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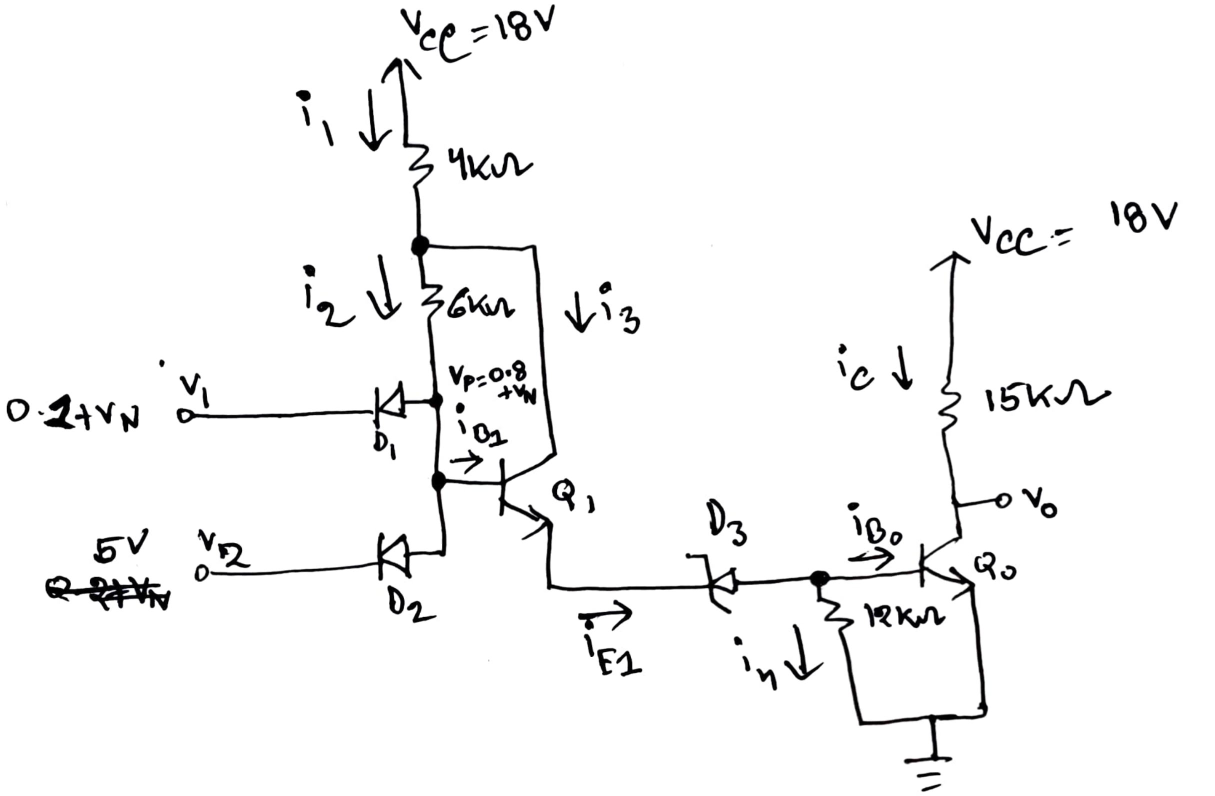

Given that,

V_γ (diode) = 0.6V

V_γ (transistor) = 0.5 V

V_D (conducting voltage) = 0.7V

V_{zn} (zener breakdown voltage) = 7.6 V

V_{BE} (sat) = 0.8V

V_{CE} (sat) = 0.2V

V_{BE} (F.A) = 0.7V

Common emitter current gain, = 30

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(a) One input low,

So, $V_P = 0.8 + V_N$

~~Malfunction occurs when D_1, D_2, T are~~

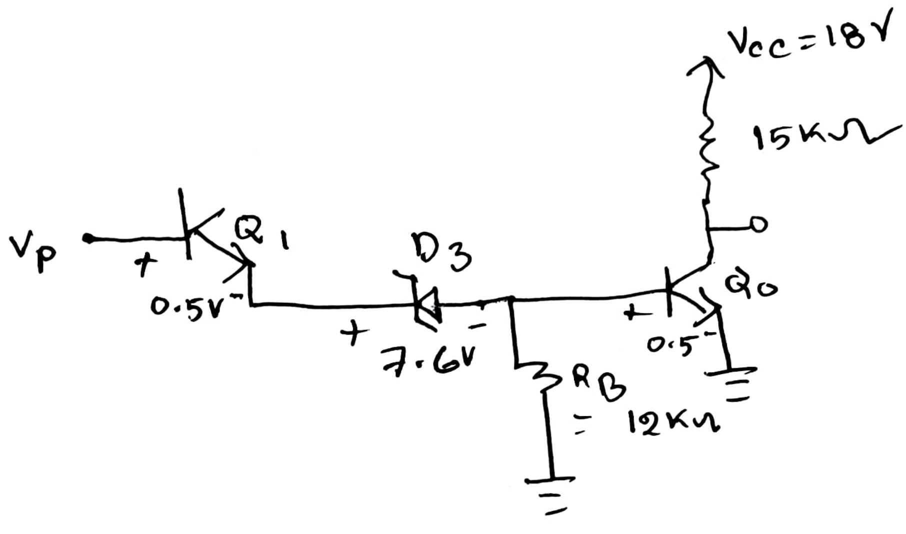
Malfunction occurs when Q_1, Q_2, D_3 gets turned ON.

~~Origi~~ Originally the components,

Q_1, Q_2, D_3 are turned off because

The voltage is not enough to turn them on. When a minimum noise voltage is added, it might turn on the Q_1, Q_2, D_3 components.

Now,



So,

$V_P = 0.5 + 0.5 + 7.6$

$= 8.6$

$V_P = 0.8 + V_N$

$\Rightarrow 8.6 = 0.8 + V_N$

$\Rightarrow V_N = 7.8\,V$

So, Low noise margin $= V_N = 7.8V$

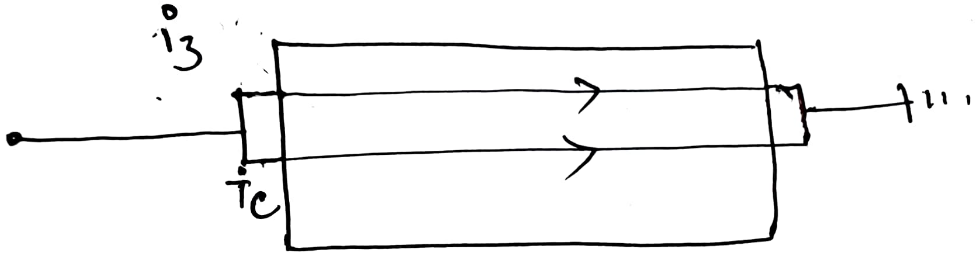
$V_{NL} = 7.8V$

(Ans)

(b)

if both inputs are high,

then,



$i_3 + i_2 = i_1$

$\Rightarrow i_3 = i_1 - i_2$

$i_3 = \beta I_{B1}$

$i_3 = \frac{\beta}{1+\beta} I_{E1}$

$\Rightarrow \beta I_{B1} = \frac{\beta}{1+\beta} I_{E1}$

$i_c = \frac{18-0.7}{15}$

$= 1.19 mA$

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$$i_1 = \frac{18 - V_{e1}}{4}$$

$$i_E = (\beta + 1) I_B$$

$$\Rightarrow I_{E1} = (\beta + 1) I_2$$

$$\Rightarrow I_1 = (\beta + 1) I_2$$

$$\Rightarrow \frac{18 - V_{e1}}{4} = (30 + 1) \frac{V_{e1} - 9.1}{6}$$

$$\Rightarrow V_{e1} = 9.511\,V$$

$$I_2 = \frac{V_{e1} - 9.1}{R_2} = \frac{V_{e1} - 9.1}{6} = \frac{9.511 - 9.1}{6} = 0.0685\ mA$$

$$I_1 = \frac{18 - 9.511\,V}{4} = 2.122\ mA$$

So, Power disipation $= (18 - 0)(2.122 + 1.19)$

$$= 59.62\ mW$$

(ii)

$i_c = 1.19\ mA$

$i_4 = \frac{0.8}{12} = 0.067\ mA$

$\therefore i_B = i_{E_1} - i_4$

$= 2.055\ mA$

$\beta_{min} = \frac{i_c}{i_B} = \frac{1.19}{2.055} = 0.58$ (minimum value)

(Ans)