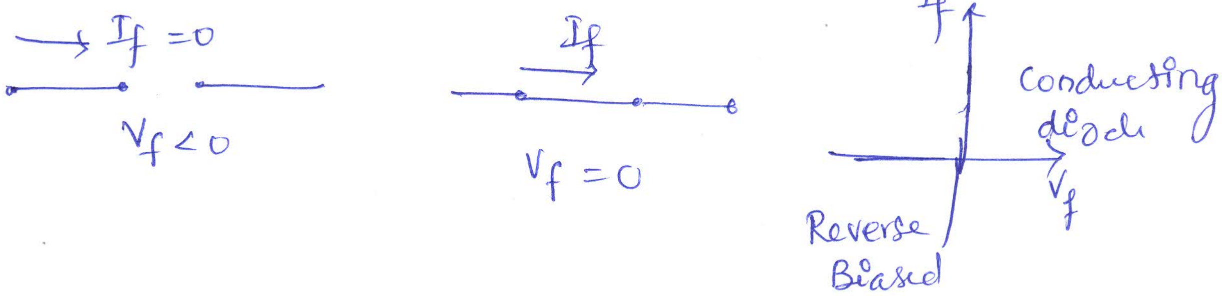
# Solutions for

# Internal Exam I

Q 1. Ideal and piecewise linear approximation model.



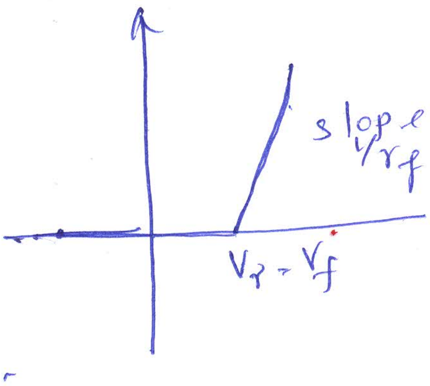

* The drop across the conducting diode is also zero.

* In case of ideal diode, it is assumed that it starts conducting instantaneously when applied voltage $V_f$ is just greater than zero. and hence cut in voltage is zero.

* So conducting diode can be ideally replaced by a short circuit.

* While ideally a reverse biased diode is assumed to be open circuit as the reverse current for an ideal diode is zero.

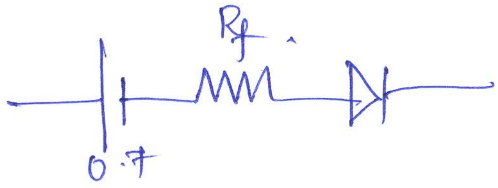
Piecewise linear method.




The approximation of characteristics with the help of pieces of straight lines is called linear piecewise approximation

To obtain this approximation $V_f = V_\gamma$ is marked on a voltage axis and then a straight line is drawn with a slope equal to reciprocal of its dynamic forward resistance.

Thus the approximation consists of two straight line pieces. one horizantal and other with slope $(1/r_f)$ This is shown above.

Equivalent circuit 


Q.1 (B) Ge diode.

$T = 100^\circ C$

$I_S = 16\,\mu A$

$I_F = 60\,mA$. $\eta = 1$

$$I_F = I_S\left(e^{V_f/\eta V_T} - 1\right) \longrightarrow (1)$$

$$V_T = \frac{kT}{q} = \frac{1.38\times10^{-23}\times 373}{1.6\times10^{-19}}$$

$V_T = 0.03217V$.

By substituting in the eq (1)

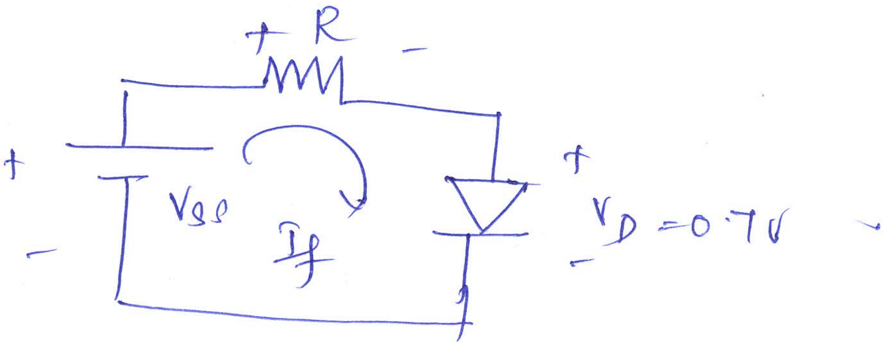
$$60\times10^{-3} = 16\times10^{-6}\left[e^{V_f/1\times0.03217} - 1\right]$$

$$\left[e^{(V_f/32.17\times10^{-3})} - 1\right] = 3750$$

$$e^{\left(V_f / 32.17 \times 10^{-3}\right)} = 3751$$

$$\boxed{V_f = 0.2647V}$$

3.




By applying KVL,

$V_{SS} - I_f R - V_D = 0$

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$$I_f = \frac{20 - 0.7}{10}$$

$$\boxed{I_f = 1.93A}$$

$$\boxed{V_{SS} = V_D = 20V}$$

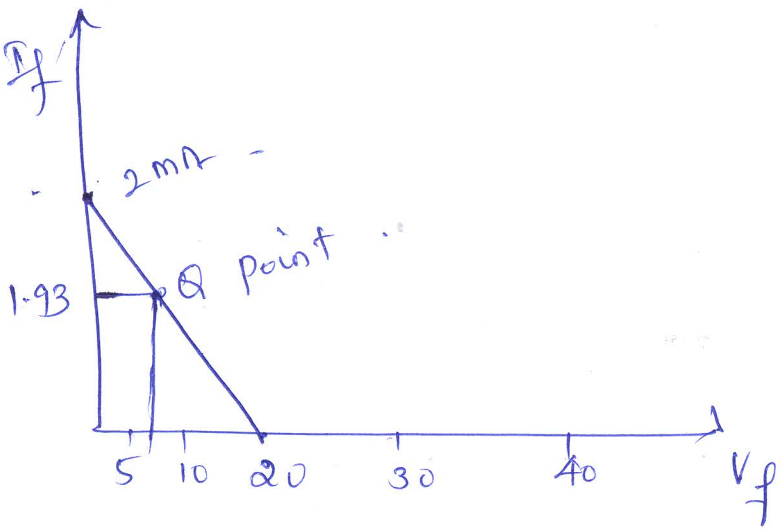
Sub $V_D = 0$

$V_{SS} - I_f R = 0$

$$I_f = \frac{V_{SS}}{R}$$

$$I_f = 20/10$$

$$\boxed{I_f = 2\,mA}$$



4.
(B)

$I_B = 150\,\mu A$.

$I_C = 2.5\,mA$

$\alpha = ?$ $\beta = ?$

$I_E = ?$

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

$$= \frac{2.5 \times 10^{-3}}{150 \times 10^{-6}}$$

$$\boxed{\beta = 16.66}$$

$$\alpha = \frac{\beta}{1+\beta}$$

$$= \frac{16.66}{1 + 16.66}$$

$$\alpha = 0.944$$

$I_E = I_C + I_B$

$I_E = 150 \times 10^{-6} + 25 \times 10^{-3}$

$I_E = 2.65\,mA$

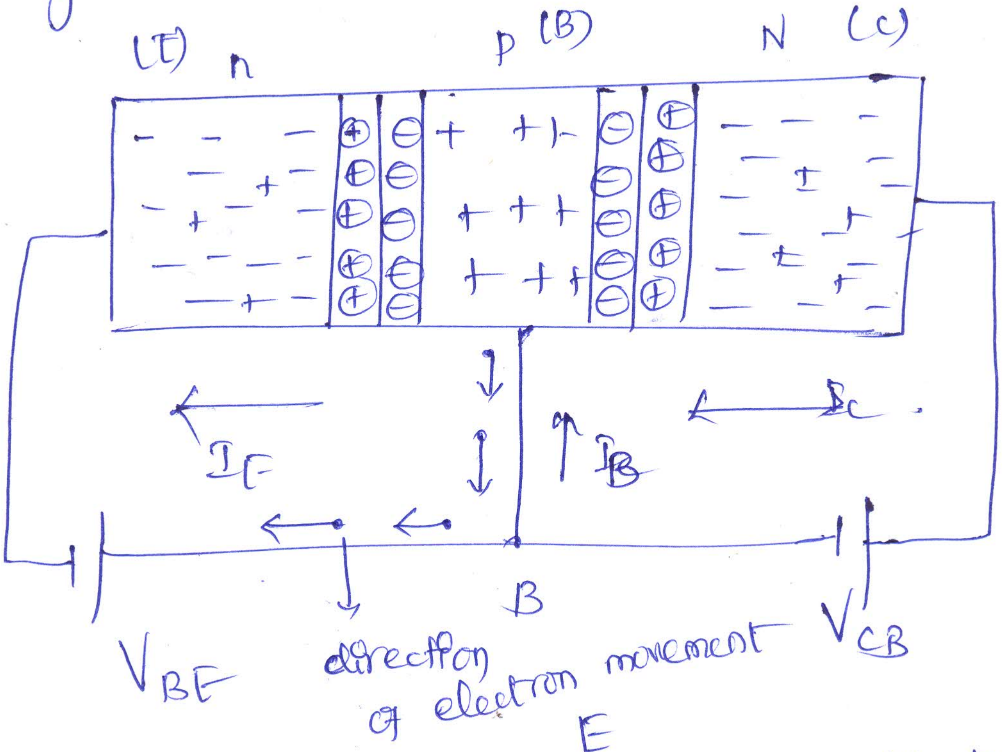
(iii) $I_B$ changed to 25

$I_C = I_C + 10$

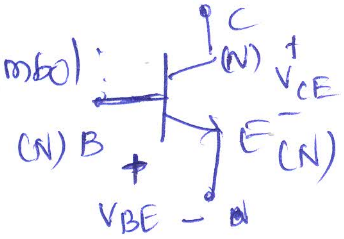
$$\beta = \frac{2.5\,mA + \cancel{25\,mA}^{10mA}}{150\,\mu A + 25\,mA}$$

$$\boxed{\beta = 71.42 \simeq 72}$$

5. Woring of NPN Transistor :




Symbol:




EB jn → F.B

CB jn → R.B.

N — (Emitter) heavily dopped

P (Base) → lightly dopped

N (Collector) → moderately dopped

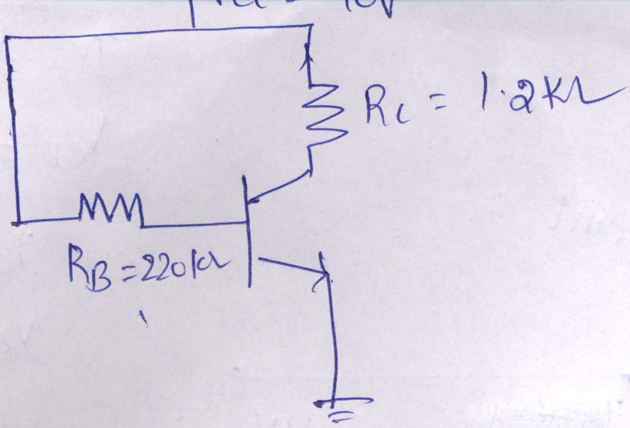
* In NPN transistor, N is of N type and Base of P type and Collector of N type.

* Due to diffussion electrons from Emitter (N) will move twowards Base. Due to the less doping in base, few electrons from emitter recombine with holes present in Base. The maximum electrons from emitter reach collector.

The lack of holes in base will be compansated by the holes supplied by the battery.

Thus $I_E = I_B + I_C$.

6.




By applying KVL to the input loop.

$$V_{CC} - R_B I_B - V_{BE} = 0$$

$$I_B = \frac{V_{CC} - V_{BE}}{R_B} \Rightarrow 4.22 \times 10^{-5} A.$$

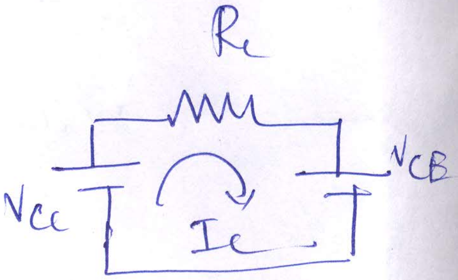
$$I_C = \beta I_B$$

$$I_C = 50 \times 4.22 \times 10^{-5}$$

$$I_C = 2.11 \times 10^{-3}$$

$$\boxed{I_C = 2.11 mA}$$

By applying KVL to o/p loop,




$$V_{CC} - I_C R_C - V_{CE} = 0$$

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

$$\boxed{V_{CC} = 7.468V}$$

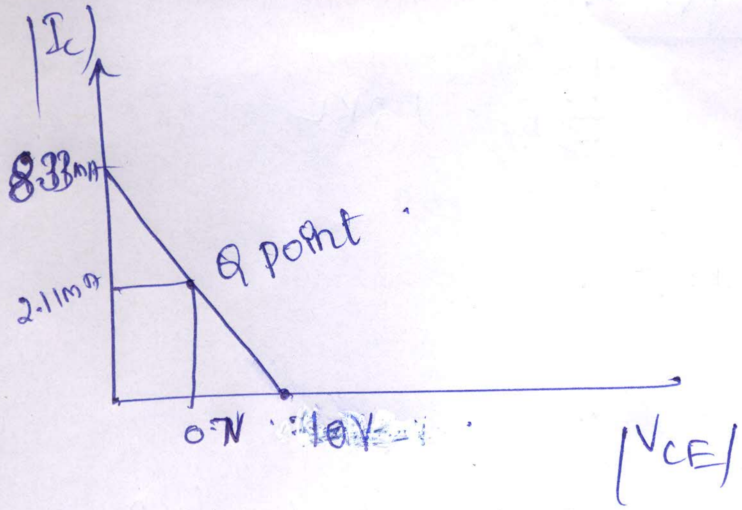
$$V_{CE} = V_C - V_E$$

$$V_{CE} = V_C = 7.468V \quad \because V_E = 0.$$

$$V_{BE} = V_B - V_E$$

$$V_{BE} = V_B = 0.7V$$

$$=$$




Dc load line

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

sup. $I_C = 0$

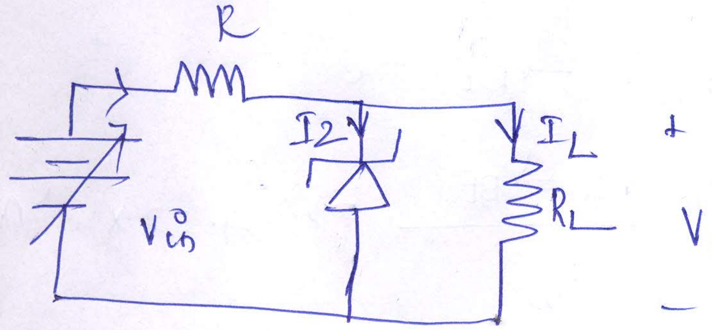
$V_{CC} = V_{CE} = 10V$.

$I_C = \frac{V_{CE}}{R_C}$

$= 2.11mA$

Q2.

(B)




$R_L = 1K\Omega \quad V_Z = 6.1V$.

$I_L = \frac{V_Z}{R_L} = \frac{6.1}{1\times10^3} = 2.5mA.$

$I = I_{Zmin} + = 2.5mA$.

$I = I_{Zmin} + I_L = 2.5 + 6.1 = 8.6mA$

$V_{in(min)} = V_Z + IR = 6.1 + (8.6\times10^{-3} \times 2.2\times10^{3})$

$= 25.02V$.

$V_{in(max)}, I_Z = I_{Zmax} = 25mA$.

$I = I_{Zmax} + I_L$

$= 25 + 6.1 = 31.1mA$.

$V_{in(max)} = V_Z + IR = 6.1 + (31.1\times10^{-3} \times 2.2\times10^{3})$

$= 74.52V$

$\therefore$ The range of input that can be varied is 25.02V to 74.52V for which output is constant.