DEPARTMENT OF ELECTRNICS & COMMUNICATION ENGINEERING, KITSW

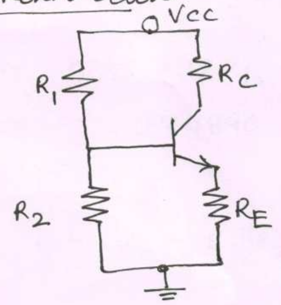
COURSE: **U14EI 205 - BASIC ELECTRONICS ENGINEERING**	**ECE-I, Semester-II, 2015-16**

ASSIGNMENT-6 HINTS &SOLUTIONS of Q8,Q9 & Q10

8. Design a self bias circuit using a Ge transistor with Vcc=16V and Rc=1.5KΩ for obtaining of V_{CE}=8V and Ic=4mA. Assume S=12 & β=50.

Design a self-bias circuit using Ge transistor with $V_{cc} = 16V$, $R_C = 1.5k\Omega$ for fixing the Q-point at (4mA, 8V) (I_C, V_{CE}). Assume $S = 12$ and $\beta = 50$.

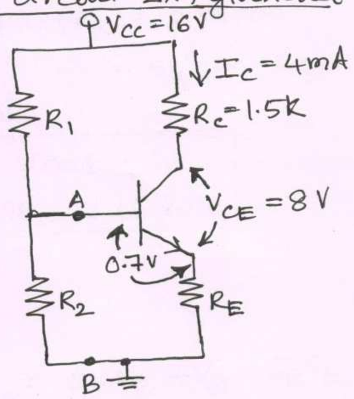
The self-bias circuit is shown below.



Ge Transistor
i.e, $V_{BE} = 0.3V$

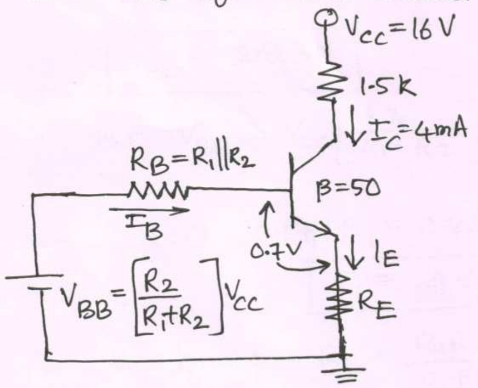
If Si-Transistor take $V_{BE} = 0.7V$

The circuit with given data



As part of the design so we need to calculate the values of R_1, R_2 and R_E

Thevenin's equivalent circuit across points A&B.



✓ $I_C = \beta I_B \Rightarrow I_B = \frac{I_C}{\beta}$

$$I_B = \frac{4mA}{50} = 0.08mA$$

✓ $I_E = I_C + I_B = 4mA + 0.08mA$

$$I_E = 4.08mA$$

✓ KVL to o/p loop eqn :

$$V_{cc} = I_C R_C + V_{CE} + I_E R_E$$

$$16 = (4mA)(1.5k) + 8V + (4.08mA)R_E$$

$$16 = 6 + 8 + (4.08mA)R_E$$

$$R_E = \frac{16-14}{4.08mA} = 0.490k\Omega$$

(or) $R_E = 490\Omega$ ✓

✓ Use stability factor expression to get some values

$$S = \frac{1+\beta}{1+\beta\left[\frac{R_E}{R_E+R_B}\right]} \Rightarrow 12 = \frac{1+50}{1+50\left[\frac{490\Omega}{490+R_B}\right]}$$

$$\Rightarrow 12 + 600\left(\frac{490}{490+R_B}\right) = 51 \Rightarrow 12(490+R_B) + 294000 = 51(490+R_B)$$

$$\Rightarrow 5880 + 12R_B + 294000 = 24990 + 51R_B$$

$$\Rightarrow 274890 = 39R_B \Rightarrow \boxed{R_B = 7048.46\Omega \text{ (or) } 7.05\,k\Omega}$$

✓ But $R_B = R_1 \| R_2 = \frac{R_1R_2}{R_1+R_2}$

✓ Write KVL to Input loop eqn: $V_{BB} = I_BR_B + V_{BE} + I_ER_E$

$$\therefore V_{BB} = (0.08mA)(7.05k\Omega) + 0.3 + (4.08mA)(0.490k\Omega)$$

$$V_{BB} = 0.564 + 0.3 + 1.992 = 2.8632V$$

$$\boxed{V_{BB} = 2.863V}$$

✓ But $V_{BB} = V_{CC}\left[\frac{R_2}{R_1+R_2}\right] = 16\left[\frac{R_2}{R_1+R_2}\right] \Rightarrow \frac{2.863}{16} = \frac{R_2}{R_1+R_2}$

$$0.179 = \frac{R_2}{R_1+R_2}$$

(or) $0.179R_1 = 0.821R_2$

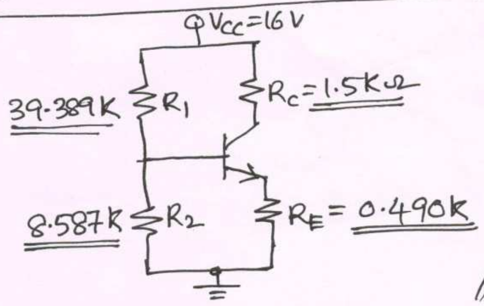
$$\boxed{R_1 = 4.587R_2}$$

✓ we know $R_B = \frac{R_1R_2}{R_1+R_2} \Rightarrow 7.05\,k = \frac{(4.587R_2)R_2}{5.587R_2}$

(or) $\boxed{R_2 = \frac{(7.05k)(5.587)}{4.587} = 8.587\,k\Omega}$

$$\boxed{\text{As } R_1 = 4.587R_2 = (4.587)(8.587k\Omega) = 39.389\,k\Omega}$$

Hence the circuit with the designed values is



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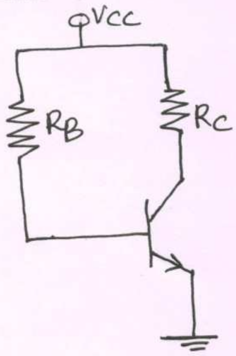
9.

For a fixed bias circuit using Ge-transistor with $R_B = 100\,k\Omega$, $R_C = 22\,k\Omega$, $V_{CE} = 4V$, $V_{CC} = 10V$, find the stability factor.

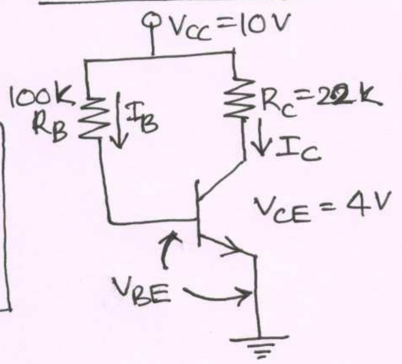
Sol:

The fixed bias circuit is shown below



Given
Ge-transistor
So $V_{BE} = 0.3V$

The circuit with given data



✓ The stability factor of fixed bias circuit is $(1+\beta)$

So we need to calculate, first, β of the transistor,

→ β can be estimated from I_C and I_B values, as $\boxed{\beta = \frac{I_C}{I_B}}$

✓ KVL to input loop: $V_{CC} = I_B R_B + V_{BE} \Rightarrow 10 = I_B(100k) + 0.3$

$$I_B = \frac{10 - 0.3}{100K} = 0.097\,mA \quad (or) \quad \boxed{I_B = 0.097\,mA}$$

✓ KVL to output loop: $V_{CC} = I_C R_C + V_{CE} \Rightarrow 10 = I_C(22k) + 4$

$$I_C = \frac{10-4}{22k} = 0.273\,mA \quad (or) \quad \boxed{I_C = 0.273\,mA}$$

✓ β - of the transistor: $\beta = \frac{I_C}{I_B} = \frac{0.273\,mA}{0.097\,mA} = 2.82$

✓ stability factor $S = 1 + \beta \Rightarrow S = 1 + 2.82 \Rightarrow \boxed{S = 3.82}$

✓ $S = 3.82$

$$\frac{dI_C}{dI_{CO}} = 3.82 \Rightarrow dI_C = (3.82)\,dI_{CO}$$

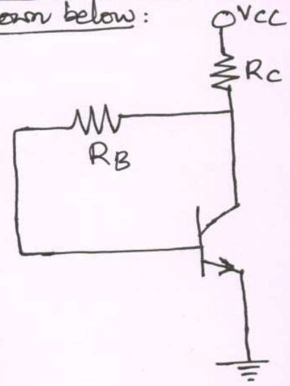
i.e, the collector current changes by 3.82 times as much as the reverse leakage current (I_{CO}) changes //.

10.

[Q-10 | A6 | 2015-16 | II sem]

Design a collector to base bias circuit with $V_{cc}=15V$, $V_{CE}=5V$, $I_C=5mA$, $\beta=100$.

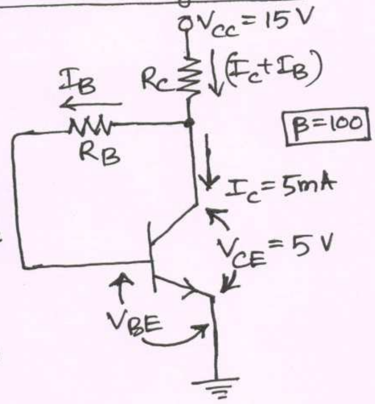
Sol: The collector to base bias circuit is shown below:



As transistor type is not mentioned. let us assume Si-transistor

$\therefore V_{BE}=0.7V$

The circuit with given data



✓ $I_C=\beta I_B \Rightarrow I_B=\frac{I_C}{\beta}=\frac{5mA}{100}=0.05mA$

$$\boxed{I_B=0.05mA}$$

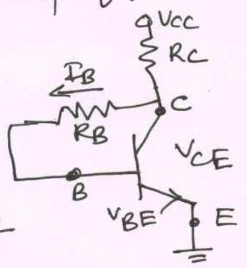
As part of design, we need to calculate the values of R_C & R_B

✓ KVL to output loop:

$V_{cc}=R_C(I_C+I_B)+V_{CE} \Rightarrow 15=R_C(5mA+0.05mA)+5$

$\Rightarrow R_C=\frac{15-5}{5.05mA}=1.980k\Omega$ (or) $\boxed{R_C=1.980k\Omega}$

✓ To find R_B: Instead of writing input loop eq^n^, we use simple transistor voltage relationship



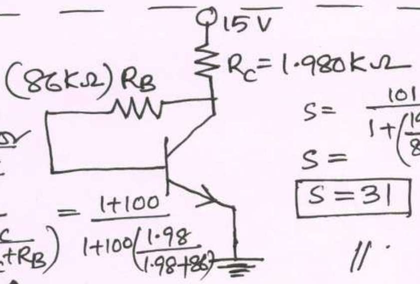
$V_{CE}=V_{CB}+V_{BE}$

$5=I_BR_B+0.7$

$R_B=\frac{5-0.7}{I_B}=\frac{4.3}{0.05mA}=86k\Omega$

$$\boxed{R_B=86k\Omega}$$

$\therefore$ The circuit with the designed values is shown here



*** Stability factor of this ckt

$S=\frac{1+\beta}{1+\beta\left(\frac{R_C}{R_C+R_B}\right)}=\frac{1+100}{1+100\left(\frac{1.98}{1.98+86}\right)}$

*** Remember ↑

$S=\frac{101}{1+\left(\frac{198}{87.96}\right)}$

$S=$ $\boxed{S=31}$ //