NORTH SOUTH UNIVERSITY

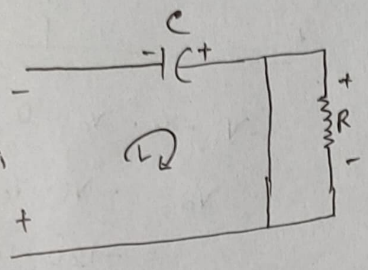
Department of Electrical and Computer Engineering

Assignment – 01

Name	: Joy Kumar Ghosh
Student ID	: 2211424 6 42
Course No.	: EEE 111
Course Title	: Analog Electronics
Section	: 11
Date	: 09 November 2023

Ans. to the ques. no.01

a)

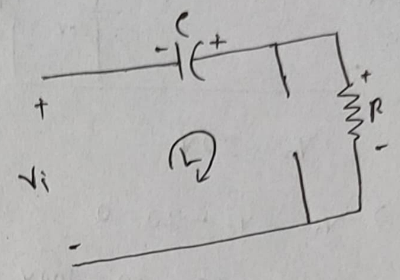


$V_o = 0$

KVL,

$-V_i + V_c = 0$

$\therefore V_c = V_i = 120V$

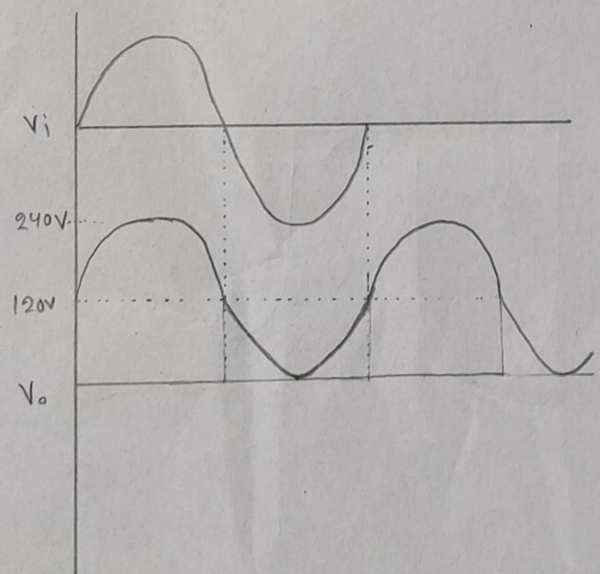


KVL,

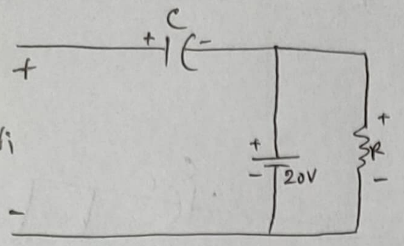
$V_i + V_c - V_o = 0$

$V_o = V_i + V_c$

$= 240V$



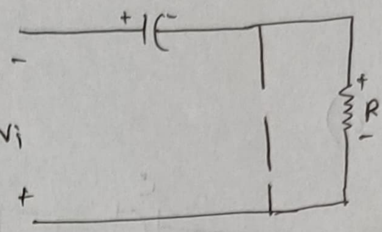
b)



$V_o = 20V$

$\Rightarrow V_i - V_c - 20 = 0$

$\Rightarrow V_c = 120 - 20 = 100V$

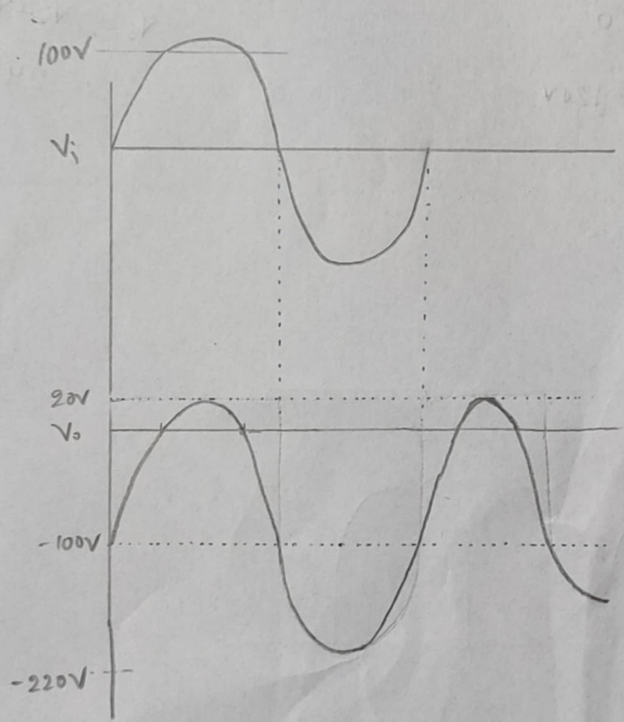


$-V_i - V_c - V_o = 0$

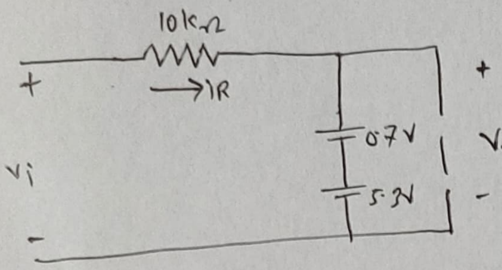
$V_o = -V_i - V_c$

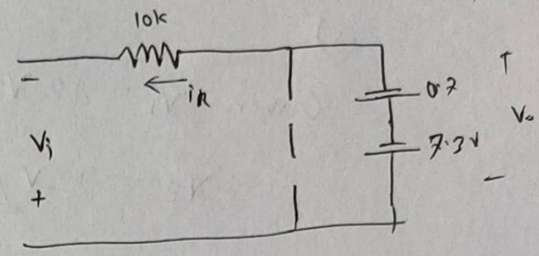
$= -120 - 100$

$= -220V$



Ans. to the ques. no. 02

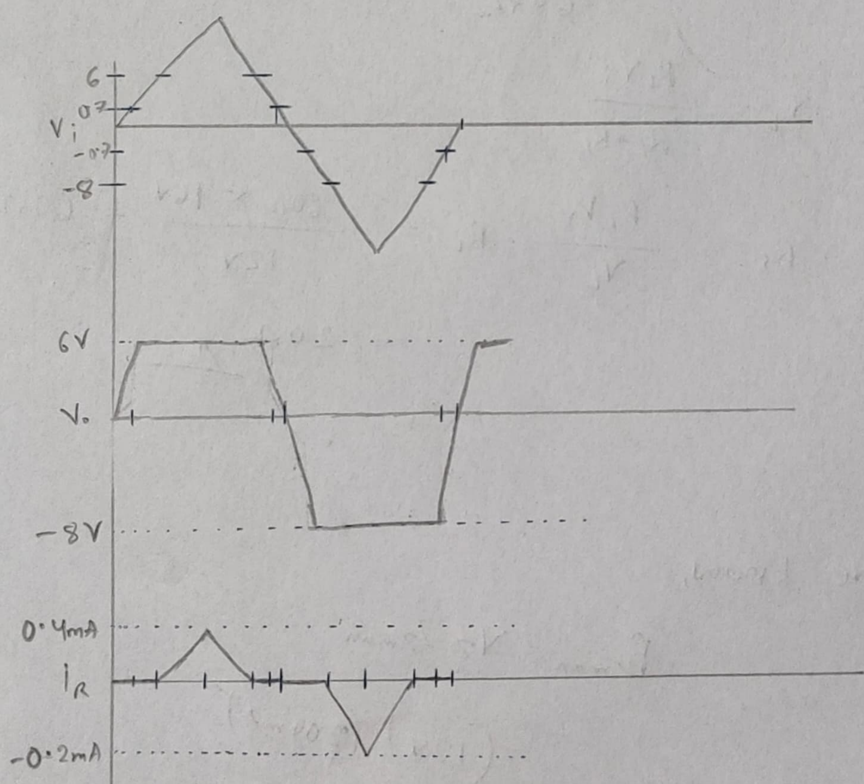




$V_o = 8V$

$V_o = (5.3 + 0.7)V$

$= 6V$



Ans. to the ques. no. 03

a)

Given $V_L = 12\,V$

$\therefore V_Z = 12V$ Ans

We know,

$$R_L = \frac{V_L}{I_L} \quad \Big| \text{ where } I_L = 200\,mA$$

$$= \frac{12V}{200mA}$$

$$= 60\Omega$$

Again $V_L = \dfrac{R_L V_i}{R_L + R_s}$

$$\therefore R_s = \frac{R_L V_i}{V_L} - R_L = \frac{60\Omega \times 16V}{12V} - 60\Omega$$

$$= 20\Omega$$ Ans

b)

We know,

$$P_{Zmax} = V_Z I_{Zmax}$$

$$= (12V)(200mA)$$

$$= 2.4\,W$$

Ans

Ans. to the ques. no. 04

a)

Given,

$\alpha_{dc} = 0.980$

We know,

$$\beta_{dc} = \frac{\alpha_{dc}}{1-\alpha_{dc}} = \frac{0.980}{1-0.980}$$

$$= 49$$

Therefore, $\beta_{dc} = 49$.

b)

Given,

$\beta_{dc} = 120$

We know,

$$\alpha_{dc} = \frac{\beta_{dc}}{1+\beta_{dc}} = \frac{120}{1+120}$$

$$= 0.9917$$

Therefore, $\alpha = 0.9917$.

c)

Given,

$\beta_{dc} = 120$

$I_c = 2.0 \text{ mA}$

We know,

$I_c = \beta_{dc} \times I_B$

$\therefore I_B = \frac{I_c}{\beta_{dc}} = \frac{2 \text{ mA}}{120}$

$= 16.67 \ \mu A$

Again,

$I_E = I_c + I_B$

$= 2 \text{mA} + 16.67 \ \mu A$

$= 2.01667 \text{ mA}$

Therefore,

$I_E = 2.0167 \text{ mA}$

$I_B = 16.67 \ \mu A$

Ans. to the ques. no. 05

a)

From the given circuit, we can say that,

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

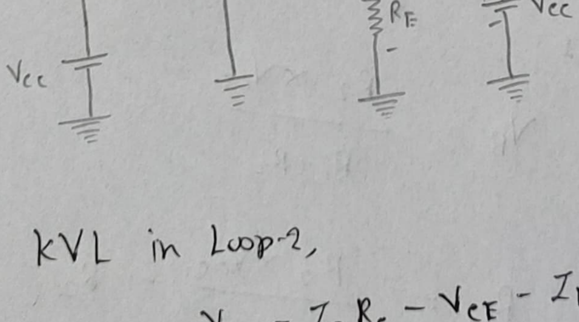
Where,
$V_C = 12V$
$V_{CC} = 18V$
$R_C = 4.7 \, k\Omega$

$$\therefore I_C = \frac{V_{CC} - V_C}{R_C}$$

$$= \frac{(18-12)V}{4.7 \, k\Omega}$$

$$= 1.2766 \, mA$$

b)



Applying KVL in Loop-2,

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

$$\Rightarrow V_{CC} - I_C R_C - I_C R_E = V_{CE} = V_C - V_E \quad [\because I_C \cong I_E]$$

$$\Rightarrow V_E = V_C - V_{CC} + I_C R_C + I_C R_E$$

$$\therefore V_E = 12V - 18V + 6V + 1.2766mA \times 1.2k\Omega$$

$$= 1.5319 V$$

Therefore, $V_E = 1.5319 V$

c)

We know,

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

$$\therefore V_B = V_{BE} + V_E$$

$$= 0.7V + 1.5319 V$$

$$= 2.2319 V$$

Therefore, $V_B = 2.2319 V$

d)

We know that,

$$V_B = \frac{R_2 \times V_{CC}}{R_1 + R_2}$$

$$\therefore R_1 = \frac{R_2 \times V_{CC}}{V_B} - R_2$$

$$= \frac{5.6k\Omega \times 18V}{2.2319 V} - 5.6k\Omega$$

$$= 39.56 k\Omega$$ Ans

Ans. to the ques. no. 06

a)

We know,

$$I_B = \frac{V_{CC} - V_{BE}}{R_B + \beta(R_C + R_E)}$$

Where,

$V_{CC} = 16\,V$

$V_{BE} = 0.7\,V$

$R_B = 270\,k\Omega$

$R_C = 3.6\,k\Omega$

$R_E = 1.2\,k\Omega$

$\beta = 120$

$$= \frac{16\,V - 0.7\,V}{270\,k\Omega + 120(3.6\,k\Omega + 1.2\,k\Omega)}$$

$$= 18.0851\ \mu A$$

Therefore,

$$I_B = 18.0851\ \mu A$$

b)

We know,

$$I_C = \beta I_B$$

$$= 120 \times 18.0851\ \mu A$$

$$= 2.1702\ mA$$

Therefore, $I_C = 2.1702\ mA$.

c)

According to circuit, we can write that,

$$V_c = V_{cc} - V_{Rc}$$

$$= V_{cc} - I_{Rc} \times R_c$$

$$= V_{cc} - (I_B + I_c) \times R_c \quad [KCL]$$

$$= 16V - (2.1702\,mA + 18.0851\,\mu A) \times 3.6\,k\Omega$$

$$= 8.1222\,V$$

Therefore,

$$V_c = 8.1222\,V.$$

Ans. to the ques. no. 07

a)

We know,

$$r_e = \frac{26\,mV}{I_E}$$

Now,

$$V_B = \frac{R_2 \times V_{cc}}{R_1 + R_2} = \frac{4.7\,k\Omega \times 16V}{39\,k\Omega + 4.7\,k\Omega}$$

$$= 1.72V$$

Again,

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

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

$$= 1.72V - 0.7V$$

$$= 1.02V$$

$$\therefore I_E = \frac{V_E}{R_E} = \frac{1.02V}{1.2k\Omega}$$

$$= 0.85\ mA$$

Therefore,

$$r_e = \frac{26mV}{0.85mA}$$

$$= 30.59\,\Omega \quad \underline{A}$$

b)

We know,

$$Z_i = R_1 \parallel R_2 \parallel \beta r_e$$

$$= \left(\frac{1}{39k\Omega} + \frac{1}{4.7k\Omega} + \frac{1}{100 \times 30.59\,\Omega} \right)^{-1}$$

$$= 1.77\ k\Omega$$

From the circuit,

$$Z_o = R_c \parallel r_o$$

Since, $R_c << r_o$

we can write, $Z_o \cong R_c = 3.9\ k\Omega$

Therefore,

$$Z_i = 1.77\ k\Omega$$

$$Z_o = 3.9\ k\Omega$$

c)

We know, $A_v = -\dfrac{Z_o}{r_e} = -\dfrac{3.9k\Omega}{30.59\Omega}$

$= -127.49$

Therefore,

$$A_v = -127.49$$

d)

As Z_i not dependent on r_o,

$$\therefore Z_i = 1.77\ k\Omega$$

Now,

$$Z_o = R_c \parallel r_o \qquad \Big| \text{ where, } r_o = 25\ k\Omega$$

$$= \left(\frac{1}{3.9k\Omega} + \frac{1}{25\ k\Omega} \right)^{-1}$$

$$= 3.37\ k\Omega$$

Then,

$$A_v = -\frac{Z_o}{r_e} = -\frac{3.37\ k\Omega}{30.59\ \Omega}$$

$$= -110.29$$

Therefore,

$$Z_i = 1.77\ k\Omega$$

$$Z_o = 3.37\ k\Omega$$

$$A_v = -110.29$$

Ans. to the ques no. 08

a)

We know,

$$I_E = \frac{V_{EE} - V_{BE}}{R_E}$$

$$= \frac{6V - 0.7V}{6.8\,k\Omega}$$

$$= 0.779\ mA$$

Therefore,

$$r_e = \frac{26\,mV}{0.779\,mA}$$

$$= 33.38\,\Omega$$

b)

We know,

$$Z_i = R_E \parallel r_e$$

$$= \left(\frac{1}{6.8\,k\Omega} + \frac{1}{33.38\,\Omega}\right)^{-1}$$

$$= 33.22\,\Omega \quad \underline{A}$$

And, $Z_o = R_C = 4.7\,k\Omega$ $\underline{A}$

~~Then~~

c)

We know,

$$A_v = \frac{\alpha R_C}{r_e}$$

$$= \frac{(0.998)(4.7k\Omega)}{33.38\Omega}$$

$$= 140.52$$

Therefore,

$$A_v = 140.52$$

Ans. to the ques. no. 10

a)

We know,

$$V_B = \frac{R_2 V_{CC}}{R_1 + R_2} = \frac{(8.2k\Omega)(20V)}{(8.2k\Omega + \cancel{56}56k\Omega)}$$

$$= 2.55V$$

Again,

$$I_E = \frac{V_E}{R_E} = \frac{V_B - V_{BE}}{R_E} = \frac{2.55V - 0.7V}{2k\Omega}$$

$$= 0.925 mA$$

Therefore,

$$I_B = \frac{I_E}{\beta + 1} = \frac{0.925\ mA}{200+1}$$

$$= 4.60\ \mu A$$

A

And, $I_c = \beta I_B$

$$= 200 \times 4.60\ \mu A$$

$$= 0.92\ mA$$

A

b)

We know,

$$r_e = \frac{26mV}{I_E} = \frac{26mA}{0.925mA}$$

$$= 28.11\ \Omega$$

A

c)

We know,

$$Z_i = R_B \parallel Z_b$$

And,

$$Z_b = \beta r_e + (\beta+1) R_E$$

$$= (200 \times 28.11\Omega) + (200+1)\ 2k\Omega$$

$$= 407.62\ k\Omega$$

Therefore

$$Z_i = (R_1 \parallel R_2) \parallel Z_b$$

$$= \left(\frac{1}{56k\Omega} + \frac{1}{8.2k\Omega} + \frac{1}{407.62k\Omega} \right)^{-1}$$

$$= 7.029\ k\Omega$$ Ans

And,

$$Z_o = R_e \parallel r_e$$

$$= \left(\frac{1}{2k\Omega} + \frac{1}{28.11\ \Omega} \right)^{-1}$$

$$= 27.72\ \Omega$$ Ans

d)

We know,

$$A_v = \frac{R_E}{R_E + r_e}$$

$$= \frac{2k\Omega}{2k\Omega + 28.11\Omega}$$

$$= 0.986$$ Ans

Ans. to the ques. no. 09

a)

IG is effectively 0A in a JFET due to its unique operation: The gate-source junction is reverse-biased, creating a depletion region that prevents current flow. As the gate-source voltage is adjusted, the width of this region changes. When the voltage surpasses a certain threshold, the depletion region blocks current entirely, making IG practically 0 A.

b)

The input impedence of a JFET is extremely high due to its reverse-bias gate-source junction. This reverse bias creates a depletion region around the gate, effectively narrowing the channel between the source and drain. As a result, it becomes very difficult for minority carries to flow through the channel, resulting in a negligible gate current and a very high input impedence.

c)

The term "field effect transistor" (FET) is appropriate for this three-terminal device because the current flowing between its terminals is controlled by an electric field generated by the voltage applied to the gate terminal. This electric field, rather than an ~~extra~~ external current, modulates the conductivity of the channel between the source and drain terminals, hence the name "field effect."