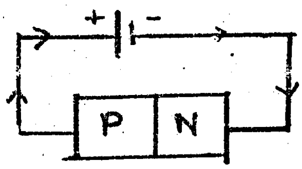
CHP. 18
SHORT QUESTIONS

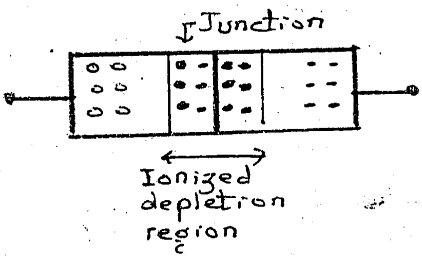
Q 18.1. Electrons are majority carriers and holes are minority carriers in the n-type substances and opposite is the case in the p-type substances. Current is constituted by the flow of electrons (electronic current) in n-type substances and by the flow of holes (conventional current) in p-type substances. Both the currents flow in opposite directions when a battery is put in the circuit.

Q 18.2. Net charge on them is zero and they remain electrically neutral unless a battery is put in the circuit which makes electrons and holes drift in opposite direction.

Q 18.3 When electric potential of anode (P-type), is greater by 0.2V w.r.t cathode (n-type) then such pn-junction is called forward biased, as the electrons always move from a lower potential to a higher potential.



Q18.4 An n-region contains free electrons as majority charge carriers and p-region contains holes as majority charge carriers, just after the formation of the junction. The free electrons in the n-region because of their random motion, diffuse into the p-region. As a result of their diffusion, a chargeless region is formed around the junction in which the charge carriers are not present. So it offers resistance for the flow of current.



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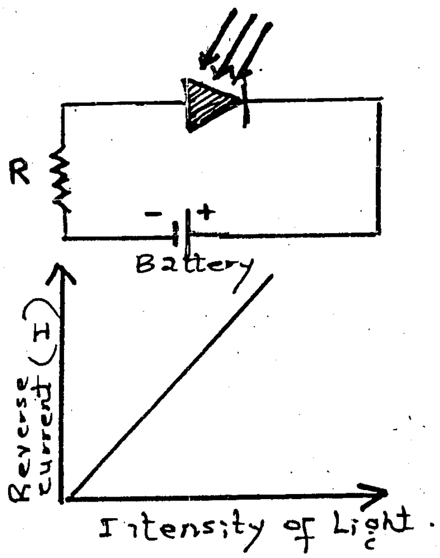
Q18.5: Forward biasing will reduce the width of depletion region whereas reverse biasing will increase the width of depletion region.

Q18.6: This is because silicon is opaque to light.

REASON: During forward bias conduction in a LED, the electron undergoes an energy change before combining with the hole. The energy radiated by the electron appears as light. In ordinary silicon diode, this radiated energy is very small. So no visible light is seen due to the transition of electron i.e; the ordinary silicon diode does not emit light because it has low value of forward bias as compared to LED.

Q 18.7:



Photodiode is used for detection of light. When no light falls on the reverse biased junction of the photo diode, no current flows. But when light falls on it the electron and hole pairs are generated due to breakage of covalent bonds. due to which the diode starts conducting. Hence it is always reverse biased. When p-n junction is exposed to light, the reverse current increases with the intensity of light as shown in fig.

Q 18.8: The base region has very small doping level as compared to emitter and collector. This means that it has very few number of holes or electrons in it. When electrons or holes enter into the base region from emitter, the number of recombination of

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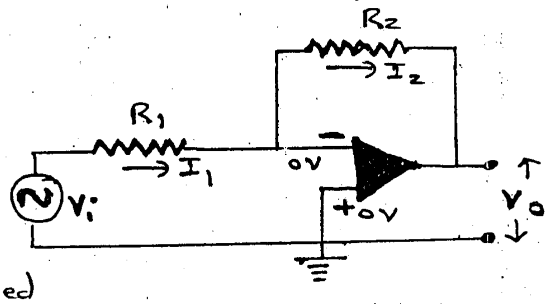
these charges with the charges already present in the base is small. Thus base current is also small.

Q 18.9: For its normal operation the input junction is always forward biased while the output junction is reverse biased. In case of common-emitter amplifier, input is applied between base and emitter. The output is obtained between collector and emitter. Hence emitter base junction is always forward biased and collector base junction is always reverse biased.

Q 18.10:



In an inverting amplifier, input signal voltage V_i to be amplified is applied at inverting terminal (–) through resistance and V_o is the output voltage. The non-inverting terminal is grounded and its potential is zero. Since V_+ is at ground potential so V_- is virtually at ground potential i.e; $V_- = 0$

The open loop voltage gain of this amplifier is about 10^5 i.e;

$$A_{OL} = \frac{V_o}{V_i} = 10^5$$

As $V_i = V_+ + (-V_-) = 0 - V_- = -V_-$

So $A_{OL} = \frac{V_o}{-V_-} = -\frac{V_o}{V_-} = 10^5$ or $V_- = 0$

That is V_- is virtually at ground potential. This is called principle of virtual ground (input is virtually at ground potential.)

Voltage gain Current through $R_1 = I_1 = \frac{V_i - V_-}{R_1} = \frac{V_i - 0}{R_1} = \frac{V_i}{R_1}$

& current through $R_2 = I_2 = \frac{V_- - V_o}{R_2} = \frac{0 - V_o}{R_2} = \frac{-V_o}{R_2}$

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Using Kirchhoff's current rule;

$$I_1 = I_2$$

$$\frac{V_i}{R_1} = -\frac{V_o}{R_2}$$

$$\text{or } G = \frac{V_o}{V_i} = -\frac{R_2}{R_1}$$

which is the voltage gain of inverting amplifier.

Q 18.11: For input A=1, B=0

(a) output = 0

then the gate is either an AND gate or XNOR gate.

(b) output = 1

The gate may be an OR gate, NAND gate or XOR gate.

Q 18.12:

(i) c (ii) d (iii) d (iv) a (v) b (vi) c
(vii) a (viii) d (ix) a

P.18.2

DATA: $I_c = 10\,mA = 10^{-2}A$ = collector current

current gain $= \beta = 200$

Base emitter voltage $= V_{BE} = 0.6V$

$V_{cc} = 9V$

$R_B = ?$

Sol. As $\beta = I_c / I_B$

$$I_B = \frac{I_c}{\beta} = \frac{10^{-2}}{200} = 0.5 \times 10^{-4} A \quad \text{——— (1)}$$

we know that

$$V = V_{cc} - V_{BE} \quad \text{——— (2)}$$

$$V = 9 - 0.6 = 8.4 \text{ volt} \quad \text{——— (3)}$$

Using the relation;

$$V = I_B R_B$$

$$R_B = \frac{V}{I_B} = \frac{8.4}{0.5 \times 10^{-4}} = 16.8 \times 10^{4}\,\Omega$$

$$R_B = \boxed{168\,K\Omega}$$

P.18.3.

DATA: $V_{cc} = 9V$

$V_{CE} = 7.875V$

$R_c = 1K\Omega = 10^{3}\Omega$

$R_B = 100\,K\Omega = 10^{5}\Omega$

$\beta = 100$

(i) Base current $= I_B = ?$

(ii) collector current $= I_c = ?$

(iii) Potential drop across $R_c = V_c = ?$

Sol. (ii) Potential drop across $R_c = V_{cc} - V_{CE}$

$$= 9 - 7.875 = 1.125V \quad \text{(1)}$$

$$\therefore I_c = \frac{V_{cc} - V_{CE}}{R_c} = \frac{1.125}{10^{3}} = 1.125 \times 10^{-3} A = \boxed{1.125\,mA}$$

(i) put $\beta = \frac{I_c}{I_B}$

$$\text{or} \quad I_B = \frac{I_c}{\beta} = \frac{1.125 \times 10^{-3} A}{100} = 11.25 \times 10^{-6} A$$

$$I_B = \boxed{11.25\,\mu A}$$

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(iii) As Potential drop across R_c = $\boxed{1.125\ V}$

OR Potential drop across $R_c = I_c R_c$

$= 1.125 \times 10^{-3} \times 10^{3}$

$= \boxed{1.125 V}$

P.18.4:

DATA. $R_1 = 10 K\Omega = 10 \times 10^3 \Omega$

$R_2 = 4 K\Omega = 4 \times 10^3 \Omega$

output of op-amp circuit $= V_o = ?$

Sol. Using Kirchhoff's law

(current through R_1) + (current through R_2) = (current through R_3)

I_1 = Current through $R_1 = \frac{(5-0)V}{10 \times 10^3} = 0.5 \times 10^{-3} A$ —— (1)

I_2 = Current through $R_2 = \frac{-2V-0}{4 \times 10^3} = -0.5 \times 10^{-3} A$ —— (2)

I = Total current through $R_3 = I_1 + I_2$

$= 0.5 \times 10^{-3} - 0.5 \times 10^{-3} = 0$

$\therefore V_o$ = output $= \boxed{0}$ $\because I = \frac{V_o - 0}{R_3} = \frac{V_o}{20 \times 10^3}$

$0 = \frac{V_o}{20 \times 10^3}$

$V_o = 0$

P.18.5.

DATA: $R_1 = 10 K\Omega = 10 \times 10^3 \Omega$

$R_2 = 40 K\Omega = 40 \times 10^3 \Omega$

Gain of non inverting amplifier $= G = ?$

Sol. Using the rel.;

$G = 1 + \frac{R_2}{R_1}$

$= 1 + \frac{40 \times 10^3}{10 \times 10^3}$

$= 1 + \frac{40}{10}$

$G = 1 + 4 = \boxed{5}$