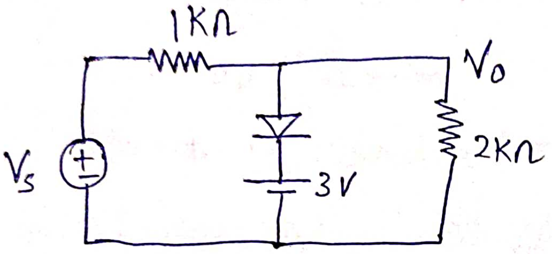
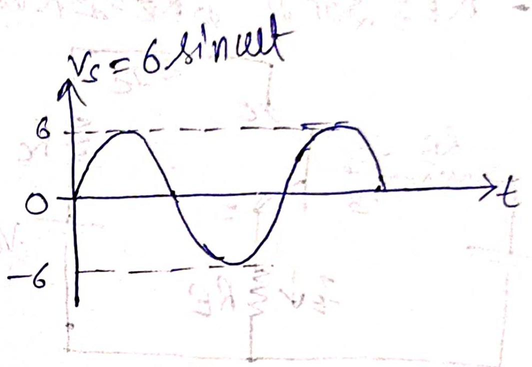
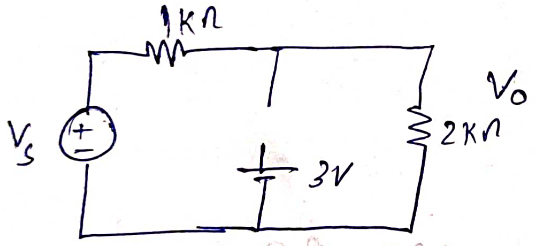
Tutorial(6)

Qus.4)





initially diode OFF so, $(-6V \leq V_s \leq 4.5V)$



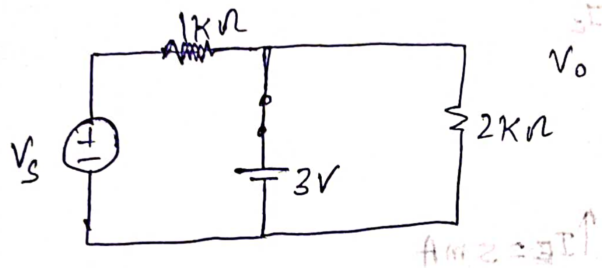
$V_o = \frac{2}{3} V_s \Rightarrow V_o = 4\sin\omega t$

~~diode~~

for diode to be ON when $V_o > 3V$

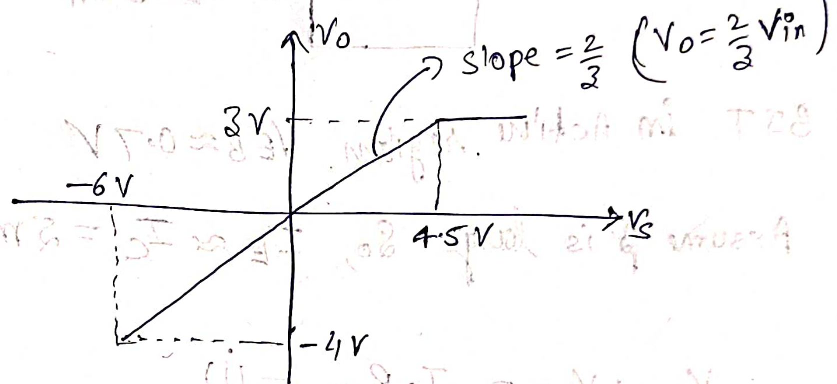
from relation $V_o = \frac{2}{3} V_s$

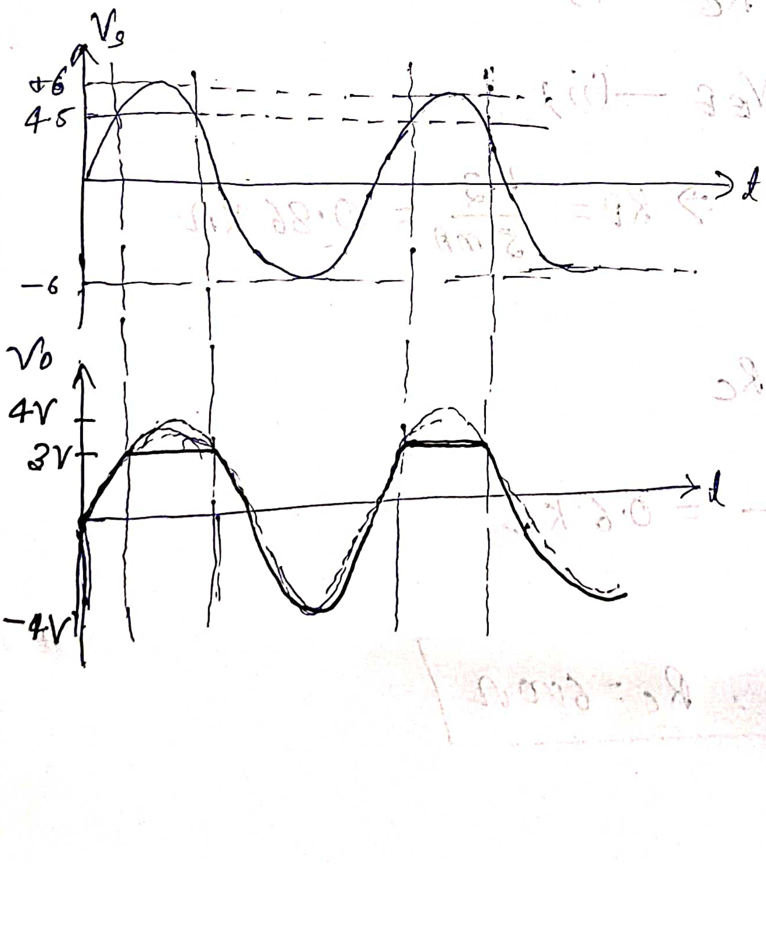
$3 > \frac{2}{3} V_s \Rightarrow V_s > 4.5 V$



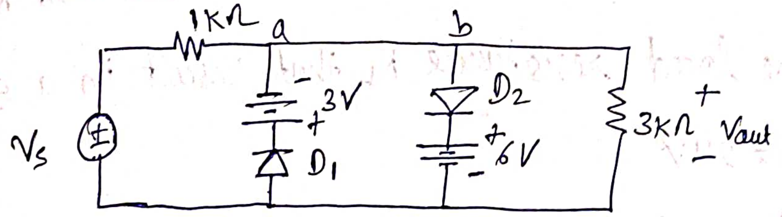
$\Rightarrow \boxed{V_o = 3V}$

Transfer c/s :-





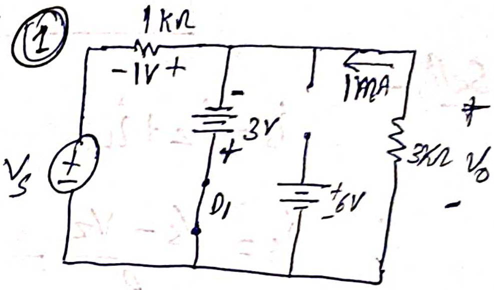
Q1) $V_s = 12 \sin\omega t \; V$, $V_{out} = ?$



Soln:-

Range of input	D_1	D_2	V_{out}
(1) $-12 \leq V_i \leq -4V$	ON	OFF	$-3V$
(2) $-4V \leq V_i \leq 8V$	OFF	OFF	$\frac{3}{4}V_s$
(3) $8V \leq V_i \leq 12V$	OFF	ON	$6V$

(1)



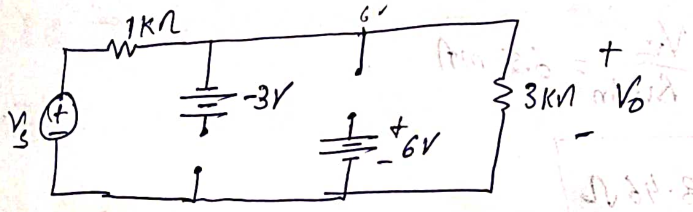
So, $\boxed{V_0 = -3V}$

$I = \frac{V_0}{3k\Omega} = 1mA$

$V_s = -1V + V_0$

$\boxed{V_s = -4V}$

(2)

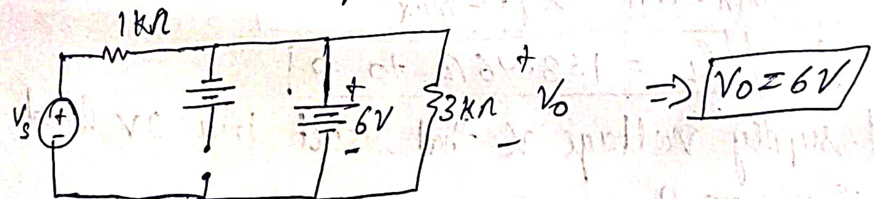


$\boxed{V_0 = \frac{3}{4} V_s}$

if D_2 is going to ON then $V_0 = +6V$ So condition for V_s

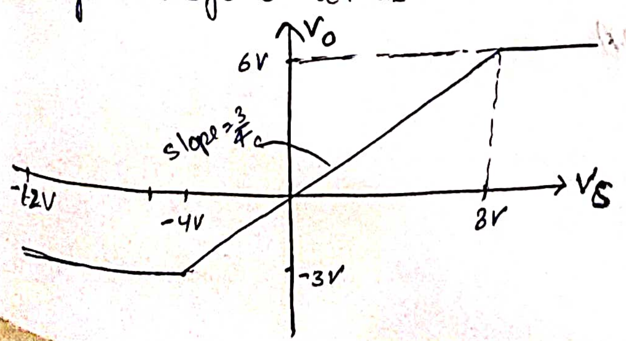
is $\Rightarrow$ $6 = \frac{3}{4} V_s \Rightarrow \boxed{V_s = 8V}$

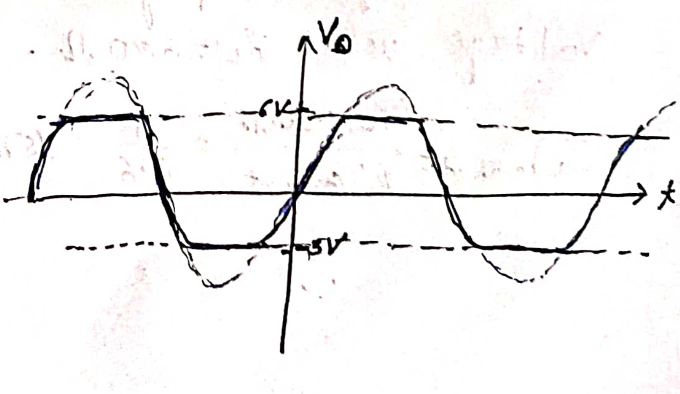
(3)



$\Rightarrow \boxed{V_0 = 6V}$

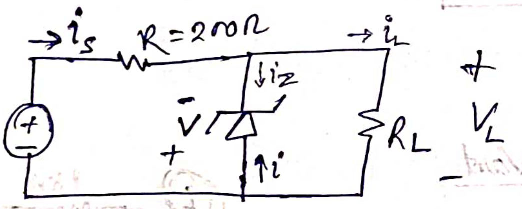
Voltage transfer characteristics (VTC):





Q.2) Break down voltage of zener diode is 9V and operate with a reverse current between 10 and 100 mA. Given that $R = 800\Omega$

(a) Find the range of the load resistance R_L that result in a 9V load voltage when $V_s = 24V$



Sol:-

$i_s = i_z + i_L$

$i_s = \dfrac{V_s - V_z}{R} = \dfrac{24-9}{200} = 75\,mA$

$i_L = \dfrac{V_z}{R_L} = \dfrac{9}{R_L}$

$i_s = i_{z\,min} + i_{L\,max}$

$75mA = 10mA + \dfrac{V_z}{R_{L\,min}} \Rightarrow \dfrac{V_z}{R_{L\,min}} = 65\,mA$

$$\boxed{R_{L\,min} = \frac{9}{65} = 138.46\,\Omega}$$

for $(R_L)_{max}$:-

$i_s = i_{z\,max} + i_{L\,min}$

∵ Supply current is constant = 75 mA and zener can allow current = 100mA

Hence total current will flow through zener diode only.

So, $i_{L\,min} = 0A \Rightarrow \boxed{R_{L\,max} = \infty}$

Range of $\boxed{R_L = 138.46\Omega \text{ to } \infty}$

(b) find the range of supply voltage V_s that result in a 9V load voltage when $R_L = 600\,\Omega$.

$(I_L)_{constant} = \dfrac{(V_L)_{constant}}{(R_L)_{constant}} = \dfrac{9}{0.6} = 15\,mA$

$$\frac{(V_s)_{min} - V_Z}{R} = (I_Z)_{min} + I_L$$

$$\frac{(V_s)_{min} - 9}{0.2} = 10 + 15 = 25$$

$$\Rightarrow \boxed{(V_s)_{min} = 14V}$$

$$\frac{(V_s)_{max} - V_Z}{R} = (I_Z)_{max} + I_L$$

$$\frac{(V_s)_{max} - 9}{0.2} = 100 + 15 = 115$$

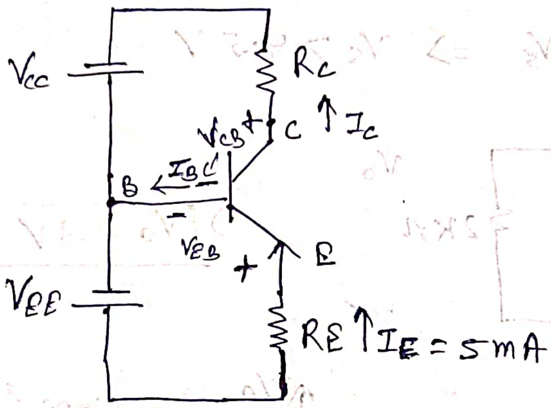
$$\boxed{(V_s)_{max} = 32}$$

range $\boxed{14V \leq V_s \leq 32V}$

Ans.3) Given - $V_{CC} = V_{EE} = 5V$, $I_E = 5mA$, $V_{CB} = -2V$

$R_E, R_C = ?$

Sol^n :-



for BJT in Active region $V_{EB} \approx 0.7V$

Assume β is large So, $I_E \approx I_C = 5mA$

$$V_{CC} + V_{CB} = I_C R_C \quad -(i)$$

$$I_E R_E + V_{EB} = V_{EE} \quad -(ii)$$

$$5mA \times R_E = 5 - 0.7 \Rightarrow R_E = \frac{4.3}{5mA} = 0.86 \, K\Omega$$

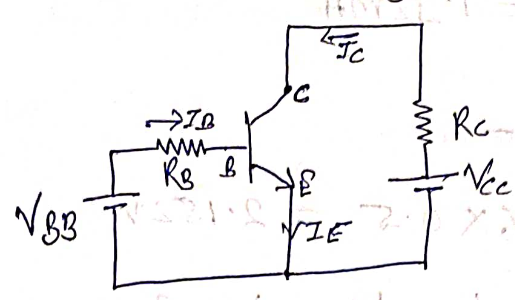
from eq^n (i) -

$$5 - 2 = I_C R_C$$

$$R_C = \frac{3}{5} = 0.6 \, K\Omega$$

So $\boxed{R_E = 860\Omega, \quad R_C = 600\Omega}$

Q.4) Given - $R_B = 270K\Omega$, $V_{BB} = V_{CC} = 6V$, $\beta = 120$



Sol^n/- Assuming BJT to be in active region when $R_C = 3K\Omega$

As B-E Junction is forward bias, we can assume $V_{BE} \approx 0.7V$

$$I_B = \frac{V_{BB} - V_{BE}}{R_B} = \frac{6 - 0.7}{270K} = 0.01963\,mA$$

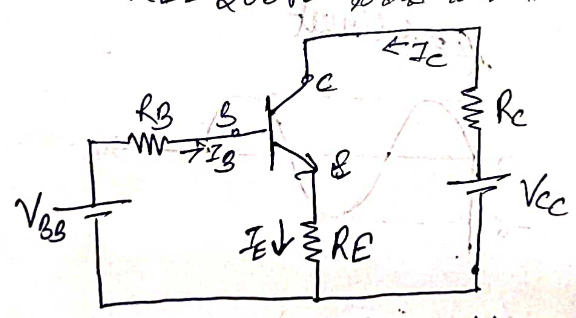
$$I_C = \beta I_B = 120 \times 0.01963 = 2.3556\,mA$$

$$V_{CE} = V_{CC} - I_C R_C = 6 - 2.3556 \times 3 = -1.0668\,V$$

$$V_{BC} = V_{BE} - V_{CE} = 0.7 - (-1.0668) = 1.7668\,V$$

- BC Junction is F.B, hence our assumption is not correct.
- BJT is not in active region, when $R_C = 3K\Omega$.

Q.5) Given - $R_E = 500\Omega$ ~~$R_C = 3K\Omega$~~



(i) Assuming BJT in active region, $V_{BE} = 0.7V$

$$V_{BB} - I_B R_B - 0.7 - I_E R_E = 0$$

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

$$V_{BB} - 0.7 = I_B R_B + (1+\beta) I_B R_E$$

$$I_B = \frac{6 - 0.7}{R_B + (1+\beta) R_E} \approx 0.016\,mA$$

$$I_C = \beta I_B = 120 \times 0.016 = 1.92\,mA$$

$$V_{CE} = V_{CC} - I_C R_C - I_E R_E$$

$$V_{CE} = 6 - 1.92 \times 1.5 - 1.936 \times 0.5 = 2.152\,V$$

* B-E Junction in F.B and BC junction in R.B.
* BJT is operating in active region

(ii) when $R_C = 3\,K\Omega$, and ~~so~~ assuming BJT is operating in active region.

$$V_{CE} = V_{CC} - I_C R_C - I_E R_E = -0.728\,V$$

- Our assumption is wrong
- BJT will ~~op~~ not operating in active region for $R_C = 3\,K\Omega$.