unit 1 tutorial sheet

28 October 2024 02:23 AM

unit 1 tutorial sh...

Basics Electronics (22EC13)

Tutorial-1

a) $\beta = \frac{\alpha}{1-\alpha} = \frac{0.98}{0.02} = 49$ $I_C = \beta I_B + (\beta+1) I_{CO}$ $= 50(6n)$ $I_C = 0.3\mu A$

1. A silicon transistor has its I_{co}=6nA and α=0.98. If I B=0 and VCE=4V then I c = ___
2. An NPN transistor has I_{co}=30nA, I_B=0, VCE=4V and Ic=30uA. The value of β = ___
3. The measured terminal voltages (in Volts) of different NPN transistors are given in Table-1. For each of the transistors, find V_{BE}, V_{CB} and identify the region of operation.

	V_E	V_B	V_C
Q1	0	0.7	0.7
Q2	0	0.8	0.1
Q3	-2.7	-2.0	0
Q4	0	0	0.3
Q5	0.7	0.7	0

β Table-1 1 4 24 49 249

4. Find the values of β that correspond to α value of 0.5, 0.8, 0.96, 0.98 and 0.996.
5. Find the values of α that correspond to β value of 40, 60, 80, 99, 149 and 249.

0.975, 0.983, 0.987, 0.993, 0.996

6. In the fixed base current biasing circuits of fig 1 and 2.Determine the operating point of the silicon transistor. Q (V_{CE}, I_C)

Fig 1 Fig 2

7. In the circuit of fig 3, determine V_C, V_E, V_B and Ic.

Fig 3

8. In the circuit of fig 4, find V_B, I_E, I_B, Ic and V_C.

(a) $\beta = \frac{\alpha}{1-\alpha} = \frac{0.98}{0.02} = 49$

$I_C = \beta I_B + (\beta+1) I_{CO}$ $= 50(6n)$ $I_C = 0.3\mu A$

(b) $30\mu = (\beta+1) 30n$

$1000 = \beta + 1$

$\beta = 999$.

(2) (a) fb | 0.7 — 0.7 — 0 — active — fb

(b) fb | 0.1 — 0.8 — fb — 0 — saturation — 89

(c) gb | 0 — -2 — fb — -2.7 — 0.3 — active

(d) fb — 0 — gb 0 — cutoff

(e) fb | 0 — 0.7 — gb 0.2 — reverse

(4) (a) $0 - (390K) I_B - V_{BE} = -9$; (b) $5 - (330K) I_B - V_{BE} = -5$

$9 = (390K) I_B + 0.7$ $10 - 0.7 = (330K) I_B$

$I_B = \frac{9 - 0.7}{390K}$ $I_B = \frac{9.3}{330K}$

$I_B = 0.0213mA$ $I_B = 28.2\mu A$

$I_B = 21.3\mu A$

$I_C = \beta I_B = 60 \times 21.3\mu$ $I_C = \beta I_B$

$I_C = 1.27mA$ $= 80 \times 28.2\mu$

$I_C = 2.25mA$

$0 - (3.9K)(I_C) - V_{CE} = -9$ $5 - (2K) I_C - V_{CE} = -5$

$V_{CE} = 9 - (1.27m)(3.9K)$ $V_{CE} = 10 - (2K)(2.25m)$

$= 9 - 4.953$ $= 10 - 4.5$

$V_{CE} = 4.047V$ $V_{CE} = 5.5\ V$

(5) $V_{CC} = 18V$; $I_B = \frac{V_{CC} - V_{BE}}{R_B + (\beta+1) R_E}$

$R_C = 2.2$

$\beta = 50$

$R_E = 1k\Omega$

$R_B = 199k\Omega$ $= \frac{18 - 0.7}{(199k) + (51)(1K)}$

$= \frac{17.3}{250K}$

$18 - I_C R_C = V_C$ $I_B = 69.2\ MA$

$18 - (3.46m)(2.2k) = V_C$ $I_C = \beta I_B$

$V_C = 10.38\ V$ ✓ $= 50(69.2\mu)$

$I_C = 3.46mA$ ✓

$V_E - I_C R_E = 0$ $I_E = (\beta+1) I_B$

$V_E = (3.529m)(1k)$ $= 51(69.2)$

$V_E = 3.529\ V$ ✓ $= 3.529mA$

$18 - I_B R_B = V_B$

$V_B = 18 - (69.2\mu)(199K)$

$= 18 - 13.77$

$V_B = 4.2\ V$ ✓

(6)

$0 - V_{BE} - I_E R_E = -10$

$-0.7 - I_E (10K) = -10$

$I_C = \frac{9.3}{10K}$

$I_E = 0.93mA$

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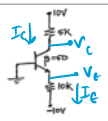
$V_{CC} = 10$

$R_C = 5K$

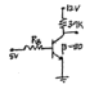
$\beta = 50$



$V_{cc} = 10$, $R_c = 5K$, $\beta = 50$, $R_E = 10K$

Fig 4

In the inverter circuit of fig 5, determine the maximum value of R_B, so that the circuit could be used an inverter.



$V_{cc} = 12V$, $R_c = 3.9K\Omega$, $\beta = 80$

Fig 5

In the inverter circuit of fig 6, determine the minimum value of β, so that the circuit could be used an inverter.

Fig 6

Determine the operating point of silicon transistor in the voltage divider biasing circuit fig 7. Also determine S_{ICO}.

$V_{cc} = 18V$, $R_c = 3.3K$, $\beta = 100$, $R_E = 2.7k$, $R_1 = 30K$, $R_2 = 15K$

Fig 7

In an RC coupled CE amplifier, $R_1 = 50K\Omega$, $R_2 = 25K\Omega$, $R_C = R_L = 2K\Omega$, $\beta = 99$ and $I_E = 2mA$. Determine the voltage gain, input impedance and output impedance of the amplifier.

$I_c = \frac{9.3}{101K}$

$I_c = 0.93mA$

$I_c = (\beta+1) I_B$

$I_B = \frac{0.93m}{51}$

$I_B = 18.2\mu A$

$I_c = \beta I_B$

$= 0.91mA$

$V_E - I_E R_E = -10$

$V_E = -10 + (0.93m)(10K)$

$V_E = -0.7V$

$10 - I_C R_C = V_c$

$V_c = 10 - (0.91m)(5K)$

$V_c = 5.45V$

(7) $\rightarrow 12 - I_C R_C - V_{CE} = 0$

$12 - (\beta+1) I_B R_C - 0.3 = 0$ (saturation)

$12 - (80) I_B (3.9K) - 0.3 = 0$

$I_B = \frac{11.7}{312K} \Rightarrow I_B = 37.5\mu A$

$\rightarrow 5 - I_B R_B - V_{BE} = 0$

$5 - (37.5\mu) R_B - 0.7 = 0$

$R_B = \frac{4.3}{37.5\mu}$

$R_B = 114.7K\Omega$

(8) $5 - I_C R_C - V_{CE} = 0$

$5 - \beta I_B R_C - V_{CE} = 0$

$5 - \beta(10.5\mu)(33K) - 0.3 = 0$

$\beta = \frac{4.7}{10.5 \times 10^{-6} \times 33 \times 10^{3}}$

$\beta = 135.6$

$3 - I_B R_B - V_{BE} = 0$

$3 - I_B (220K) - 0.7 = 0$

$I_B = \frac{2.3}{220K}$

$I_B = 10.5\mu A$

(9) Q-pt $(V_{CE}, I_C) = ?$, $S_{ICO} = ?$

$V_{th} = \frac{V_{cc} R_2}{R_1 + R_2}$

$= \frac{18 \times 15K}{30K + 15K}$ (2, 1)

$V_{th} = 6V$

$R_{th} = R_1 \| R_2$

$= \frac{30K \cdot 15K}{30K + 15K}$

$R_{th} = 10K\Omega$

$\rightarrow V_{th} - I_B R_{th} - V_{BE} - (\beta+1) I_B R_E = 0$

$I_B = \frac{V_{th} - V_{BE}}{R_{th} + (\beta+1) R_E}$

$= \frac{6 - 0.7}{10K + 101(2.7K)}$

$= \frac{5.3}{282.7K}$

$I_B = 18.7\mu A$

$I_C = \beta I_B = 100 I_B = 1.87mA$

$I_E = (\beta+1) I_B = 101 I_B = 1.88mA$

$\rightarrow V_{cc} - I_C R_C - V_{CE} - I_E R_E = 0$

$18 - (1.87m)(3.3K) - V_{CE} - (1.88m)(2.7K) = 0$

$V_{CE} = 18 - 6.171 - 5.07K$

$V_{CE} = 6.753V$

Q-pt (V_{CE}, I_C)

$Q_1 = (6.753V, 1.87mA)$

$\rightarrow S_{ICO} = \frac{1+\beta}{1 + \frac{\beta R_E}{R_{th} + R_E}}$

$= \frac{101}{1 + \frac{100 \times 2.7K}{10K + 2.7K}}$

$= \frac{101}{1 + \frac{270}{12.7}} = \frac{101}{21.25}$

$S_{ICO} = 4.7529$

(10) $R_1 = 50K\Omega$

$R_2 = 25K\Omega$

$R_C = R_L = 2K\Omega$

$\beta = 99$

$I_E = 2mA$

$Z_i = R_{th} \| (\beta+1) r_e$

$Z_o = R_L \| R_C$

$A_V = \frac{-R_C \| R_L}{r_e}$

$R_{th} = R_1 \| R_2$

$= \frac{50K \cdot 25K}{50K + 25K}$

$R_{th} = 16.67K\Omega$

$r_e = \frac{26mV}{I_E}$

$= \frac{26mV}{2mA}$

$r_e = 13\Omega$

$Z_i = \frac{R_{th}(\beta+1)r_e}{R_{th}+(\beta+1)r_e}$

$= \frac{(16.67K)(100)(13)}{16.67K + 100 \times 13}$

$= \frac{21671}{17.97K}$

$= 1205.95$

$Z_i = 1.206K\Omega$

$Z_o = R_C \| R_L$

$= \frac{(2K)(2K)}{2K+2K}$

$Z_o = 1K\Omega$

$A_V = \frac{-R_C \| R_L}{r_e}$

$= \frac{-1K}{13}$

$A_V = -76.9231$

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Tutorial-1

11	a) Three amplifiers of voltage gains 20dB, 26dB and 32dB are cascaded to obtain an output voltage of 2V. Calculate the input voltage needed. b) An amplifier having a power gain of 17dB delivers a power output of 40W to a load of 1KΩ. Calculate (i) the input power needed and (ii) the input voltage needed, if the voltage gain of the amplifier is 38dB.	
12	Calculate the voltage gain vo/vi , input impedance Zi and output impedance Zo for the circuits of fig 8 and 9	

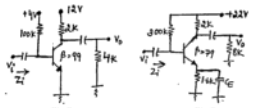

Fig 8

Fig 9

(11a)

$A_{V1} = 20dB \quad V_o = 2V$

$A_{V2} = 26dB \quad V_i = ?$

$A_{V3} = 32dB$

$A_{V_{tot}} = 20 \log\left(\frac{V_o}{V_i}\right)$

$20 + 26 + 32 = 20 \log\left[\frac{2}{V_i}\right]$

$\frac{78}{20} = \log\left[\frac{2}{V_i}\right]$

$10^{3.9} = \frac{2}{V_i}$

$V_i = \frac{2}{10^{3.9}} = \frac{2}{7943.28} = 0.3mV$

(11b)

$A_p = 17dB$ i) $P_i = ?$

$P_o = 40W$ ii) $V_i = ?$ if $A_V = 38dB$

$R = 1K\Omega$

$\rightarrow A_p = 10 \log\left(\frac{P_o}{P_i}\right)$

$17 = 10 \log\left(\frac{40}{P_i}\right)$

$P_i = \frac{40}{10^{1.7}}$

$P_i = 0.798W$ (i)

$\rightarrow A_V = 20 \log\left(\frac{V_o}{V_i}\right)$

$P = \frac{V^2}{R}$

$V_o = \sqrt{P_o R}$

$= \sqrt{40 \times 1K}$

$V_o = 200$

$38 = 20 \log\left(\frac{200}{V_i}\right)$

$\log\left(\frac{200}{V_i}\right) = 1.9$

$V_i = \frac{200}{10^{1.9}}$

$V_i = 2.5179V$ (ii)

(12a) A_V, Z_i, Z_o ?

$Z_i = R_C \| (\beta+1) r_e$

$= \frac{R_C(\beta+1)r_e}{R_C + (\beta+1)r_e}$

$= \frac{(100K)(100)(7.87)}{100K + (100)(7.87)}$

$r_e = \frac{26mV}{I_E}$

$4 - I_B R_B - V_{BE} = 0$

$4 - I_B(100K) - 0.7 = 0$

$I_B = \frac{3.3}{100K}$

$I = 33uA$

$= \frac{(100k)(100)(7.87)}{100k + (100)(7.87)}$

$= \frac{7.87 \times 10^7}{100k + 0.787k}$

$Z_i = 781\,\Omega$

$4 - I_B(100k) - 0.7 = 0$

$I_B = \frac{3.3}{100k}$

$I_B = 33\mu A$

$I_E = (\beta+1) I_B = 3.3mA$

$r_e = \frac{26mV}{3.3mA}$

$r_e = 7.87\,\Omega$

$\rightarrow Z_o = R_L \| R_C$

$= \frac{(4k)(2k)}{4k + 2k}$

$Z_o = 1.33k\,\Omega$

$\rightarrow A_v = \frac{-R_C \| R_L}{r_e}$

$= \frac{-1.33k}{7.87}$

$|A_v| = -169$

(12b) $Z_i = R_C \| (\beta+1) r_e$; $r_e = \frac{26mV}{I_E}$

$= \frac{R_C (\beta+1) r_e}{R_C + (\beta+1) r_e}$

$= \frac{(2k)(80)(6.5261)}{(2k) + (80)(6.5261)}$

$Z_i \approx 522\,\Omega$

$22 - I_B R_B - V_{BE} - I_E R_E = 0$

$I_B = \frac{22 - V_{BE}}{R_B + (\beta+1) R_E}$

$= \frac{22 - 0.7}{300k + (80)(1.6k)}$

$= \frac{21.3}{428k}$

$I_B = 49.8\mu A$

$I_C = (\beta+1) I_B = 80 I_B$

$I_E = 3.984mA$

$r_e = \frac{26mV}{3.984mA}$

$r_e = 6.5261\,\Omega$