SEMICONDUCTOR DA-2
(SLOT - B1+TB1)

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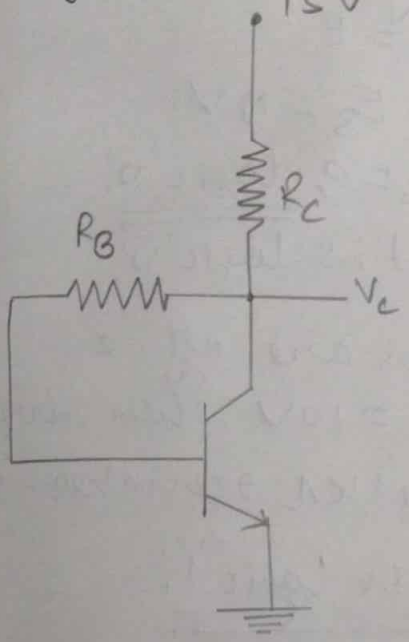
(1) Silicon transistor $\beta = 71$ and $V_{BE(on)} = 0.7V$.
If $V_c = 9V$, the ratio of R_B and R_c



Here, $I_C R_C = 15 - V_c$

$I_C R_C = 15 - 9 = 6V$ — (1)

also, $I_c = \beta I_B$

Now, $I_B R_B = V_c - V_{BE(on)}$

$= 9 - 0.7 = 8.3V$

i.e $I_B R_B = 8.3V$ — (2)

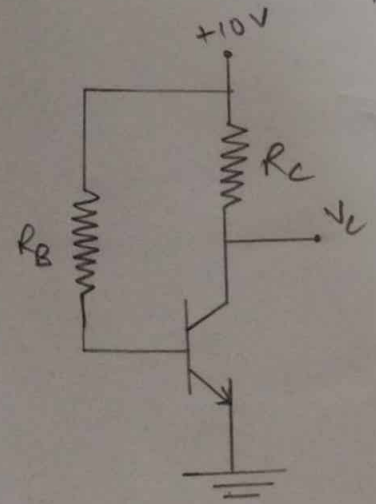
Ratio divide eq^n (2)/(1)

$$\frac{I_B R_B}{I_C R_C} = \frac{8.3}{6}$$

$$\Rightarrow \frac{R_B}{R_C} = \frac{8.3}{6} \times \frac{\beta I_B}{I_B} = \frac{8.3}{6} \times 71$$

$$\therefore \frac{R_B}{R_C} = 98.21$$ Ans.

(2) Here transistor is in active mode and $V_c = 2V$.
To get $V_c = 4V$ we replace R_c by R_{CA}.
R_{CA} / R_c



Here, $V_c = 2V$

$I_C R_C = 10 - 2 = 8V$ — (1)

We have, $V_c = 4V$

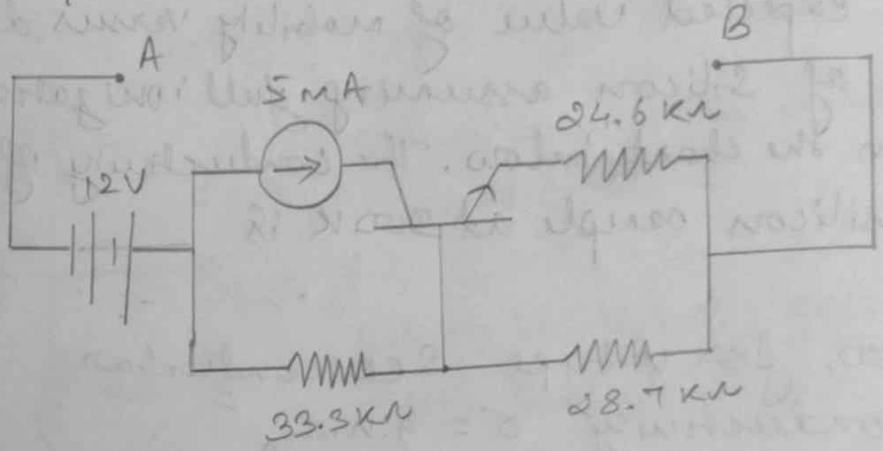
$I_C R_{CA} = 10 - 4 = 6V$ — (2)

Here, eq^n (2)/(1)

$$\frac{I_C R_{CA}}{I_C R_C} = \frac{6}{8} = \frac{3}{4} = 0.75$$ Ans

$$\frac{R_{CA}}{R_c} = 0.75$$

③ Find the incremental resistance measured b/w the terminals A & B, $\beta = \infty$



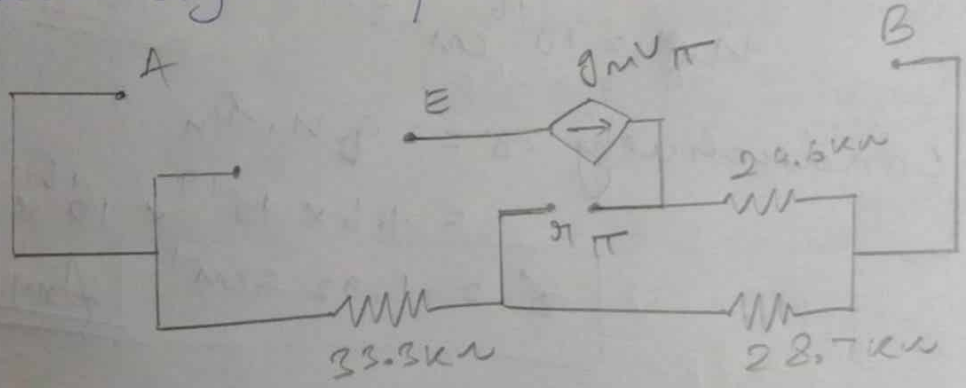
Q: $\beta = \infty$

Soln: $I_C = 5mA$

$$g_m = \frac{I_C}{V_T} = \frac{5mA}{25mV} = 0.2 = 200\,mS$$

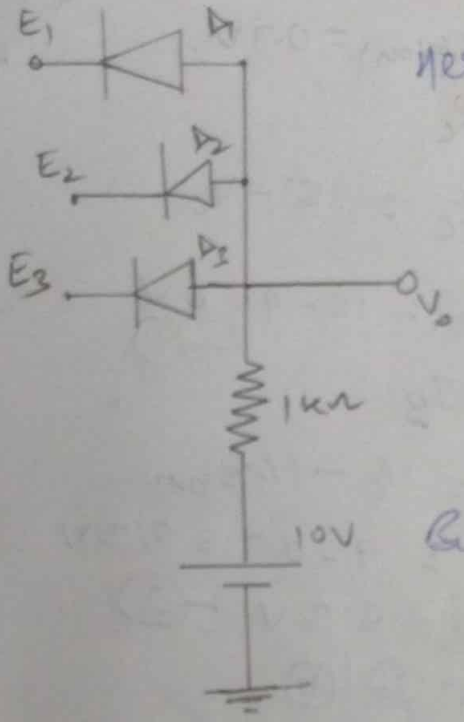
$$g_\pi = \frac{V_T}{I_B} = \frac{\beta V_T}{I_C} = \infty = r_\pi$$

∴ Small signal equivalent



∴ $R_{AB} = 62k\Omega$ Ans

(Q4) 10 V is considered logic '1' and 0V as logic '0'. What gate does it implement?



Here, 0V = logic '0' 10V = logic '1'

when any of the diode is on then $V_o = E$

i.e $E_1 = E_2 = E_3 = 0V$

which is, $V_o = 0$, logic '0'

Here, output is logic '0'.

But when diodes are off i.e $E_1 = E_2 = E_3 = 10V$, then current across the 1kΩ resistor = 0

$\therefore V_o = 10V$ which is logic '1'.

E_1	E_2	E_3	O/P
0	0	0	0
0	0	1	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

Then truth table implies that the given circuit is will act as 3-input AND gate

Ans.

(05) A piece of silicon is doped uniformly with phosphorous with doping concentration of $10^{16}\ cm^{-3}$. The expected value of mobility versus doping conc. of silicon assuming full ionization is given in the chart below. The conductivity of the silicon sample at 300K is ____

Sol^n. Here, for n-type semiconductor conductivity $\sigma = q.n.\mu_n$

Here, doping concentration is $n = 10^{16}\ cm^{-3}$

The mobility values from graph are

$\mu_n = 1200\ cm^2 V^{-1} sec^{-1}$

$\mu_p = 400\ cm^2 V^{-1} sec^{-1}$

Assuming, complete ionization, we have electron concentration

$n = 10^{16}\ cm^{-3}$

Now, conductivity $\sigma = q.n.\mu_n$

$= 1.6 \times 10^{-19} \times 10^{16} \times 1200$

$\sigma = 1.92\ S\,cm^{-1}$ Ans