CT2 : Semiconductor Devices

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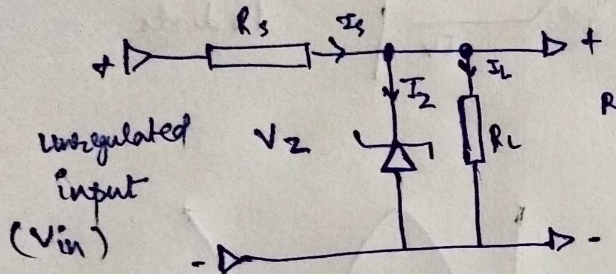
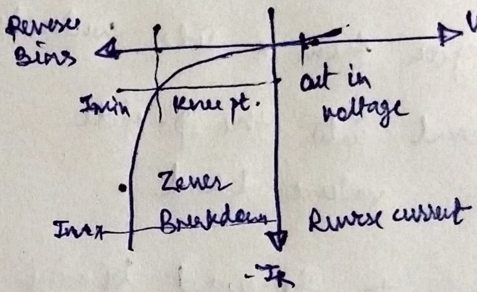
Ans 1

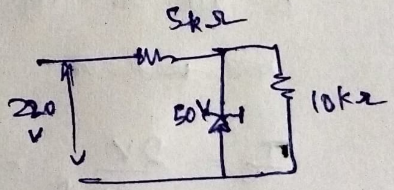
a) Zener Diode is a heavily doped PN junction in reverse biased. it acts as voltage stabilizer. In order to protect electronic device from input voltage fluctuation, zener diode is used.





Zener diodes are used as Shunt Voltage Regulators to regulate voltage across small loads. They have sharp reverse breakdown voltage and it will be constant for wide range. Thus we connect zener diode parallel to the load such that applied voltage will reverse bias it, if it exceeds the zener breakdown voltage.

b) $V = \dfrac{10 \times 220}{5+10} = 146.66$



voltage drop across R = 220 − 50 = 170 V.

Load current, I_L = 50/10 = 5 mA

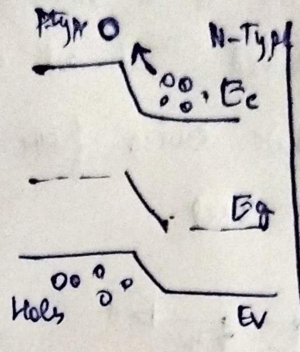
$I_{R,I} = \dfrac{170}{5} = 34$ mA

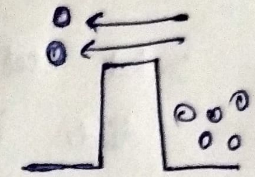
Zener current, $I_Z = I - I_L$

$= 34 - 5 = 29$ mA

Ans 2 a) Tunnel Diode is heavily doped pn junction which shows negative resistance. when voltage value increases, current flow decreases. It works based on Tunnel Effect.

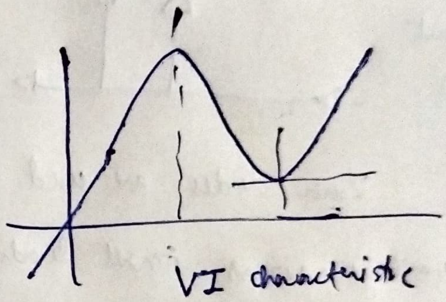
Tunneling effect is known as direct flow of electrons across small depletion region from n-side conduction band into the p-side valence band.





Pn diode

Due to forward biasing, because of heavy doping & conduction happens in the diode.



VI characteristic

Applications:

↳ can be used as switch, amplifier, oscillator.

↳ shows fast response, used as high frequency component.

↳ act as logic memory storage device.

b) $I_C = \frac{2V}{2k\Omega} = 1\,mA$

as, $\alpha = \frac{I_C}{I_E}$

$I_E = \frac{I_C}{\alpha} = \frac{1}{0.95} = 1.05\ mA$.

Now,

$I_E = I_B + I_C$

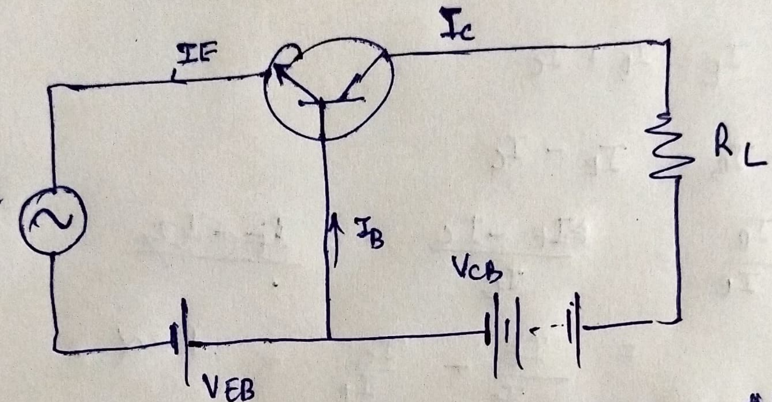
$I_B = I_E - I_C = 1.05 - 1$

$= 0.05\ mA$

Ans 3 a) BJT is a device prepared by two PN junctions, that uses both electrons and electron hole as charge carriers.

It is used in oscillators and amplifiers.

It can acts an amplifier by raising the strength of a weak signal. Voltage applied to emitter base junction, makes it remain in forward biased condition.



The emitter current caused by the input signal contributes the collector current, which when flows through load resistor R_L, results in a large voltage drop across it.

$R_i = \frac{\Delta V_{BE}}{\Delta I_B}$, $R_o = \frac{\Delta V_{CE}}{\Delta I_{C}}$

current gain $= \frac{\Delta I_C}{\Delta I_B}$

voltage gain $= \frac{\Delta V_{CE}}{\Delta V_{BE}}$.

Power gain

$= \left(\frac{I_C}{I_B}\right) \frac{I_C \times R_{AC}}{I_B \times R_i}$.

b) $\beta = 50$, $I_b = 20\ \mu A$

$\left(\alpha = 50/51 = 0.98\right)$.

$I_c = \beta I_b$

$I_c = 50 \times 20\ \mu A = 10^{-3}$ A.

$I_e = \frac{I_c}{\alpha} = \frac{10^{-3}}{0.98} = 1.02 \times 10^{-3}$ A

Ans 4 a) The current amplification factor or current gain of a transistor is the ratio of output current to the input current.

current amplification factor, $\alpha = \frac{\Delta I_C}{\Delta I_E}$.

base current amplification factor, $\beta = \frac{\Delta I_C}{\Delta I_B}$

As $I_E = I_B + I_C$

$I_B = I_E - I_C$

$\frac{I_B}{I_E} = \frac{I_E - I_C}{I_E}$

$= \frac{I_E}{I_E} - \frac{I_C}{I_E} = 1 - \alpha$.

$= \frac{1/\beta}{1/\alpha} = 1 - \alpha$

$\Rightarrow \alpha/\beta = 1 - \alpha$

$\Rightarrow \alpha = \beta - \alpha\beta$

$\alpha(1+\beta) = \beta$

$\alpha = \frac{\beta}{1+\beta}$ or $\beta = \frac{\alpha}{1-\alpha}$.

b) $I_C = \frac{V_{CE}}{R_C} = \frac{1V}{1k\Omega} = 1mA$

$I_B = \frac{I_C}{\beta} = \frac{1mA}{45}$

$I_B = 0.022$ mA.