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End Sem Exam: Basic Electronic Circuit

1. Given $R_f = 120\,\Omega$
peak to peak of input sine wave = 24 V

$\therefore$ peak input voltage $V_m = 12$ V

and $R_L = 1.76\,K\Omega$
V_c, cut in voltage for Si = 0.7 V

(i) $\therefore$ DC output voltage $= \dfrac{2(V_m - 2V_c) \times R_L}{\pi(R_s + 2R_f + R_L)}$

$$= \frac{2(12-1.4) \times 1760\,\Omega}{\pi(240\,\Omega + 1760\,\Omega)}$$

$$\boxed{\text{dc output voltage} = 5.94\text{ V}}$$

(ii) rms output voltage $= \dfrac{I_m R_L}{\sqrt{2}}$

$$= \frac{(V_m - 2V_c) \times R_L}{\sqrt{2}(R_s + 2R_f + R_L)}$$

$$= \frac{(12-1.4) \times 1760\,\Omega}{\sqrt{2}(240\,\Omega + 1760\,\Omega)}$$

$$= 6.59\text{ V}$$

(iii) rectification efficien $\eta = \dfrac{81.2\%}{\left(1 + \frac{R_s}{R_L} + \frac{2R_f}{R_L}\right)}$

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$$\eta = \frac{81.2\%}{\left(1 + \frac{240}{1760}\right)}$$

$$\eta = 71.456\%$$

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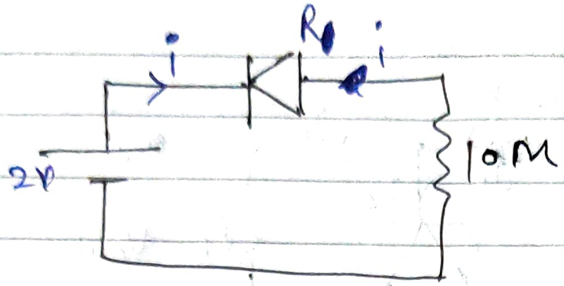
(2)



the diode is reverse biased
Let resistance of the diode be R.
given reverse saturation current = 100nA.

$$\therefore \quad i = 100\,nA$$

$$2 - iR - i(10M) = 0$$

$$(R + 10M) = \frac{2}{100n\,A}$$

$$R + 10^7 = 2 \times 10^7$$

$$\boxed{R = 10^7\ \Omega}$$ Answer

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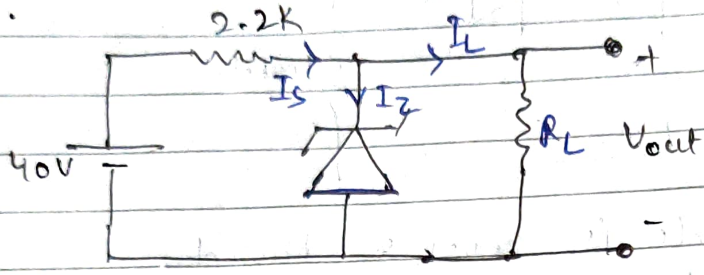
3.



Given $V_Z = 8V$

$I_{Z(min)} = 500\ \mu A = 0.5 mA$

$I_{Z(max)} = 12 mA$

Voltage across zener diode = 8 V

$\therefore \quad I_S = \dfrac{40-8}{2.2K} = 14.545 mA$

~~and~~

Using KVL,

$I_S = I_Z + I_L$

The maximum current through load resistor is

$I_{L(max)} = I_S - I_{Z(min)}$

$= 14.545 mA - 0.5 mA$

$= 14.045 mA$

and minimum current through load resistor is

$I_{L(min)} = I_S - I_{Z(max)}$

$= 14.545 mA - 12 mA$

$= 2.545 mA$

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Since, $I_L = \frac{V_Z}{R_L} \Rightarrow R_L = \frac{V_Z}{I_L}$

$\therefore R_{L(min)} = \frac{V_Z}{I_{L(max)}} = \frac{8}{14.045\,mA}$

$= 569.59\,\Omega$

and $R_{L(max)} = \frac{V_Z}{I_{L(min)}} = \frac{8}{2.545\,mA}$

$= 3.143\,k\Omega$

Hence, the range of load resistor so that the zener diode operates in breakdown region is $569.59\,\Omega$ to $3.143\,k\Omega$.

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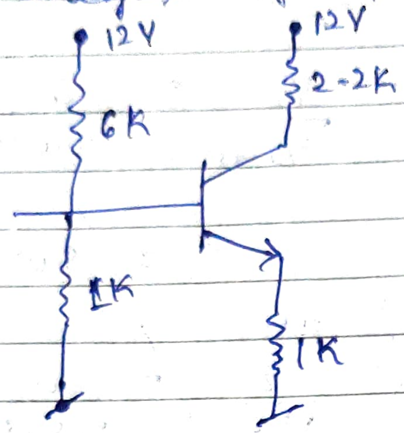
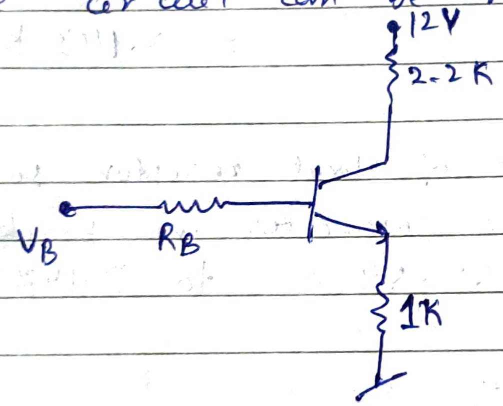
4.

(i) DC analysis of first stage

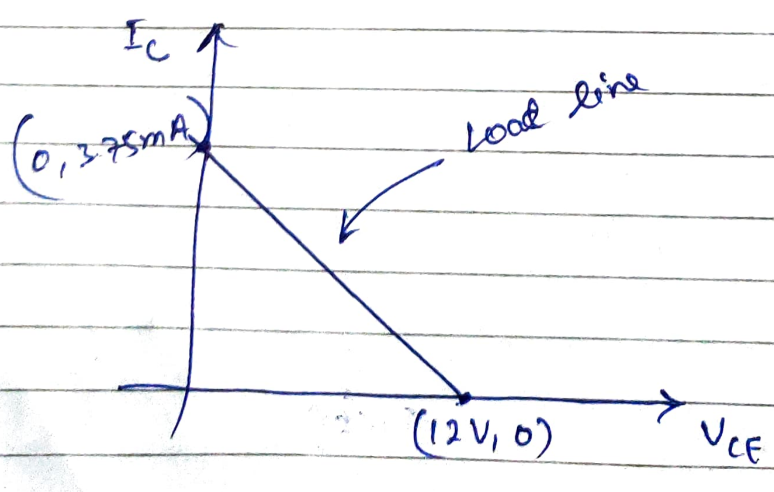


The circuit can be redrawn as



$$V_B = \frac{12 \times 1K}{1K + 6K} = \frac{12}{7} V$$

$$R_B = (1K \parallel 6K) = \frac{6}{7} K\Omega$$



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In the circuit if $V_{CE} = 0$,

$$I_C = \frac{12}{3.2K} = 3.75\,mA$$

and if $I_C = 0$,

$$V_{CE} = 12\,V$$

Hence, load line is shown in figure.

(ii) Using KVL in base-emitter circuit,

$$V_B - I_B R_B - V_{BE} - I_E R_E = 0$$

$$I_B = \frac{\frac{12}{7} - \frac{7}{10}}{\frac{6}{7}K + (101)(1K)}$$

$$I_B = \frac{1.014}{101.85K} = 0.00995\,mA$$

$$\therefore I_C = 0.995\,mA$$
$$I_E = 1.0049\,mA$$

$$\therefore V_C = 12 - (2.2K)(0.995\,mA)$$
$$= 9.811\,V$$

$$V_E = (1K)(1.0049\,mA) = 1.0049\,V$$

$$V_B = \frac{12}{7} - (0.00995)\left(\frac{6}{7}K\right)$$
$$= 1.7057\,V$$

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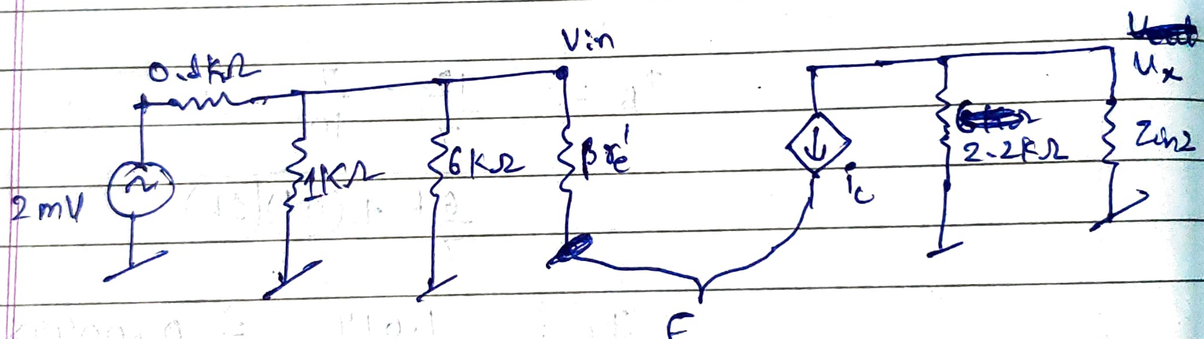
Clearly, ~~diode~~ transistor is in active region.

and Q point is (V_{CE}, I_C)

$$V_{CE} = 9.811 - 1.0049$$
$$= 8.8061 \text{ V}$$

$\therefore$ Q point is $(8.8061\text{ V}, 0.995\text{ mA})$

(iii) Using AC analysis and π model of transistor the circuit can be redrawn as



~~Input resistance~~

$$\beta r_e' = \frac{\beta \eta V_T}{I_E} = 5174.6\ \Omega$$

$\therefore$ Input impedance for stage 1.

$$Z_{in1} = (1\text{ k}\Omega) \parallel (6\text{ k}\Omega) \parallel (5.174\text{ k}\Omega)$$

$$= 0.73\text{ k}\Omega$$

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(iv) $A_V = \frac{R_C \parallel Z_{in2}}{r_e'}$

$Z_{in2} = (6K\Omega) \parallel (1K\Omega) \parallel (\beta r_e')$

$= 0.73\ K\Omega$

$\therefore A_V = \frac{(2.2K) \parallel (0.73K)}{51.746}$

$A_V = \frac{0.5482K}{51.764}$

$A_V = 10.59$

$\therefore$ for first stage $A_V = 10.59$

RW.

0.4545

+ 1.3698

1.824

(v) voltage ~~at~~ input $(V_{in}) = \frac{2mV \times (Z_{in})_1}{(Z_{in})_1 + R_B}$

$= 0.948V$

$\therefore V_x = 10.59 \times 0.948$

~~= 10.039~~

$= 10.039\ V$

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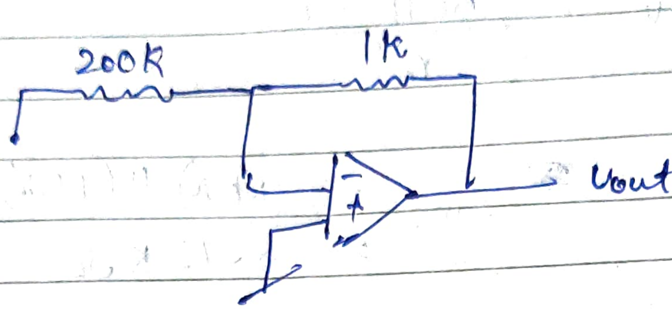
5.



$A_{ol} = 2 \times 10^5$

For non ideal Op Amp

$R_2 = 1K$

$R_1 = 200K$

$$G = \frac{V_{out}}{V_{in}} = \frac{-R_2/R_1}{1 + \left[\left(1 + \frac{R_2}{R_1}\right)/A\right]}$$

$$= \frac{\frac{-1K}{200K}}{1 + \left(\left(1 + \frac{1K}{200K}\right)/2 \times 10^5\right)}$$

$$= \frac{5 \times 10^{-3}}{1 + (5.025 \times 10^{-6})}$$

$$= 4.999 \times 10^{-3}$$

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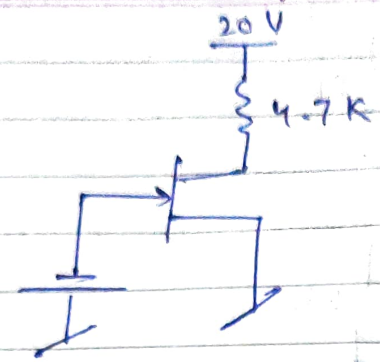
1.



The drain current,

$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$

$$I_D = (10\,mA)\left(1 - \frac{2}{4}\right)^2$$

$$I_D = 2.5\,mA$$

and $V_D = 20 - (4.7K)(2.5mA)$

$= 8.25\,V$