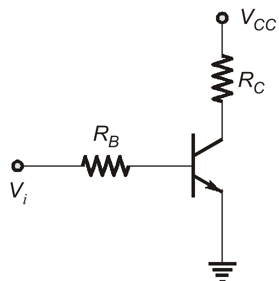
Analog Electronics

Contents

MADE EASY Publications

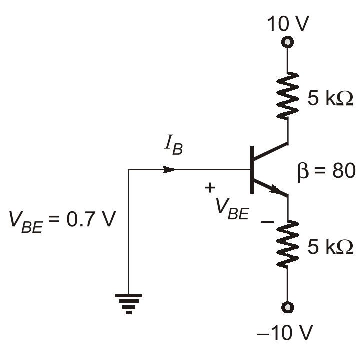
2 CHAPTER BJT Biasing and Thermal Stabilization

Q.1 In the transistor circuit shown, give the reason for collector to ground voltage to be V_{CC}.

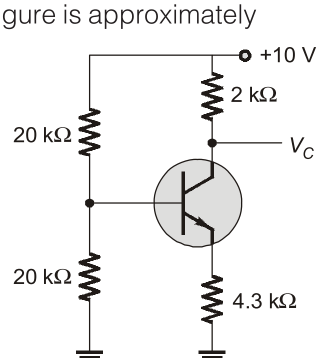


(a) Collector emitter terminals shorted
(b) Collector resistance open circuit
(c) Input voltage V_i is negative
(d) Collector base terminal shorted.

Q.2 Find the value of base current in the circuit ____ μA.

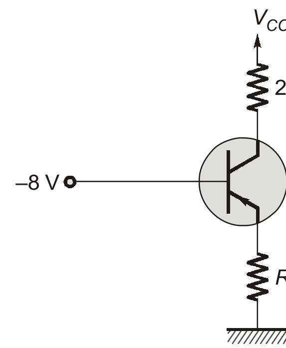


Q.3 The collector voltage V_C of the circuit shown in the given figure is approximately



(a) 2 V (b) 4.6 V
(c) 8 V (d) 8.6 V

Q.4 The transistor circuit shown in the figure given below is to function as an amplifier. If I_{CQ} = 3 mA, what is the value of V_{CC} (approximate)?



(a) 15 V (b) –15 V
(c) –10 V (d) –13.5 V

Q.5 **Assertion (A):** A self-biased BJT circuit is more stable as compared to a fixed biased one.
Reason (R): A self-biased BJT circuit uses more components as compared to a fixed biased one.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

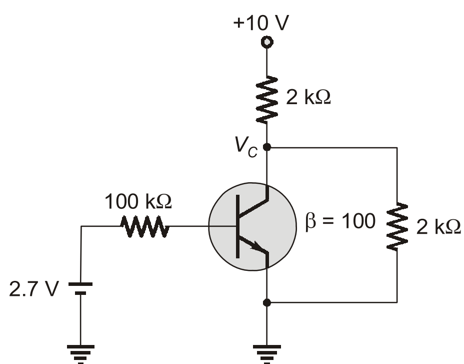
Q.6 **Assertion (A):** In a transistor switching circuit, it is desirable that the transistor should not be driven into hard saturation for fast switching applications.
Reason (R): When a transistor is under saturation on state, both its emitter-base and collector-base junctions remain under forward bias.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.7 A transistor has I_B = 100 μA and I_C = 2 mA. If I_B changes by 25 μA and I_C changes by 0.6 mA, the change in the value of β would be

(a) $\frac{3}{2}$ (b) $\frac{5}{4}$

(c) $\frac{1}{4}$ (d) $\frac{4}{5}$

Q.8 The value of V_C for the transistor shown in figure below is



(a) 3 volt (b) $\frac{1}{2}$ volt

(c) 2 volt (d) none of these

Q.9 The condition to be satisfied to prevent thermal runaway in a transistor amplifier where (P_c = Power dissipated at Collector, T_j = Junction temperature T_A = Ambient temperature, θ = Thermal resistance) is

(a) $\frac{\partial P_c}{\partial T_j} > \frac{1}{\theta}$ (b) $\frac{\partial P_c}{\partial T_A} < \frac{1}{\theta}$

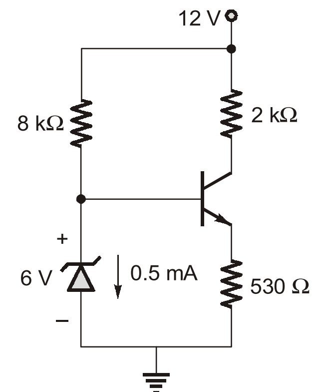
(c) $\frac{\partial P_c}{\partial T_j} < \frac{1}{\theta}$ (d) $\frac{\partial P_c}{\partial T_A} > \frac{1}{\theta}$

Q.10 Consider the following statements

1. Self bias has a higher stability than fixed-bias configuration, but it has about the same voltage gain, current gain and output impedance.
2. *CE* emitter-bias configuration with an unbypassed emitter resistor has a larger input resistance than the bypassed configuration but it will have a much smaller voltage gain than the bypassed configuration.

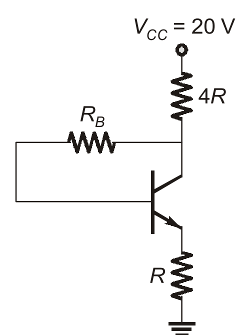
(a) Both the statements are TRUE
(b) 1 TRUE , 2 FALSE
(c) 1 FALSE, 2 TRUE
(d) Both statements are FALSE

Q.11 In the transistor circuit with break-down voltage of 6 V. The value of voltage drop between base emitter be 0.7 V, the current gain β = _____.

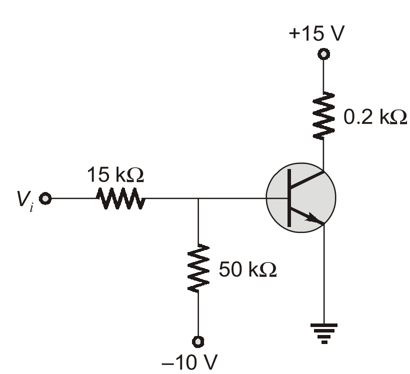


Q.12 A BJT biased in active region with *B-E* junction forward biased V_{BE} = 0.7 V. The 'β' of transistor to be 49. Assuming limiting case of $V_{CE} \le \frac{V_{CC}}{2}$, find

$\frac{R_B}{R}$ = _____.



Q.13 In the given circuit 'β' of the transistor is 50. Assuming $V_{CE\,(sat)}$ = 0.2 V and V_i = +10 V, the transistor will be operating in



(a) saturation region (b) active region
(c) breakdown region (d) cut-off region

Answers BJT Biasing and Thermal Stabilization

1. (c)	2. (22.9)	3. (c)	4. (b)	5. (b)	6. (b)	7. (d)	8. (a)	9. (c)
10. (a)	11. (39)	12. (232.5)	13. (b)	14. (a)	15. (b)	16. (0.241)	17. (86)	18. (–3.45)
19. (b)	20. (86)	21. (a)	22. (d)	23. (d)	24. (–14.81)		25. (c)	26. (a)
27. (b)	28. (a)	29. (c)	30. (d)					

Explanations BJT Biasing and Thermal Stabilization

1. (c)

As V_i is negative transistor is in cut-off.

2. (22.9)

$0 - V_{BE} - I_E 5 + 10 = 0$

$$\therefore \quad I_E = \frac{10 - 0.7}{5} = 1.86 \text{ mA}$$

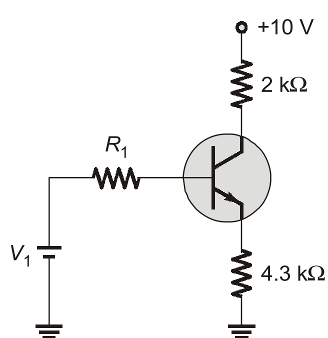
$$\therefore \quad I_B = \frac{I_E}{1+\beta} = 0.0229 \text{ mA}$$

$$= 22.9 \text{ μA}$$

3. (c)

$$V_1 = \frac{20}{20+20} \times 10 = 5 \text{ V}$$

$$R_1 = \frac{20 \times 20}{20+20} = 10 \text{ k}\Omega$$



KVL:

$$V_1 = R_1 I_B + V_{BE} + 4.3\, I_E$$

Let $\beta > 1$. So $I_B \approx 0$ & $I_E \approx I_C$

$$V_1 = V_{BE} + 4.3\, I_C$$

$$\Rightarrow \quad 5 - 0.7 = 4.3\, I_C$$

$$\Rightarrow \quad I_C = 1 \text{ mA}$$

$$V_C = 10 - 2 \times 1$$

$$\Rightarrow \quad V_C = 8 \text{ V}$$

4. (b)

$$V_E = -8 + 0.7$$

$$V_E = -7.3 \text{ V}$$

But $I_{CQ} = 3$ mA

$$V_C = 2I_C + V_{CC} = 6 + V_{CC}$$

$$V_B = -8 \text{ V}$$

For action region, $V_C < V_B$

$$6 + V_{CC} < -8$$

$$V_{CC} < -14 \text{ V}$$

5. (b)

For fixed bias,

$$S = \beta + 1$$

For self bias,

$$S = \frac{\beta + 1}{1 + \dfrac{\beta R_E}{R_B + R_E}}$$

where S is stabilization factor.

$$(S)_{\text{Self bias}} < (S)_{\text{Fixed bias}}$$

The closer the value of S to 1, the more stable the circuit.

$$S \geq 1 \text{ always.}$$

7. (d)

Given, $I_B = 100$ mA and $I_C = 2$ mA (before changes)

$$\therefore \quad \beta = \frac{I_C}{I_B} = \frac{2 \times 10^{-3}}{100 \times 10^{-6}} = 20$$

Change in values of I_B and I_C are

$$\Delta I_B = 25 \text{ μA and } \Delta I_C = 0.6 \text{ mA}$$

$\therefore$ New values of the currents are:

$$I_B' = 100 + 25 = 125 \text{ μA}$$

and $I_C' = 2 + 0.6 = 2.6$ mA

$\therefore$ New values of β is

$$\beta = \frac{I_C'}{I_B'} = \frac{2.6 \times 10^{-3}}{125 \times 10^{-6}} = 20.8$$

Hence, change in the value of β is

$$\Delta\beta = \beta_2 - \beta_1 = 20.8 - 20$$

$$= 0.8 = \frac{4}{5}$$

8. (a)

Let the transistor be in active mode.
KVL for the base circuit gives,

$$I_B = \left(\frac{2.7-0.7}{100}\right) = 0.02 \text{ mA}$$

$$\therefore \quad I_C = \beta I_B = 100 \times 0.02 \text{ mA} = 2 \text{ mA}$$

KVL at the collector node yields,

$$\frac{V_C - 10}{2\text{ k}} + \frac{V_C}{2\text{ k}} + I_C = 0$$

or, $2V_C - 10 + (2\text{ k})I_C = 0$

or, $2V_C = 10 - (2 \times 10^3 \times 2 \times 10^{-3}) = 6$

or, $V_C = 3$ volt

9. (c)

The condition to avoid thermal runaway is

$$\frac{\partial P_c}{\partial T_j} < \frac{1}{\theta}$$

10. (a)

In self bias circuit stability factor

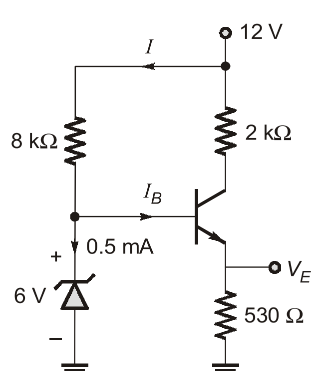
$$S = \frac{1+\beta}{1+\beta\left(\frac{R_e}{R_{Th}+R_e}\right)}$$

In fixed bias circuit stability factor

$$S = 1 + \beta$$

- In self bias circuit stability factor is very small hence thermal stability is better than that of the fixed circuit but both have almost same current gain, voltage gain and output impedance.
- *CE* emitter-biased configuration with bypassed emitter resistance will have much smaller voltage gain due to negative feedback.

11. (39)



$$I = \frac{12-6}{8} = 0.75 \text{ mA}$$

$$I = I_B + 0.5 \text{ mA}$$

$$\therefore \quad I_B = 0.25 \text{ mA}$$

$$6 - V_{BE} = V_E$$

$$V_E = 6 - 0.7 = 5.3 \text{ V}$$

$$\therefore \quad I_E = 10 \text{ mA}$$

$$\therefore \quad \beta + 1 = \frac{I_E}{I_B} = 40$$

$$\beta = 39$$

12. (232.5)

$$20 - (I_C + I_B)4R - \frac{V_{CC}}{2} - I_E R = 0$$

$$20 - 10 = (\beta + 1)I_B 4R + (1 + \beta)I_B R$$

$$\Rightarrow \quad \frac{10}{5(1+\beta)I_B} = R \quad \text{...(i)}$$

$$20 - 4R(1 + \beta)I_B - I_B R_B - 0.7 - (1 + \beta)RI_B = 0$$

$$19.3 = 5R(1 + \beta)I_B + I_B R_B \quad \text{...(ii)}$$

Putting 'β'

$$19.3 = 5R(50)I_B + I_B R_B$$

$$10 = 5(50)I_B R$$

$$I_B R = \frac{1}{25}$$

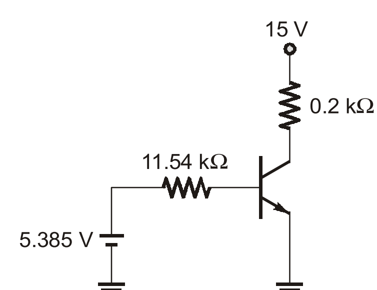
$$19.3 = 250 I_B R + I_B R_B$$

$$\frac{R_B}{R} = 25 \times 9.3 = 232.5$$

13. (b)

$$V_B = \frac{15}{65} \times (-10) + \frac{50}{65} \times 10 = 5.385 \text{ V}$$

$$R_{Th} = 15 \| 50 \text{ k}\Omega = 11.54 \text{ k}\Omega$$



$$5.385 - 11.54 I_B - 0.7 = 0$$

$$I_B = 0.406 \text{ mA}$$

$$I_C = \beta I_B = 20.29 \text{ mA}$$

$$15 - 2 \times 20.29 = V_{CE}$$

$$V_{CE} = 10.942 > V_{CE\,sat}$$

∴ Active region.

28. (a)

For a collector-to-base CE amplifier, stability factor is given by

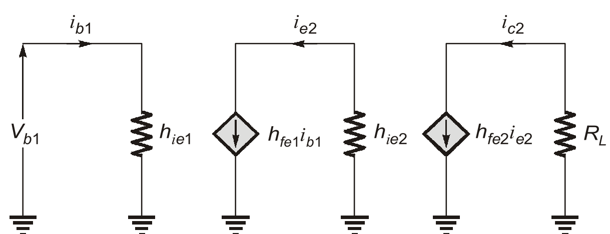
$$S = \frac{1+\beta}{1+\beta\left(\frac{R_C}{R_C+R_B}\right)}$$

Here, $R_B = \frac{V_{CEQ}}{I_B} = \frac{8}{0.25\times10^{-3}} = 32\ \text{k}\Omega$

$\therefore$ $S = \frac{101}{1+100\left(\frac{0.25}{32+0.25}\right)}$

$= 56.9 \approx 57$

29. (c)



Here, $i_{c2} = h_{fb2}\cdot i_{e2}$ and $h_{ib2} = \frac{h_{ie2}}{1+h_{fe2}}$

$V_{be1} = h_{ie}\, i_{b1}$

Also, $g_m = \frac{i_{c2}}{V_{be1}} = \frac{h_{fb2}.i_{e2}}{V_{be1}} = \frac{h_{fb2}.i_{c1}}{V_{be1}}$

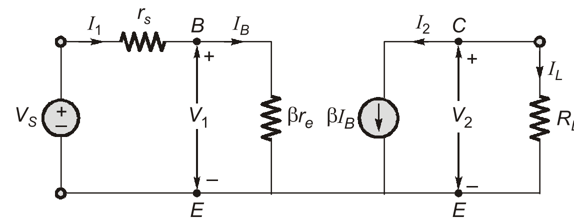
$= \frac{h_{fb2}.h_{fe1}.i_{b1}}{V_{ie1}i_{b1}} = \frac{h_{fb2}.h_{fe1}}{h_{ie1}}$

$= g_{m1}.h_{fb2} \simeq g_{m1}$ $\quad (\because h_{fb1} \approx 2)$

Hence, $g_m \approx g_{m1}$

30. (d)

The r_e model for CE amplifier is shown below.



Here, voltage gain,

$$A_V = \frac{V_2}{V_1} = -\frac{\beta I_B R_L}{I_B \beta r_e} = \frac{-R_L}{r_e}$$

Current gain,

$$A_I = \frac{I_L}{I_1} = -\frac{\beta I_B}{I_B} = -\beta$$

Input impedance,

$$Z_i = \frac{V_1}{I_B} = \frac{I_B(\beta r_e)}{I_B} = \beta r_e$$

Output admittance, $Y_0 = \frac{I_2}{V_2}$ with $V_S = 0$

and $R_L = \infty$

With $V_S = 0$, we have:

$I_B = 0$ and $I_2 = 0$;

Hence, $Y_0 = 0$

$\therefore$ Output impedance,

$$Z_0 = \frac{1}{Y_0} = \infty$$

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