PRASTHUTHI - CSE - 'C'

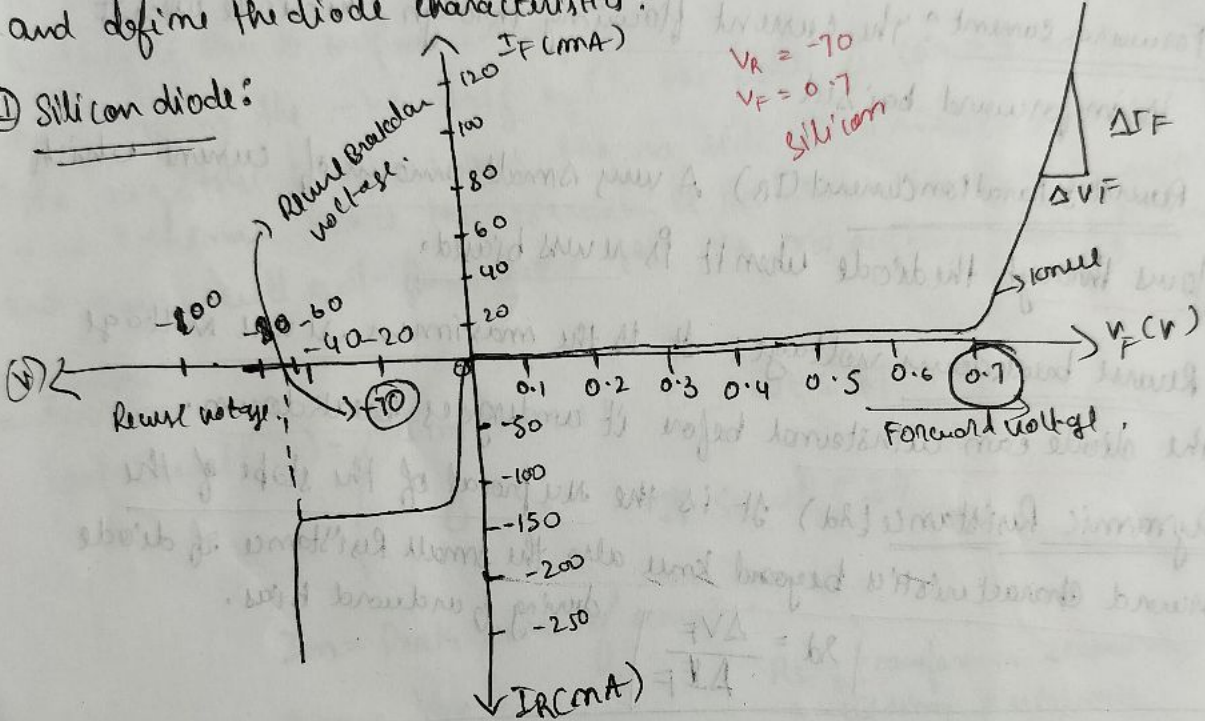
(1)

UNIT 1 BE - AnswerKey.

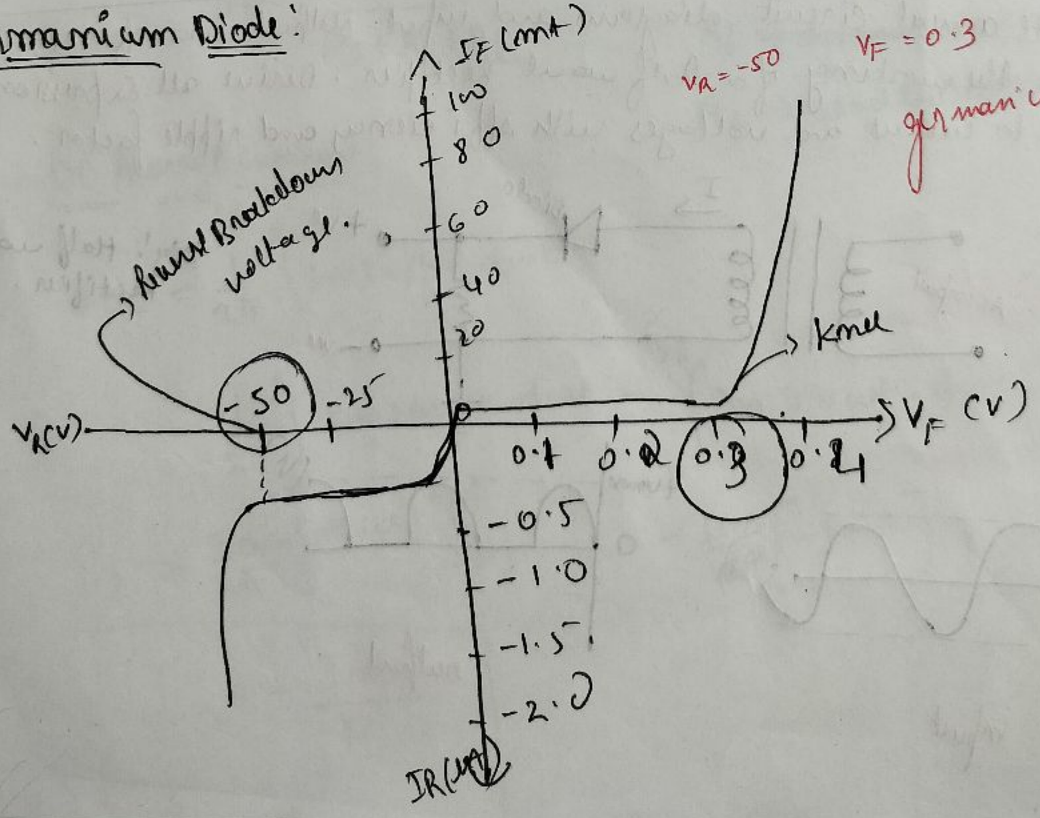
MCQ Page (1) - 3 (2)
80 Q's.

(1) Draw the VI characteristics for silicon and germanium diodes and define the diode characteristics.

(1) Silicon diode:



(2) germanium Diode:



Diode characteristics:

(knee voltage)

1) Forward voltage (VF): The voltage drop across the diode when it is forward biased / conducting

2) Forward current: The current flowing through the diode when it is in forward baised.

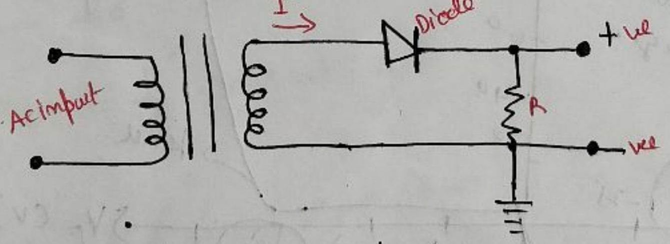
3) Reverse saturation current (I_R) A very small amount of current which flows through the diode when it is reverse biased.

4) Reverse breakdown voltage: It is the maximum reverse voltage the diode can withstand before it undergoes breakdown.

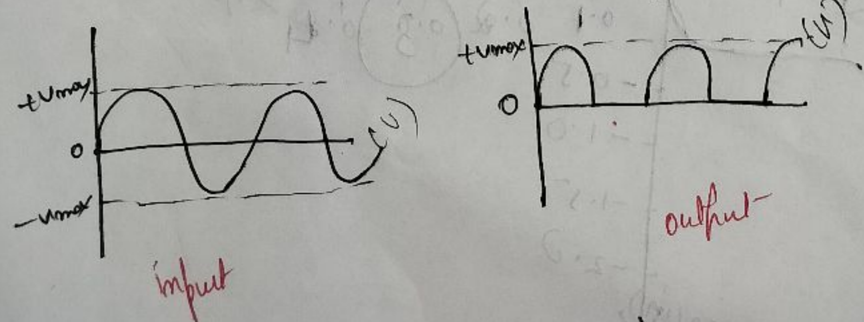
5) Dynamic Resistance (rd) It is the reciprocal of the slope of the forward characteristics beyond knee also the small resistance of diode during forward bias.

$$\boxed{rd = \frac{\Delta V_F}{\Delta I_F}}$$

2) Write a neat circuit diagram and input output waveforms, Explain the working of a half wave rectifier. Derive all expressions relevant to current and voltages with efficiency and ripple factor.



Dig: Half wave Rectifier.



②

Working:

During the +ve half cycle p side is connected to the +ve terminal and n side is connected to the negative terminal, Hence the circuit is in forward bais condition, and current starts flowing though R_L therefore there is output waveform.

Now, During the -ve half cycle the p side is connected to the negative terminal and the n side is connected to the +ve terminal hence the circuit is in reverse baised condition and current will not flow hence there is no output waveform (V_L)

Expressions:

$$\text{Load current } (I_L) = \begin{cases} I_m \sin \omega t & 0 \le \omega t \le \pi \\ 0 & \pi \le \omega t \le 2\pi \end{cases} \quad —①$$

I_m = Peak value of current.

$$I_m = \frac{V_m}{R_s + R_f + R_L}$$

R_s = transformer secondary winding Resistance.

$R_f \Rightarrow$ dynamic Resistance

$R_L \Rightarrow$ Load Resistance.

$I_{DC} \Rightarrow$ DC Average current!

$$I_{DC} = \frac{1}{2\pi}\int_0^{2\pi} I_m \sin\omega t \cdot d\omega t$$

$$= \frac{1}{2\pi}\int_0^{\pi} I_m \sin\omega t \cdot d\omega t + \underbrace{\int_{\pi}^{2\pi} I_m \sin\omega t \cdot d\omega t}_{=0 \text{ from } ①}$$

$$= \frac{I_m}{2\pi}\Big[-\cos\omega t\Big]_0^{\pi} = -\frac{I_m}{2\pi}\left[-1-1\right] = \frac{I_m}{\pi}$$

$$\boxed{I_{DC} = \frac{I_m}{\pi}}$$

V_{DC}

=) DC Average voltage.

$$V_{DC} = I_{DC} \cdot R_L$$

$$\cancel{= \frac{I_m}{\pi} \cdot \frac{V_m}{R_S + R_f + R_L}}$$

$$\therefore I_m = \frac{V_m}{R_S + R_f + R_L}$$

$$\cancel{= V_m \sin \omega t}$$

$$= \frac{I_m}{\pi} \cdot R_L$$

$$= \frac{V_m}{R_S + R_f + R_L} \cdot \frac{R_L}{\pi}$$

R_S & R_f << R_L

$$\boxed{\therefore V_{DC} = \frac{V_m}{\pi}}$$

I_{rms}.

$$I_{rms} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} I_L^2 \, d\omega t}$$

$$= \sqrt{\frac{1}{2\pi}\int_0^{\pi} I_m^2 \sin^2 \omega t}$$

$$= \sqrt{\frac{I_m^2}{2\pi}\int_0^{\pi} \frac{1 - 2\cos \omega t}{2} \, d\omega t}$$

$$\boxed{I_{rms} = \frac{I_m}{2}}$$

$$V_{rms} = I_{rms} \cdot R_L$$

$$= \frac{V_m}{2}$$

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Ripple factor:

$$r = \frac{I_{ac}}{I_{dc}} \qquad I_{ac}^2 = I_{rms}^2 - I_{dc}^2$$

$$r = \frac{\sqrt{I^2_{rms} - I^2_{dc}}}{I_{dc}^2}$$

$$r = \sqrt{\frac{I^2_{rms}}{I^2_{dc}} - 1} \qquad I_{rms} = \frac{I_m}{2} \qquad I_{dc} = \frac{I_m}{\pi}$$

$$r = 1.21 = 121\%$$

Efficiency:

$$\eta = \frac{P_{dc}}{P_{ac}} \qquad P_{dc} = I_{dc}^2 \cdot R_L$$

$$P_{ac} = I^2_{rms}\left[R_L + R_f + R_s\right]$$

$$I_{rms} = \frac{I_m}{2}$$

$$\eta = \frac{I_{dc}^2 \cdot R_L}{I^2_{rms}\left[R_L + R_f + R_s\right]} \qquad I_{dc} = \frac{I_m}{\pi}$$

$$\eta = 0.406$$

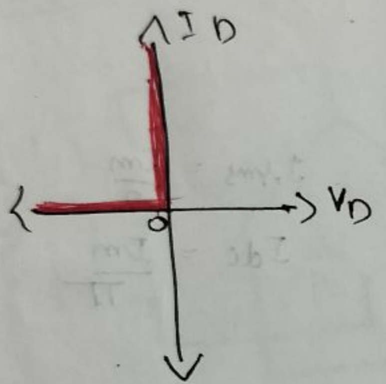
$$= 40.6\%$$

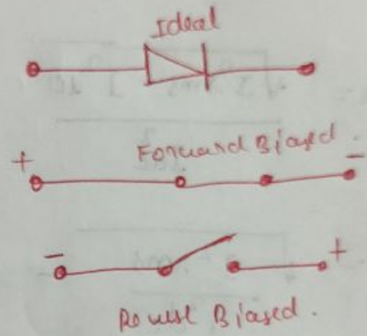
(6)

(4) Q3) Write circuit diagrams and graphs explaining diode models!

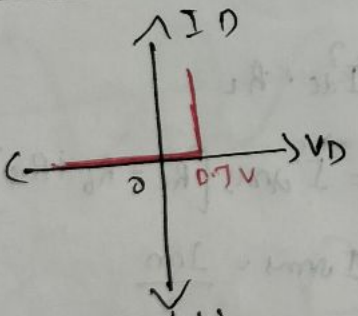
Ans:) The diode It is a two terminal non-linear device whose VI characteristics are dependent on the polarity of applied voltage.

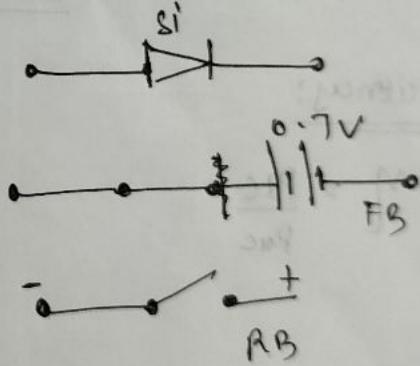
① Ideal Diode



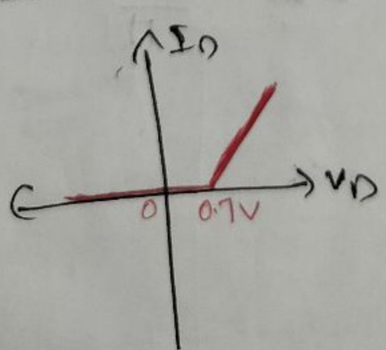


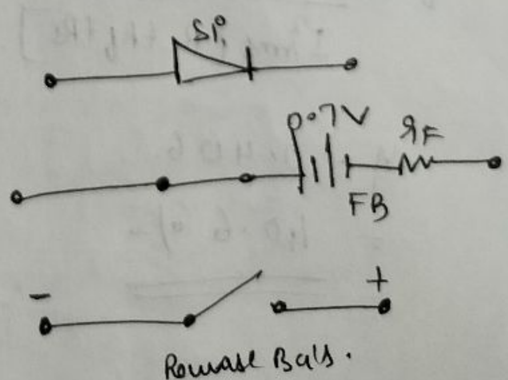
② Simplified model.





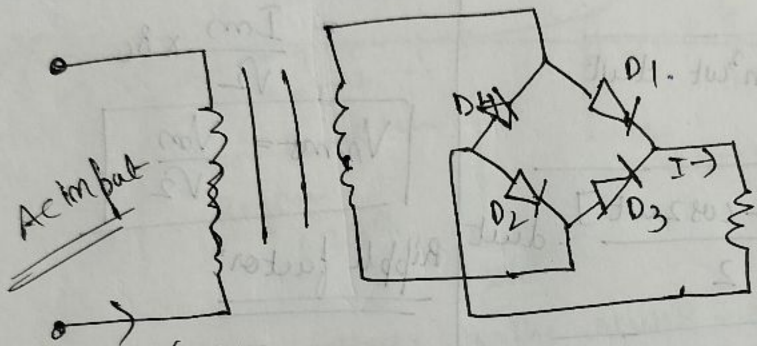
③ Piecewise Linear model!

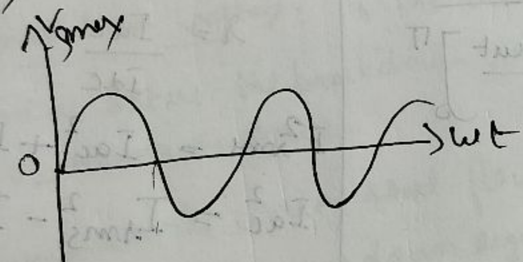


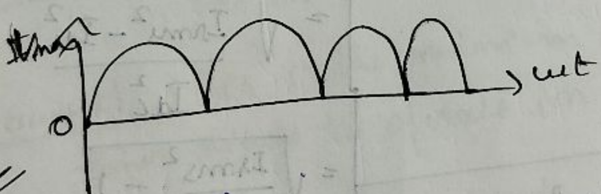


(4) write a neat circuit diagram and relevant graphs of input output waveforms to explain the working of a bridge Rectifier and Derive all the expressions relevant to current, voltage, with efficiency and ripple factor. (4)

Ans! Bridge Rectifier:







Derivation!

Dc avg current I_{DC}

$$I_{DC} = \frac{1}{2\pi}\int_0^{2\pi} I_m \sin\omega t \cdot d\omega t$$

$$= \frac{1}{2\pi}\left[\int_0^{\pi} I_m \sin\omega t + \int_{\pi}^{2\pi} I_m \sin\omega t . d\omega t\right]$$

$$I_{DC} = \frac{1}{2\pi}\left[2\int_0^{\pi} I_m \sin\omega t . d\omega t\right]$$

$$= \frac{1}{\pi}\int_0^{\pi} I_m \sin\omega t . d\omega t$$

$$\Rightarrow I_{DC} = \frac{I_m}{\pi}\left[-\cos\omega t\right]_0^{\pi}$$

$$= -\frac{I_m}{\pi}[-1-1]$$

$$\boxed{I_{DC} = \frac{2 I_m}{\pi}}$$

Dc voltage

$$V_{DC} = I_{DC} \cdot R_L$$

$$= \frac{2 I_m}{\pi} \cdot R_L \qquad I_m = \frac{V_m}{R_s + R_f + R_L} \Rightarrow \boxed{V_{DC} = \frac{2V_m}{\pi}}$$

Irms

$$I_{rms} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} I_L^2 \cdot d\omega t}$$

$$= \sqrt{\frac{1}{2\pi}\int_0^{2\pi} I_m^2 \sin^2\omega t \cdot d\omega t}$$

$$= \sqrt{\frac{I_m^2}{\pi}\int_0^{\pi}\left[\frac{1-\cos 2\omega t}{2}\right] \cdot d\omega t}$$

$$= \sqrt{\frac{I_m^2}{2\pi}\left[\omega t - \frac{\sin 2\omega t}{2}\right]_0^{\pi}}$$

$$= \sqrt{\frac{I_m^2}{2}}$$

$$\boxed{I_{rms} = \frac{I_m}{\sqrt{2}}}$$

Vrms:

$$I_{rms} \times R_L$$

$$= \frac{I_m}{\sqrt{2}} \times R_L$$

$$\boxed{V_{rms} = \frac{V_m}{\sqrt{2}}}$$

Ripple factor:

$$r = \frac{I_{ac}}{I_{dc}}$$

$$I_{rms}^2 = I_{ac}^2 + I_{dc}^2$$

$$I_{ac}^2 = I_{rms}^2 - I_{dc}^2$$

$$= \sqrt{\frac{I_{rms}^2 - I_{dc}^2}{I_{dc}^2}}$$

$$= \sqrt{\frac{I_{rms}^2}{I_{dc}^2} - 1}$$

$$= \sqrt{\frac{I_m^2/2}{4I_m^2/\pi^2} - 1}$$

$$= \sqrt{\frac{\pi^2}{8} - 1}$$

$$= 0.483$$

$r\% = 48\%$ of dc component

$$\eta = \text{Efficiency} = \frac{P_{dc}}{P_{ac}} = \frac{I_{dc}^2 \cdot R_L}{I_{rms}^2 (R_s + 2R_f + R_L)}$$

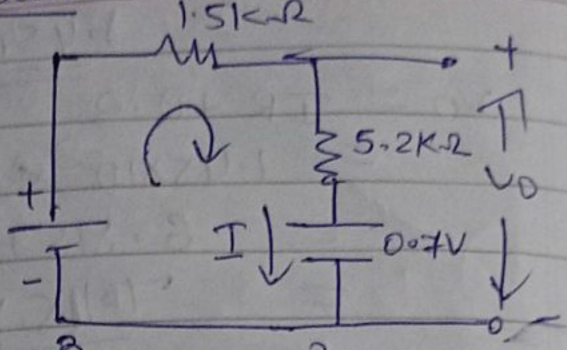
$$I_{dc} = \frac{2I_m}{\pi} \qquad I_{rms} = \frac{I_m}{\sqrt{2}}$$

$$\eta = \frac{\frac{4I_m^2}{\pi^2} \cdot R_L}{\frac{I_m^2}{2}(R_s + 2R_f + R_L)} = \frac{8}{\pi^2} \times \left(\frac{1}{1 + \left(\frac{R_s + 2R_f}{R_L}\right)}\right)$$

$$\eta = \frac{8}{\pi^2} = 0.812 \qquad \eta = 81.2\%$$

Questionbank

5) Equivalent circuit =>



by applying KVL,

$8V - 1.5I \times 10^3 - 5.2 \times 10^3 I - 0.7 = 0$

$\Rightarrow 8 - 6.7 \times 10^3 I - 0.7 = 0$

$-6.7 \times 10^3 I = 0.7 - 8$

$I = \frac{-1.3}{-6.7 \times 10^3}$

$= 1.08 \times 10^{-3}$

$I = 1.08mA$

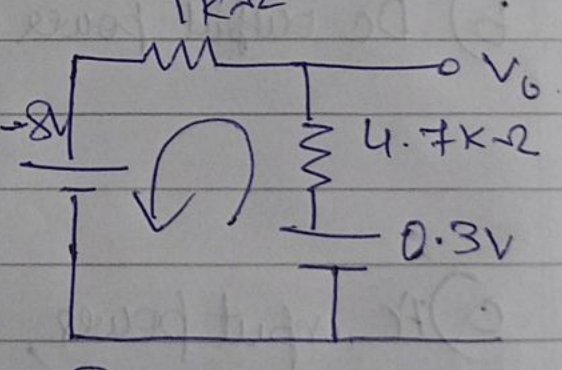
$V_O = I \times R + 0.7$

$= 1.08 \times \cancel{10^{-3}} \times 5.2 \times \cancel{10^3} + 0.7$

$= 5.616 + 0.7$

$= 6.316V$

6) Equivalent circuit =>



by applying KVL,

$-(-8) + 1 \times 10^3 I + 4.7 \times 10^3 I$
$+ 0.3 = 0$

$-8 - 5.7 I \times 10^3 = 0.3$

$I = \frac{(0.3 + 8) \times 10^{-3}}{5.7}$ * ignore -ve sign.

$32 - 25mA \times R_S - 24 = 0$

$\therefore R_S = \dfrac{32V - 24V}{25mA}$

$= 320\,\Omega$

ii) $I_Z = I_S - I_L$

$I_L = \dfrac{V_Z}{R_L} = \dfrac{24}{1200} = \underline{\underline{20mA}}$

$I_Z = 25mA - 20mA$

$= \underline{\underline{5mA}}$.

12) $V_Z = 12V$, $P_Z = 360mW$, $V_S = 24V$

i) $I_L = 0$, $I_S = I_{Z max}$

$P_Z = I_Z V_Z$

$I_Z = \cancel{\dfrac{V_Z}{P_Z}} = \cancel{\dfrac{12}{360}} = \dfrac{P_Z}{V_Z} = \dfrac{360}{12} = \underline{\underline{30mA}}$

$I_Z = I_S$.

Applying KVL (Formula), $V_S - I_S R_S - V_Z = 0$

$24 - 30 \times R_S - 12 = 0$

$R_S = \dfrac{24\cancel{30}V - 12V}{30} = \dfrac{12}{30 \times 10^{-3}}$

$= 0.4 \times 10^3 = \underline{\underline{400\,\Omega}}$

ii) $I_Z = I_S - I_L$ — (1)

$I_L = \dfrac{V_Z}{R_L} = \dfrac{12}{1240} = \underline{\underline{9.6mA}}$.

(1) ⇒ $I_Z = 30 - 9.6 = \underline{\underline{20.4mA}}$

$= 1.45 mA$

$v_0 = IR + 0.3$

$= 1.45 \times 10^{-3} \times 4.7 \times 10^{3} + 0.3$

$= 6.815 + 0.3$

$= 7.115 V$

7) Given, $V_m = 40V$, $f = 50Hz$, $R_L = 1k\Omega$, $R_f = 8\Omega$

a) peak value of load current,

$$I_m = \frac{V_m}{R_L + R_f} = \frac{40}{1 \times 10^3 + 8} = \frac{40}{1008} =$$

$$= 0.0396 = 39.6 mA$$

$$I_{dc} = \frac{I_m}{\pi} = \frac{39.6}{3.14} = 12.6 mA$$

$$I_{rms} = \frac{I_m}{2} = \frac{39.6}{2} = 19.8 mA$$

b) Dc output power, $P_{dc} = I_{dc}^2 \times R_L$

$= (12.6)^2 \times 1 \times \cancel{10^3} \times 10^{-3} \times 10^{-3}$

$= 158.76 \times 10^{-3} W$

$= 158.76 mW$

c) Ac input power, $P_{ac} = I_{rms}^2 (R_L + R_f)$

$= (19.8 \times 10^{-3})^2 (1000 + 8)$

$= 392.04 \times 1008$

$= 395176.32 \times 10^{-6}$

$= 395.17 \times 10^{-3} W$

$= 395.17 mW$

d) Efficiency, $\eta = \frac{P_{dc}}{P_{ac}} = \frac{158.76\,mW}{395.17\,mW}$

$= 0.4017$

$\%\eta = \underline{40.17\%}$

8) Given, $V_{rms} = 110V$, $R_f = 25\,\Omega$, $R_L = 1K\,\Omega$.

$V_{rms} = \frac{V_m}{\sqrt{2}} \Rightarrow V_m = V_{rms} \times \sqrt{2}$

$= \underline{155.56V}$

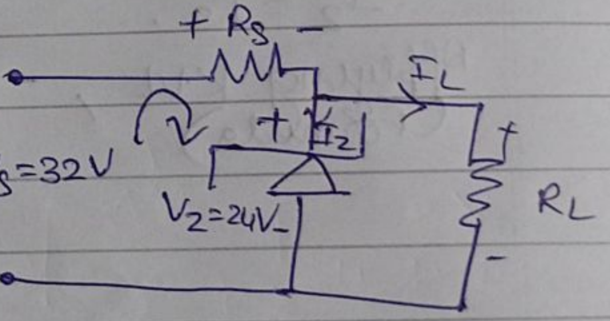
i) $I_m = \frac{V_m}{2R_f + R_L} = \frac{155.56}{50 + 1 \times 1000} = \underline{148.15\,mA}$

ii) $I_{dc} = \frac{2I_m}{\pi} = \frac{2 \times 148.15\,mA}{\pi} = \underline{94.36\,mA}$

iii) $V_{dc} = I_{dc} \times R_L = 94.36\,mA \times 1K\,\Omega$

$= \underline{94.36V}$

10) $P_Z = 600\,mW$



Apply KVL,

$32 - I_S R_S - 24 = 0$ — (1)

without load,

$I_L = 0$, for $R_L = 0$.

$I_S = I_Z + I_L$, $I_L = 0$, $I_S = I_{Z max}$.

$P_Z = I_Z V_Z$.

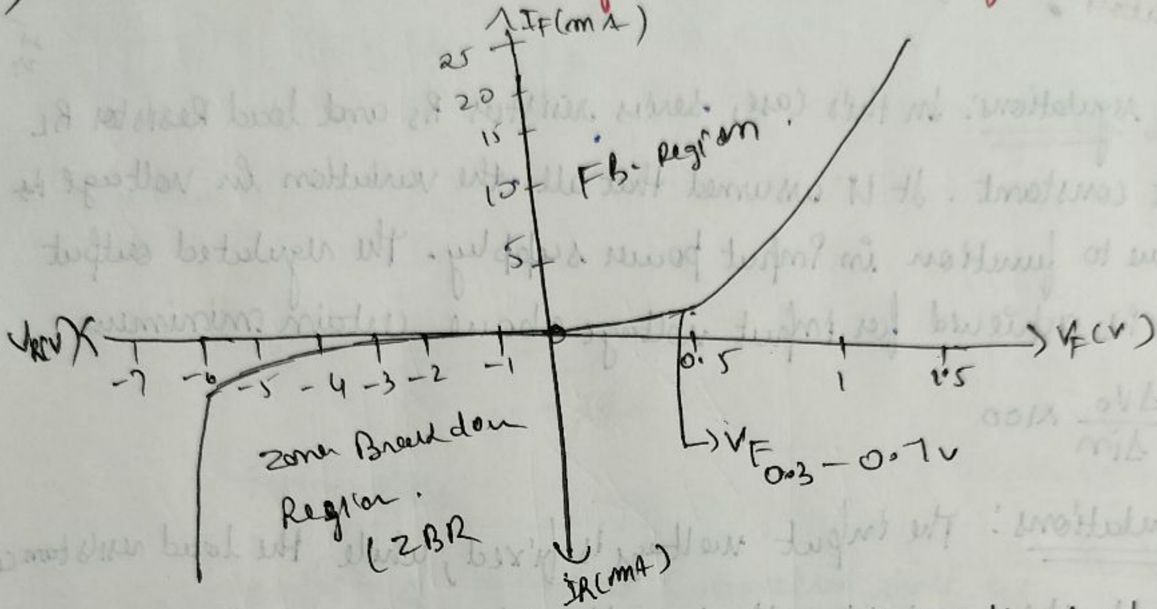
$I_Z = \frac{P_Z}{V_Z} = \frac{600\,mW}{24V} = \underline{25\,mA} = I_S$.

Substituting in (1).

5, 6, 7, 8

9, 13, 14, 15, 16 (5)

8) Draw the VI characteristics of a zener diode and define zener Parameters.



① zener Breakdown voltage: it's the reverse - bias voltage at which the device enters the breakdown region, maintaining a constant voltage V_Z across the device.

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② zener current: is the current that flows through the diode when it is in the breakdown region.

Ans!

③ knee current! This is the minimum current Required for the zener diode to operate in the breakdown.

④ ZBR: It is where the diode starts conducting a large reverse current while maintaining a nearly constant voltage across it.

i/p

13) Define Line Regulation and load Regulation in zener voltage Regulator.

Ans: Line regulations: In this case, series resistor R_s and load Resistor R_L are kept constant. It is assumed that all the variation in voltage is arise due to function in input power supply. The regulated output voltage is achieved for input voltage above certain minimum level $\frac{\Delta V_o}{\Delta in} \times 100$

Load Regulations: The input voltage is fixed, while the load resistance is varied. The constant output voltage is obtained as long as the load resistance R_L is maintained above a minimum level.

$$\frac{V_{NL} - V_{FL}}{V_{FL}} \times 100$$

15

14) Bring out the relationship b/w the transistor current gains α and β

Ans:

$$I_E = I_B + I_C \quad (1)$$

I_E → Emitter current; I_B → Base current; I_C → collector current

The ratio of collector current to emitter current is called α [common base gain]

$$\alpha_{dc} = \frac{I_C}{I_E} \quad (2)$$

The ratio of collector current to base current is called β [common emitter gain]

$$I_E = I_C + I_B$$

$$I_C = I_E \cdot \alpha_{dc}$$

$$\therefore I_C = \alpha_{dc}(I_C + I_B)$$

14) continue

$$I_C = \frac{\alpha_{dc}}{1-\alpha_{dc}} \cdot I_B$$

Further $\beta_{dc} = \dfrac{I_C}{I_B}$

$\therefore \beta_{dc} = \dfrac{\cancel{I_B}}{I_B} \dfrac{\alpha_{dc}}{1-\alpha_{dc}}$

$\therefore \cancel{\beta_{dc} = \dfrac{\alpha_{dc}}{1}}$

The Relationship of α and β parameters shall be

$$\beta = \frac{\alpha}{1-\alpha} \quad \text{and} \quad \alpha = \frac{\beta}{1+\beta}.$$

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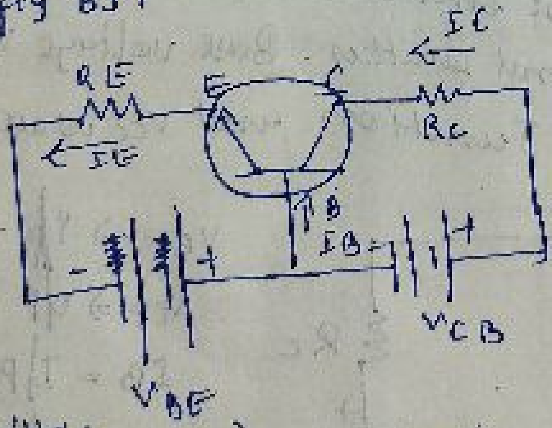
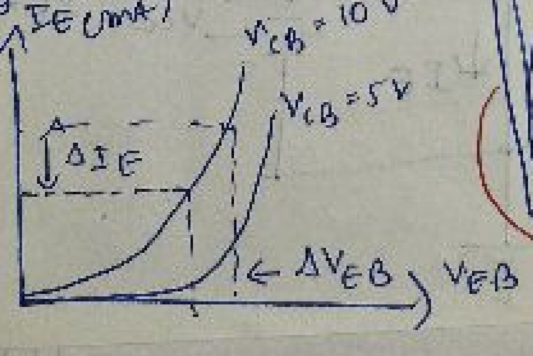
15) Write neat circuit diagram Explain the CB configuration of BJT and draw the input/output characteristics.

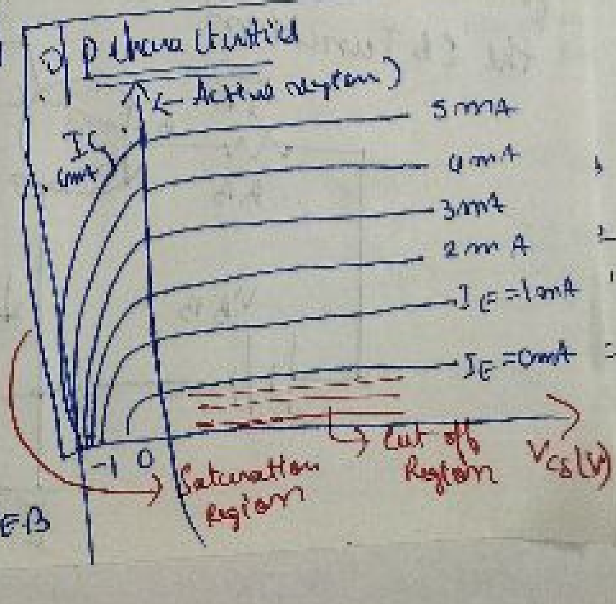
Ans: CB config BJT



$V_{BE} \Rightarrow$ i/p voltage

$V_{CE} =$ o/p "





Explanation:

The Base connection is common to both the input signal and the output signal with the input signal being applied b/w the base and the emitter terminals. output is measured b/w the base and collector terminals.

⇒ Input characteristics is the curve b/w I_E and input voltage V_{EB} for constant collector base voltage V_{CB}.

⇒ After cut in voltage I_E increases drastically with small increase in V_{EB}.

⇒ As V_{CB} increases slight increase in I_E is observed. This is due to change in the width of the depletion change.

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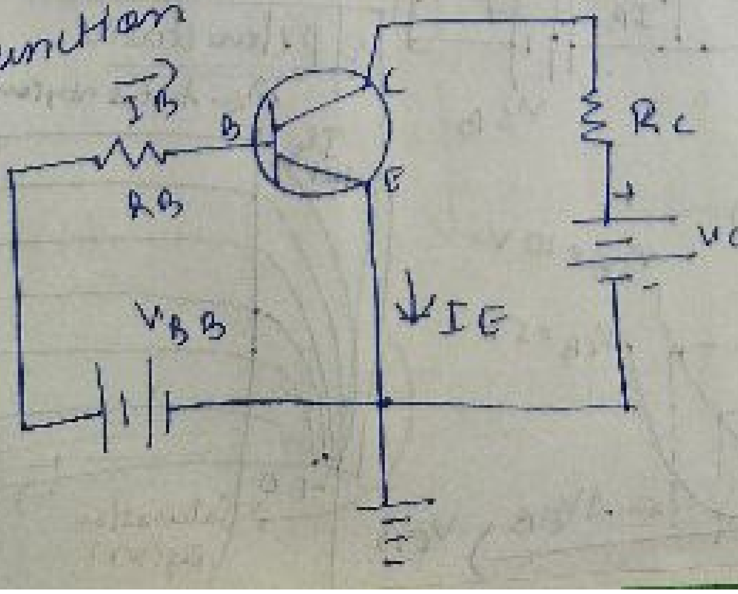
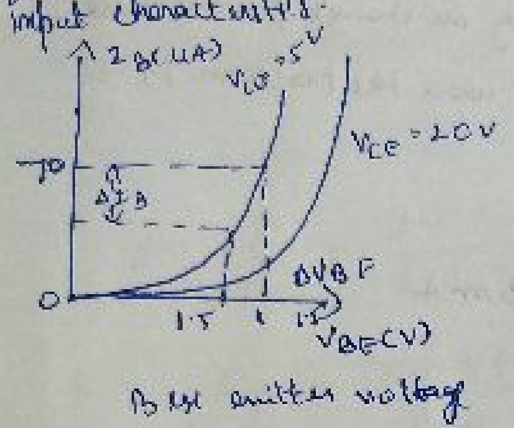
17 (6) write neat circuit diagrams explain the CE configuration of BJT and draw the i/p / o/p characteristics.

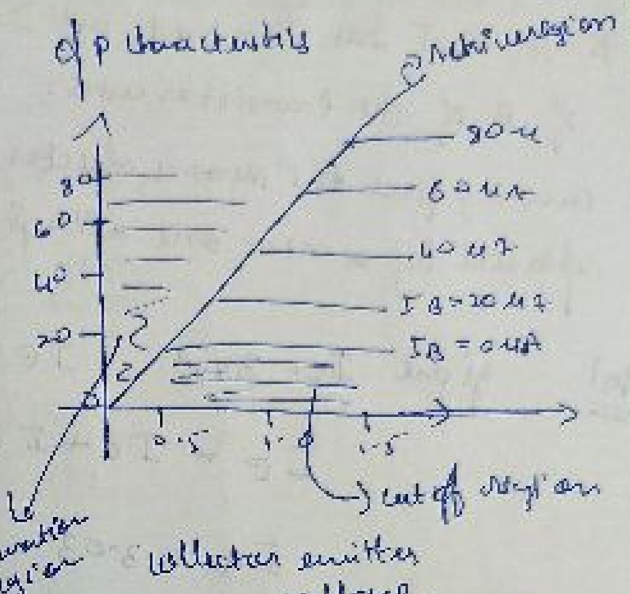
Input is applied across base emitter terminal output is collected across collector and emitter. Base voltage V_{BB} forwarded biases the BE junction and V_{CC} reverse biases the CB junction



V_{BE} ⇒ i/p voltage
V_{CE} ⇒ o/p voltage
I_B = i/p current
I_C = o/p "

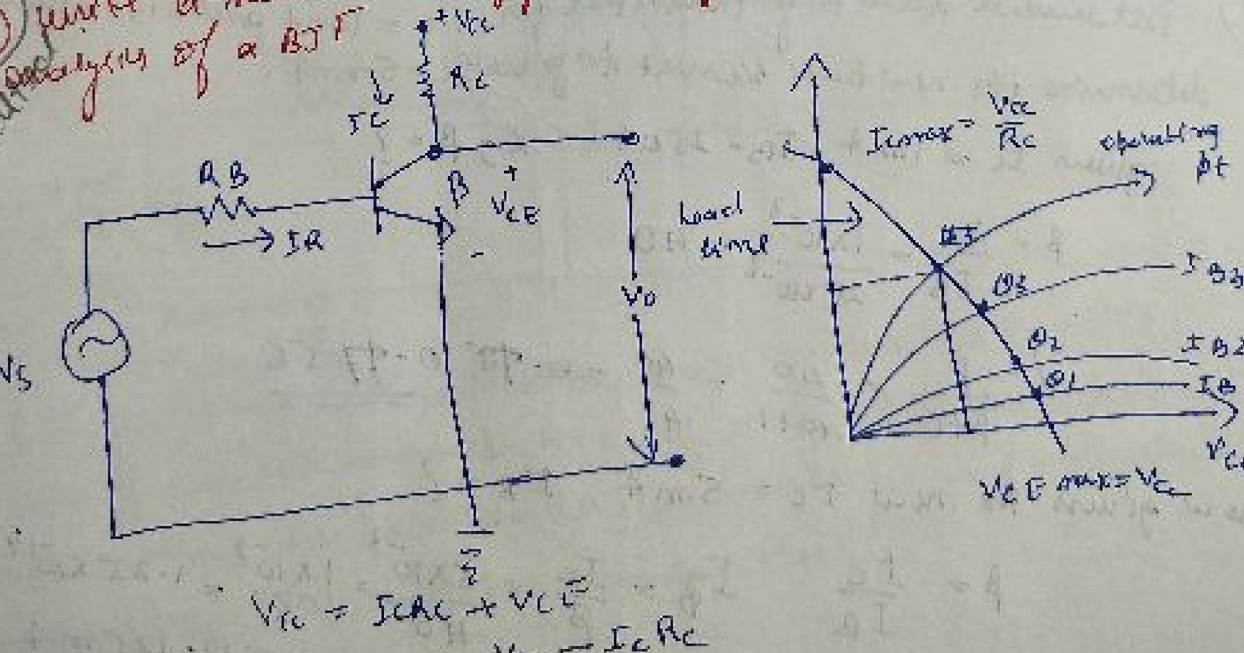
7





Transistor is in cut off & there is no collector current, the LED does not emit when sq wave goes to high level, the transistor saturates. This F Bias the LED & collector current flows through the LED & emits ~~bright~~ light. Thus, LED is on for 1 sec & off for 1 sec.

17) Write a neat circuit figure and graph, show the DC load line analysis of a BJT



$V_{CC} = I_C R_C + V_{CE}$

$\therefore V_{CE} = V_{CC} - I_C R_C$

18) A BJT has $I_C = 3mA$ and $I_E = \cancel{\#}3.03mA$ compute the value of β of the transistor used. Assuming no change from the base current, find the new collector current when the transistor is replaced by a new one with β of 70

Ans) given $I_C = 3mA$ $\quad I_E = 3.03mA$

$$I_E = I_C + I_B$$

$$I_B = 3.03 - 3 = \underline{0.03mA}$$

$$\beta = \frac{I_C}{I_B} = \frac{3 \times 10^{-3}}{0.03 \times 10^{-3}} = \frac{300}{3} = \underline{100}$$

To find new collector current when $\beta = 70$

$$I_C = \beta \times I_B = \cancel{70} \times 0.03 \times 10^{-3}$$

$$= \underline{2.1A}$$

19) Determine α and β of transistor for $I_C = 1mA$ and $I_B = 25\mu A$ determine the new base current to give $I_C = 5mA$.

given $I_C = 1mA$ $\quad I_B = 25\mu A$ $\quad \alpha, \beta = ?$

$$\beta = \frac{I_C}{I_B} = \frac{1 \times 10^{-3}}{25 \times 10^{-6}} = 40$$

$$\alpha = \frac{\beta}{\beta + 1} = \frac{40}{40+1} = \frac{40}{41} = \cancel{0.97}\ \underline{0.9756}$$

now given the new $I_C = 5mA$ $\quad I_B = ?$

$$\beta = \frac{I_C}{I_B} \qquad I_B = \frac{I_C}{\beta} = \frac{5 \times 10^{-3}}{40} = \frac{1 \times 10^{-3}}{8} = 1.25 \times 10^{-4}$$

$$= 0.125mA$$

$$= \underline{125\mu A}$$

20) Calculate α, β and I_B of transistor that has $I_C = 2.5mA$ and $I_E = 2.55mA$

$I_C = 2.5mA$ $I_E = 2.55mA$ $\alpha, \beta, I_B = ?$

$$\alpha = \frac{I_C}{I_E} = \frac{2.5 \times 10^{-3}}{2.55 \times 10^{-3}} = \underline{\underline{0.9804}}$$

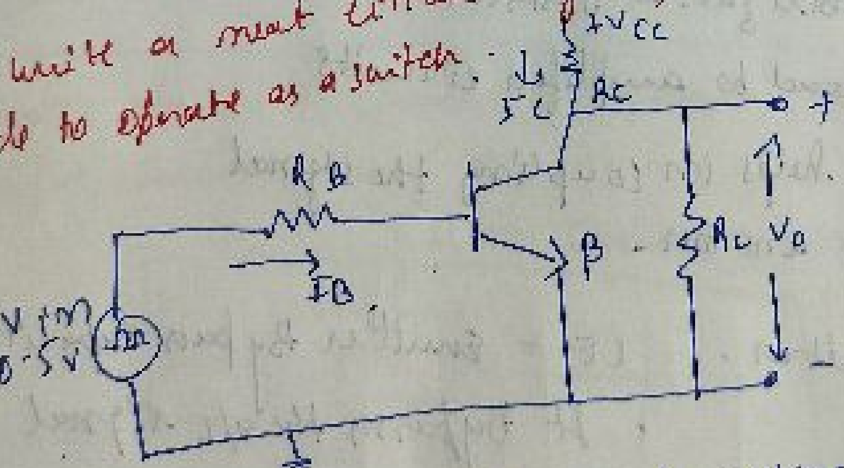
$$\beta = \frac{\alpha}{1-\alpha} = \frac{0.9804}{1-0.9804} \Rightarrow \underline{50.0}$$

now $\beta = \frac{I_C}{I_B}$

$$I_B = \frac{I_C}{\beta} = \frac{2.5 \times 10^{-3}}{50} = 5 \times 10^{-5} = \underline{\underline{0.05mA}}$$

21) Deleted Same as 17

22) Write a neat circuit Diagram, explain How BJT can be made to operate as a switch.



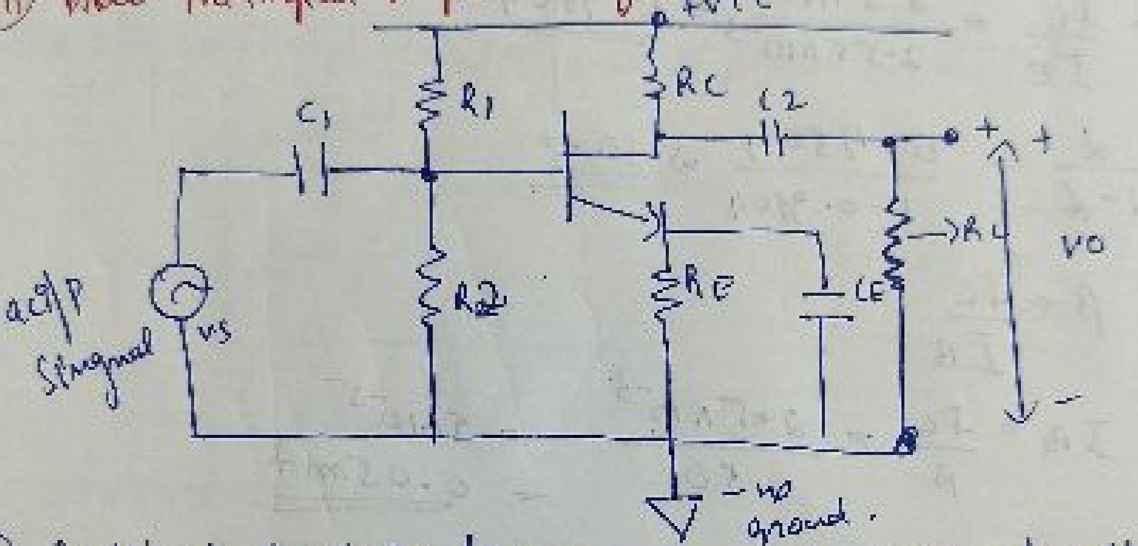
A BJT functions as a switch by transitioning b/w two stats: cut-off and saturation. In the cut off no current flows, while in saturation, the base emitter junction is forward-biased allowing current flow b/w collector and emitter.

23) write a neat circuit diagram of a CE-RC coupled amplifier.

(i) Describe the significance of each component in the circuit

(ii) Illustrate the phase reversal.

(iii) Draw the input output waveforms.



(i) • Resistors R1 & R2 forms voltage divider network for amplifier.

• RE is emitter stabilization resistor.

• RC serves as ac load to amplifier circuits

• capacitors C1 & C2 helps in coupling the signal from one stage to another.

• C1 = Input capacitor.
C2 = output "

CE = Emitter Bypass capacitor.
• It bypass the a/c signal coming out from emitter.

(ii) Phase reversal: when Vin is applied, IB↑ during +ve half cycle. Hence IC = β IB also ↑.

• During -ve half cycle base current ↓, hence collector terminal of transistor curt-ground.

• The O/P voltage is therefore collector to emitter voltage

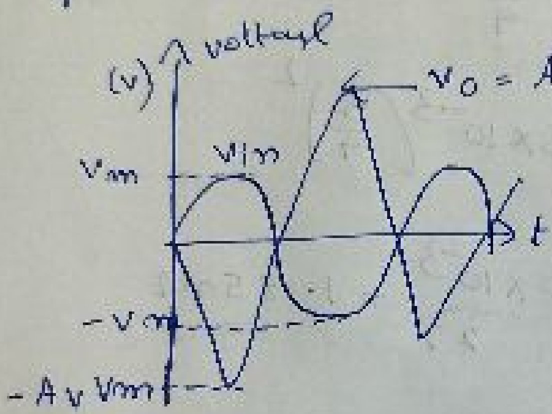
According to dc condition $V_{CE} = V_{CC} - I_C (R_C + R_E)$

• If $I_C \uparrow$, $V_{CE} \downarrow$ & will zero

• When base current $\uparrow$ $I_C \uparrow$ & $V_{CE} \uparrow$

• The O/P voltage is 180° out of phase wrt I/P

(iii)



$$\boxed{A_V = \frac{V_o}{V_{in}}}$$

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(24) ~~DK~~ ~~(25) DK~~ ~~(26) DK~~

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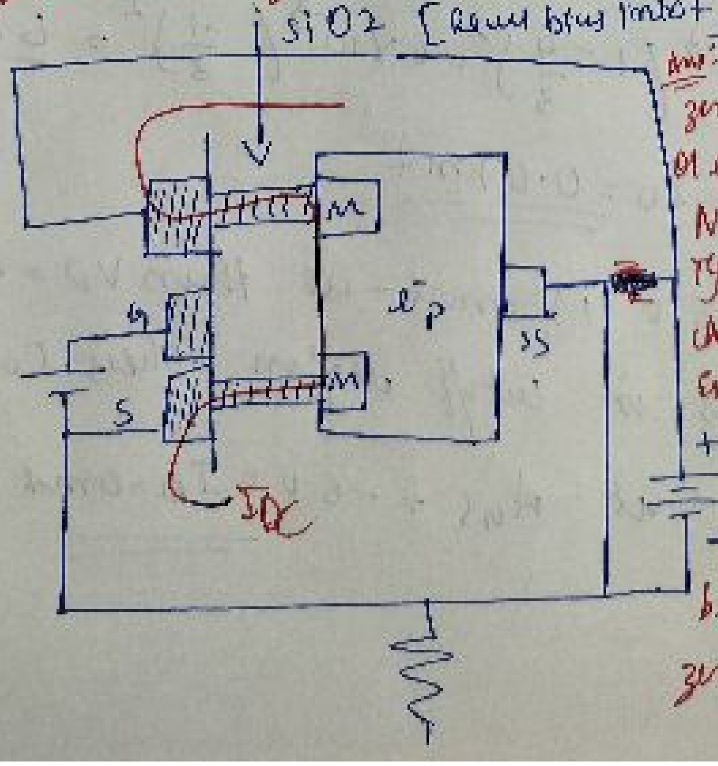
25) write the neat connection diagrams, explain the drain and transfer characteristics of n-channel enhancement type MOSFET



Ans: Drain current will be zero for the VGS is greater or equal to VTH for the N-channel enhancement type mosfet. The transfer characteristics of N-channel enhancement type mosfet is drawn b/w VGS and ID. The transfer characteristics will always be in the region and zero till VGS = VTH.

CMOS Inverter

(2)

CMOS → Complimentary MOS, It uses two MOSFETs 2 E-MOSFETs for its construction

- A p-channel and n-channel E-MOSFETs when placed on the same substrate, it is known as Complementary MOS.

- It has low input impedance, fast switching speeds and less power consumption.
- It is used in computer logic design.

- One n-type MOS (NMOS) and one p-type MOS (PMOS) are connected in pairs to form CMOS.
- Gates of the 2 devices are connected to form input terminals and 2 drain terminals are connected together to form o/p terminal, as shown in figure a) below.

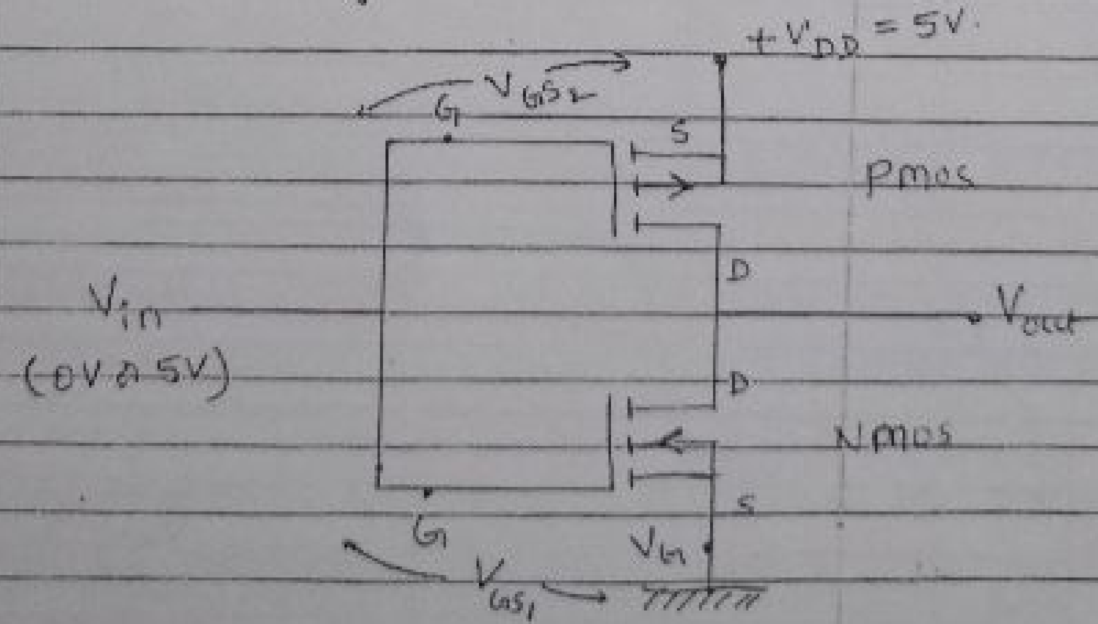


Fig a) CMOS inverter.