Tutorial problems

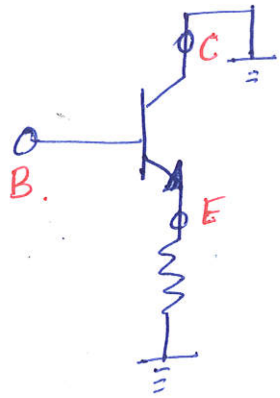
Chapter #3.

1. An Input Voltage of 2 V_{rms} [Measured from base to ground] is applied to the circuit below. Assuming that the emitter Voltage follows the base Voltage exactly and that V_{BE} (rms) = 0.1 V, calculate the circuit Voltage amplification [$A_v = V_o/V_i$] and Emitter current for $R_E = 1 K\Omega$

to find

$A_v = ?$

$I_E = ?$



Solutions

Using KVL

$V_B - V_{BE} - V_E = 0$

$2 - 0.1 - I_E R_E = 0$

$\boxed{I_E = 1.9/1000 = 1.9\,mA}$

$V_E = I_B R_E$

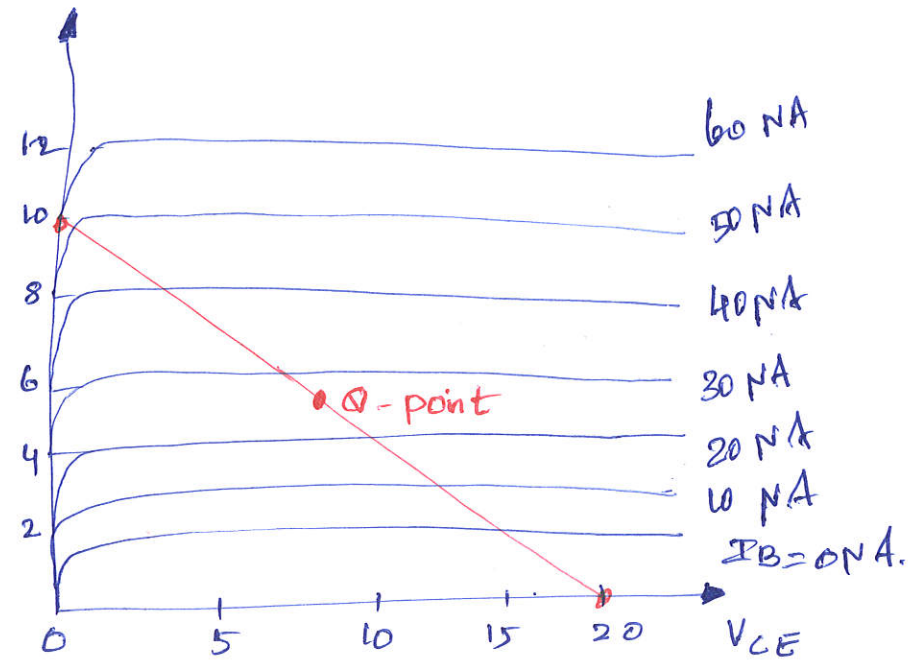
$V_E = [1.9\,mA][1000]$

$\boxed{V_E = 1.9\,V}$

$V_o = V_E$

$\boxed{A_v = \alpha = 1.9/2 = 0.95}$

(2) Given the load line below and the defined Q-point, determine the Required values of V_{cc}, R_C and R_B for a fixed bias congigrations.



from above load charateristics.

$$V_{CE} = V_{CC} = 20V \text{ at } I_C = 0mA$$

$$I_C = \frac{V_{CC}}{R_C} \text{ at } V_{CE} = 0V$$

$$R_C = \frac{V_{CC}}{I_C} = \frac{20V}{10mA} = 2k\Omega$$

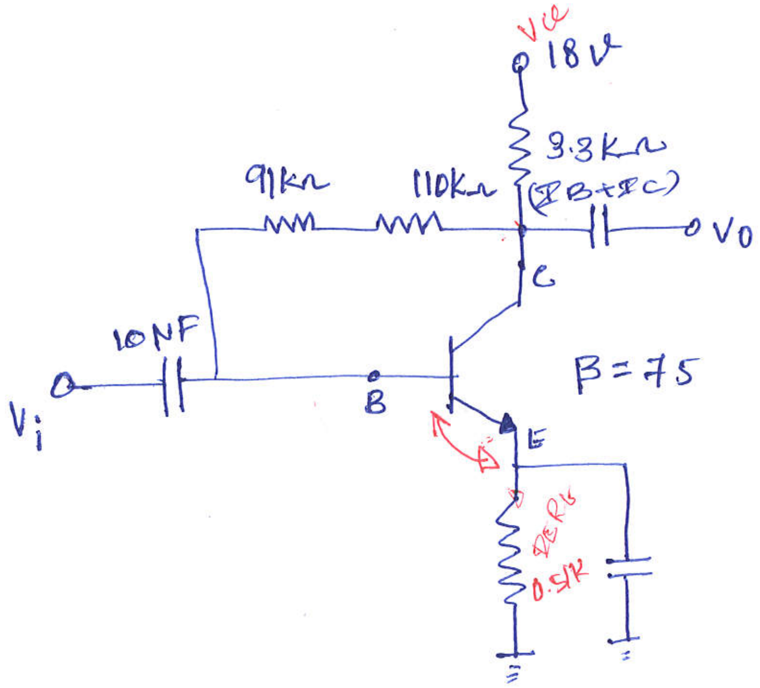
$$I_B = \frac{V_{CC} - V_{BE}}{R_B}$$

$$R_B = V_{CC} - V_{BE} / I_B = \frac{20V - 0.7V}{25\mu A} = 772k\Omega.$$

Solutions

$$\boxed{\begin{array}{l} V_{CC} = 20V \\ R_C = 2k\Omega \\ R_B = 772k\Omega \end{array}}$$

3 Determine the d.c. level of I_B and V_C for the network in figure below.



Solutions

In this case, the base Resistance for the dc analysis is composed of two resistors with a capacitors connected from their Ins to ground. the capacitors assumes the open circuit equivalence and $R_B = R_1 + R_2$.

Solving for I_B.

from K.V.L.

$$V_{CC} - 3.3k\Omega\,(I_B + I_C) - I_B\,(R_1 + R_2) - V_{BE} - I_E R_E = 0.$$

But

$$I_E = I_B + I_C$$

$$I_C = \beta I_B$$

$$R_B = R_1 + R_2$$

Thus,

$$\rightarrow V_{CC} - 3.3k\Omega(I_B + \beta I_B) - I_B\underbrace{(R_1 + R_2)}_{R_B} - V_{BE} - (I_B + I_C)R_E = 0$$

$$\rightarrow V_{CC} - 3.3k\Omega(I_B + \beta I_B) - I_B R_B - V_{BE} - (I_B + \overbrace{\beta I_B}^{I_C})R_E = 0$$

$$\rightarrow V_{CC} - 3.3k\Omega\, I_B(1+\beta) - I_B R_B - V_{BE} - I_B(1+\beta)R_E = 0$$

Simplifying.

$$I_B = \frac{V_{CC} - V_{BE}}{R_B + (1+\beta)(3.3k\Omega + R_E)}$$

$\beta = 75$

$$I_B = \frac{18 - 0.7}{[91k\Omega + 110k\Omega] + [1+\beta][3.3k\Omega + 0.51k\Omega]}$$

$$I_B = \frac{17.3V}{490.56\Omega} = 35.266\,NA$$

$$\boxed{I_B = 35.266\,NA}$$

Thus

$I_C = \beta I_B$

$I_C = [75][35.266\,nA]$

$I_C = 2.645\,mA.$

Solving for V_C.

from K.V.L.

$V_C = 18 - 3.3k\Omega\,(I_B + I_C)$

$V_C = 18 - 3.3k\Omega\,(2.645mA + 35.266nA)$

$V_C = 18 - 3.3k\Omega\,[2.68mA]$

$V_C = 18 - 8.845.$

$\boxed{V_C = 9.155V}$

4. For the network of figure below.

a) Determine I_{CQ} and V_{CEQ}

b) find V_B, V_C, V_E, and V_{BC}.

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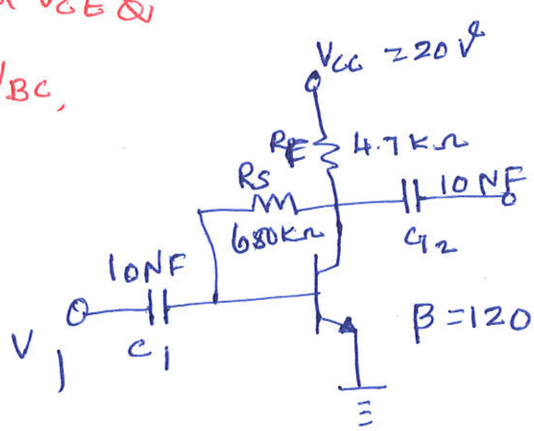


The absence of R_E reduce the reflection of resistive levels to simply that of R_c and equation for I_B reduce to.

Using KVL

$$V_{CC} - [I_B + I_C] R_C - I_B R_B - V_{BE} = 0$$

And

$$I_C = \beta I_B.$$

$1 + \beta = 120 + 1$
$= 121$

$$20 - [I_B + \beta I_B] 4.7 k\Omega - I_B [680 k\Omega] - 0.7 = 0$$

$$I_B = \frac{19.3}{121 [4.7 k\Omega] + 680 k\Omega}$$

$$\boxed{I_B = 15.456 \, NA}$$

$$I_{CQ} = \beta I_B$$

$$I_{CQ} = 120 [15.456 NA]$$

$$I_{CQ} = 1.85 \, mA.$$

$$V_{CEQ} = 20 - [I_{CQ} + I_B] [4.7]$$

$$V_{CEQ} = 20 - [1.85mA + I_E][4.7k\Omega]$$

$$V_{CEQ} = 20 - [1.85mA + 15.456\mu A][4.7k\Omega]$$

$$\boxed{V_{CEQ} = 11.23V}$$

Solving Base Voltage using KVL.

$$V_B - V_{BE} = 0$$

$$V_B = 0.7V$$

$$\boxed{V_C = V_{CEQ} = 11.23V}$$

$$V_E = 0$$

$$V_{BC} = V_B - V_C$$

$$V_{BC} = 0.7 - 11.23$$

$$\boxed{V_{BC} = -10.53V}$$

Solutions.

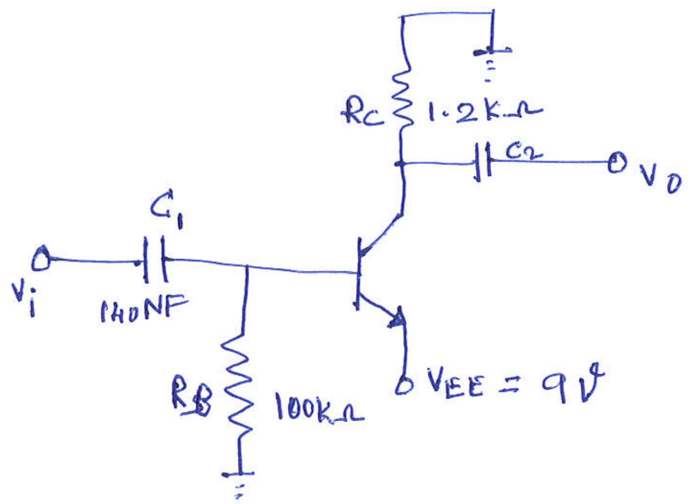
$$I_B = 15.456\mu A$$

$$V_{CEQ} = 11.23V$$

$$V_C = 11.23V$$

$$V_{BC} = -10.53V$$

(5) Determine V_C and V_B for the network of figure below.



$$-I_B R_B - V_{BE} + V_{EE} = 0$$

$$I_B = \frac{V_{EE} - V_{BE}}{R_B.}$$

$$I_B = \frac{9V - 0.7V}{100k\Omega}$$

$$= \frac{8.3V}{100k\Omega}$$

$$\boxed{I_B = 83\mu A.}$$

$$I_C = \beta I_B$$

$$= [45][83\mu A]$$

$$\boxed{I_C = 3.735\ mA.}$$

$$V_C = -I_C R_C$$

$$= -[3.735\ mA][1.2\ k\Omega]$$

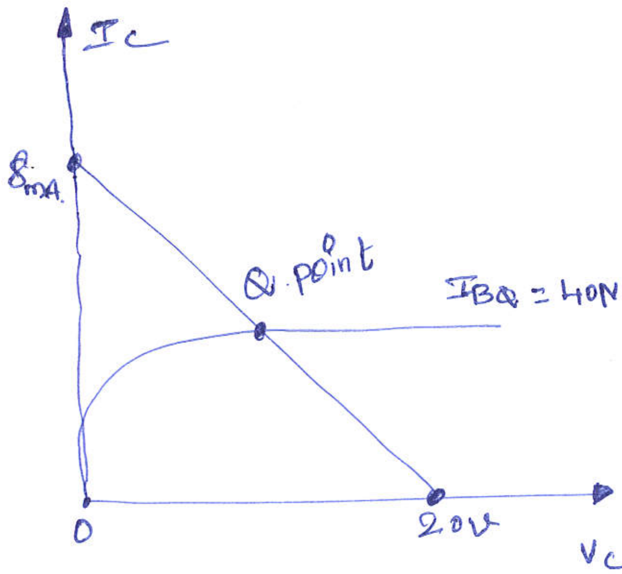
$$\boxed{V_C = -4.48V}$$

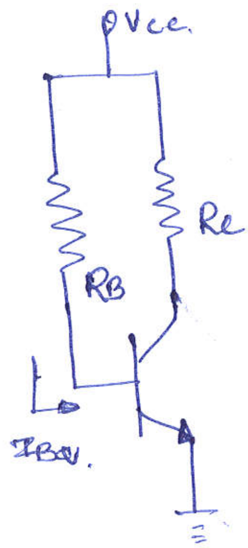
$$V_B = -I_B R_B$$

$$= -[83\ \mu A][100\ k\Omega]$$

$$\boxed{V_B = -8.3V}$$

6] Given the device charateristics and the fixed bias configuration from the figure below, determine V_{CC}, R_B, and R_C.





$V_{CC} = 20V$ from the load line

$$I_C = \left.\frac{V_{CC}}{R_C}\right|_{V_{CE}=0V}$$

$$R_C = \frac{V_{CC}}{I_C} = \frac{20V}{8mA} = 2.5K\Omega$$

<u>WKT</u>

$$I_B = \frac{V_{CC}-V_{BE}}{R_B}$$

$$R_B = \frac{V_{CC}-V_{BE}}{I_B}$$

$$R_B = \frac{20V - 0.7V}{40NA}$$

$$R_B = \frac{19.3V}{40NA}$$

$$\boxed{R_B = 482.5K\Omega}$$ Ans.

7) Given $\beta = 120$ and $I_E = 3.2mA$ for a Common-emitter configuration with $r_o = \infty\,\Omega$, determine

a) Z_i
b) A_v if a Load of $2k\Omega$ is applied
c) A_i with the $2k\Omega$ load.

a). $$r_e = \frac{26mV}{I_E} = \frac{26mV}{3.2mA} = 8.125\,\Omega$$

and $Z_i = \beta r_e = [120][8.125\,\Omega]$

$$\boxed{Z_i = 975\,\Omega}$$

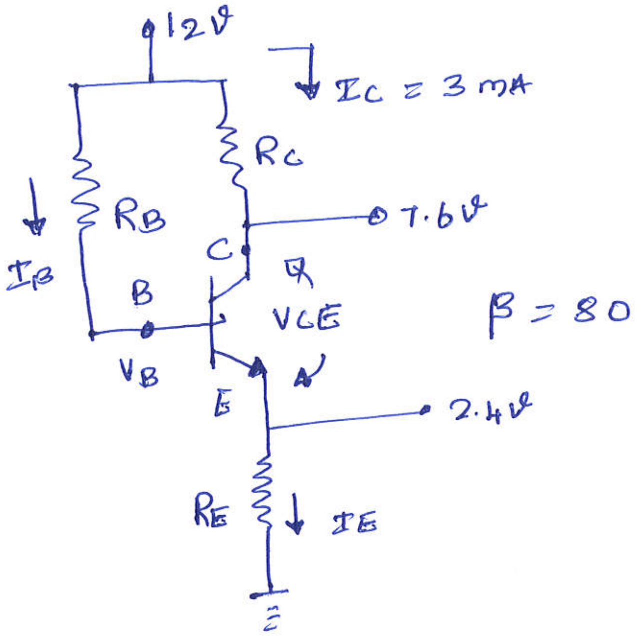
b) $$A_v = \frac{-R_L}{r_e}$$

$$= \frac{-2k\Omega}{8.125\,\Omega}$$

$$\boxed{A_v = -246.15}$$

c) $$A_i = \frac{I_o}{I_i} = \beta = 120. \quad \boxed{A_i = 120}$$

8) For given ckt. determine.



determine

a) R_C b) R_E c) R_B D) V_{CE} e) V_B

Given

$I_C = 3\,mA$

$V_C = 7.6\,V$

$V_E = 2.4\,V$

$\beta = 80$.

$V_{CC} = 12\,V$

Solutions

e) $V_B = ?$

$V_{BE} = 0.7V$ [Si]

$V_B - V_E = 0.7V$

$V_B = 2.4V + 0.7V$

$\boxed{V_B = 3.1V}$

d) V_{CE}

$V_{CE} = V_C - V_E$

$= 7.6V - 2.4V$

$\boxed{V_{CE} = 5.2V}$

c) R_B

Apply KVL in Input loop

$V_{CC} - I_B R_B = V_B$

$+12V - I_B R_B = V_B$

$+12V - I_B R_B = 3.1V$

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

$$= \frac{3\,mA}{80}$$

$$\boxed{I_B = 37.54\,\mu A}$$

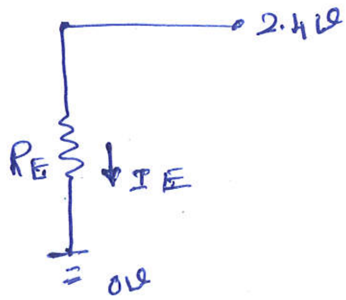
$$\cancel{R_B = \frac{12V - 37.54\,\mu A}{3.1V}}$$

$$R_B = \frac{12V - 3.1V}{37.5\,\mu A}$$

$$\boxed{R_B = 237.4\,k\Omega}$$

b] R_E

Apply KVL in R_E loop



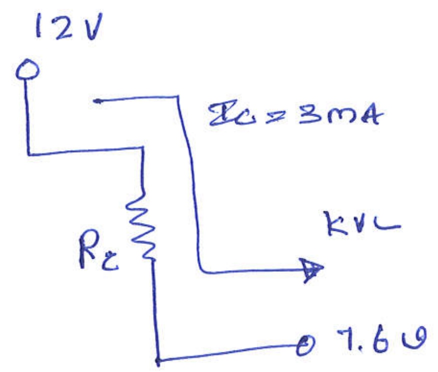
$$2.4V - I_E R_E = 0V$$

$$\therefore\ I_E = I_C$$

$$\frac{2.4V}{3mA} = R_E$$

$$\boxed{R_E = 0.8\,k\Omega}$$

a) R_c

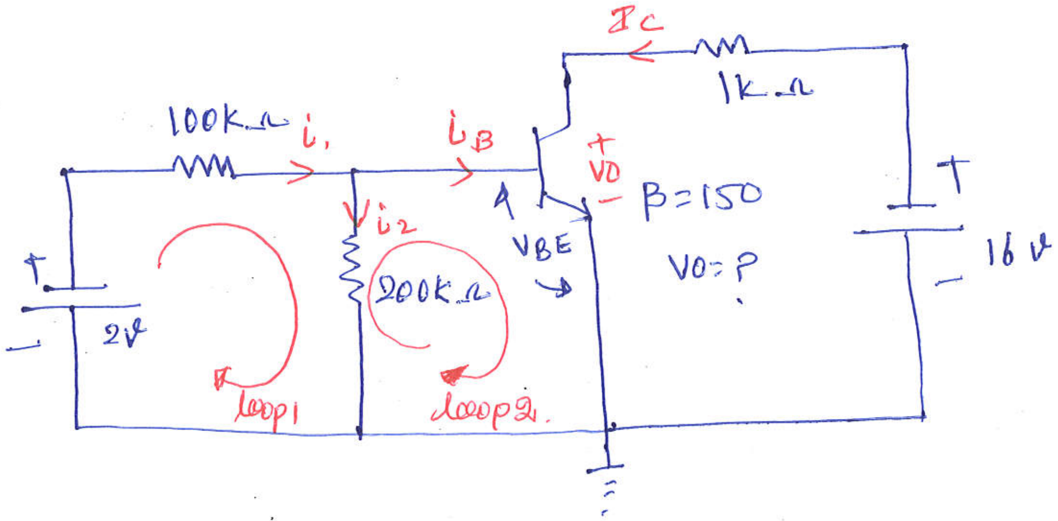


$$12V - I_C R_C = 7.6V$$

$$R_C = \frac{12V - 7.6V}{3mA}$$

$$\boxed{R_C = 1.47\,k\Omega}$$

9] Analysis given circuit. find V_o = ?



Given

$\beta = 150$

$V_{BE} = 0.7$

Relations.

$$I_C = \alpha I_E$$

$$I_C = \beta I_B$$

$$I_E = [1+\beta]\, I_B$$

i) KCL $i_1 = i_2 + I_B$

② KCL $\rightarrow i_1(100k) + i_2(200k) - 2V = 0 \rightarrow$ Loop 1

$-i_2(200k) + V_{BE} = 0$ loop 2

$V_{BE} = i_2(200k)$

$\frac{V_{BE}}{200k} = i_2$

$i_2 = \frac{0.7}{200k}$

$\boxed{i_2 = 3.5\mu A}$

Now Sub i_2 Value in loop 1

$i_1(100k) + 3.5\mu A(200k) - 2V = 0$

$i_1(100k) = \underline{2 - (3.5\mu A)(200k)}$

$i_1 = \frac{2 - (3.5\mu A)(200k)}{100k}$

$\boxed{i_1 = 13\mu A}$

③ Now Apply i_1 & i_2 Value in KCL equation.

$i_1 = i_2 + I_B$

$13\mu A = 3.5\mu A + I_B$

$I_B = 13\mu A - 3.5\mu A$

$\boxed{I_B = 9.5\mu A}$

Now we find $I_C = ?$

$$I_C = \beta I_B$$

$$I_C = 150 \times 9.5 NA$$

$$\boxed{I_C = 0.001425}$$

Now we find V_O using ohms law.

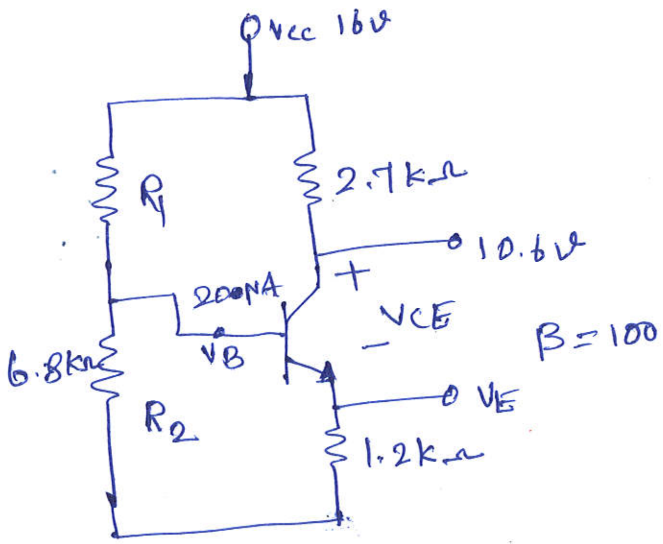
$$16 - V_O = (0.001425)(1K)$$

$$V_O = 16 - (0.001425)(1K)$$

$$\boxed{V_O = 14.575 V}$$

(10) Determine and Analysis

a) I_C b) V_E c) V_{CC} d) V_{CE} e) V_B f) R_1.



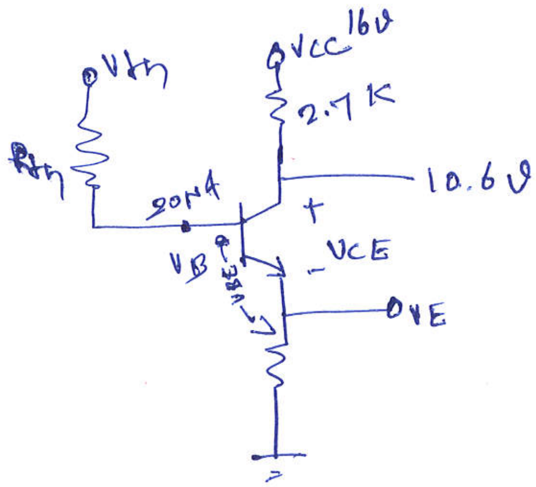
Given

$I_B = 20\,NA$, $V_C = 10.6\,V$, $R_C = 2.7\,k\Omega$, $R_2 = 6.8\,k\Omega$

$R_C = 2.7\,k\Omega$, $B = 100$, $R_E = 1.2\,k$.

Solutions

Now we can draw Thevenin equivalent ckt



$$V_{th} = \frac{V_{cc} R_2}{R_1 + R_2}$$

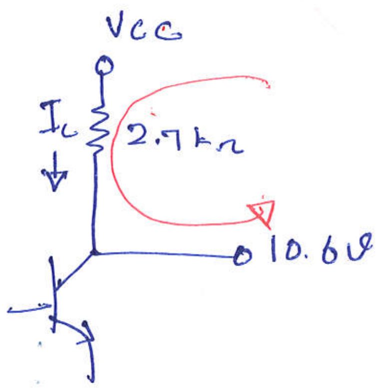
$$R_{th} = \frac{R_1 R_2}{R_1 + R_2}.$$

a) $I_C = ?$

$I_C = B I_B$

$I_C = 100 \times 200NA$

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



c) $V_{cc} = ?$

$V_{cc} - I_C R_C = 10.6\,V$

$V_{cc} = 10.6 + (2mA)(2.7k\Omega)$

$$\boxed{V_{cc} = 16\,V}$$

b) $V_E = ?$

WKT

$$I_E = I_C + I_B$$

I_B is very small

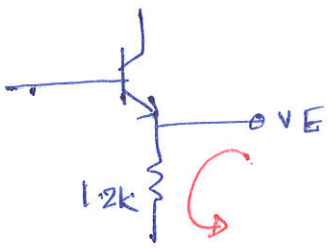
∴

$$I_E \simeq I_C$$

$$I_E = 2\,mA + 20\,\mu A$$

$$= 2\,mA + 0.02\,mA$$

$$\boxed{I_E = 2.02\,mA}$$ → Reason $I_E \simeq I_C$



$$V_E - I_E R_E = 0$$

$$V_E = I_E R_E$$

$$V_E = (2.02\,mA)(1.2\,k\Omega)$$

$$\boxed{V_E = 2.424\,V}$$

d) $V_{CE} = ?$

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

$$V_{CE} = 10.6\,V - 2.424\,V$$

$$\boxed{V_{CE} = 8.176\,V}$$

e) $V_B = ?$

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

$$0.7 = V_B - 2.424\,V$$

$$\boxed{V_B = 3.124\,V}$$

f) $R_1 = ?$

potential point

$V_{th} \simeq V_B$

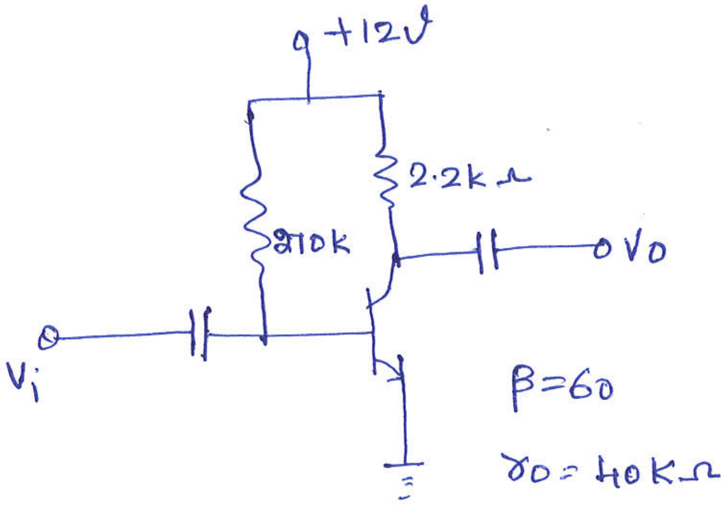
$$V_{th} = \frac{V_{cc} R_2}{R_1 + R_2}$$

$$V_{th} = \frac{16 \times 6.8}{R_1 + 6.8\,k\Omega}$$

$V_{th} \simeq V_B$

$$3.12\,V = \frac{16 \times 6.8}{R_1 + 6.8\,k\Omega}$$

$$\boxed{R_1 = 28\,K\Omega}$$



for the network shown,

i) Determine Z_i and Z_o

ii) Determine Voltage gain

iii) Determine Current gain.

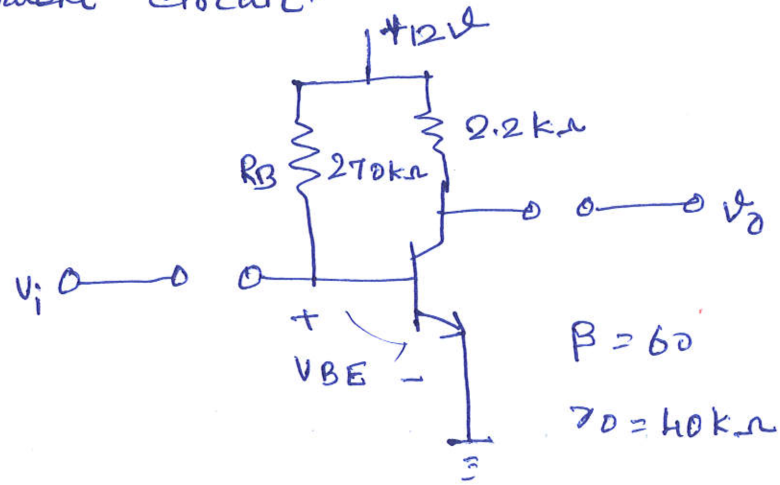
Solutions

$R_B = 270.k\Omega$ $\beta = 60$

$R_c = 2.2\,k\Omega$ $r_o = 40k\Omega$

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

D.c. equivalent circuit.



an applying K.V.L → Input loop

$$-12V - I_B R_B + V_{BE} = 0V$$

$$I_B = \frac{12V - 0.7V}{270K\Omega}$$

$$\boxed{I_B = 0.04185mA = 41.85\mu A.}$$

Calculate I_E.

$$I_E = I_C + I_B$$

$$= \beta I_B + I_B = [\beta+1] I_B$$

$$I_E = 61 \times 41.85 \mu A$$

$$\boxed{I_E = 2552.85\mu A = 2.553 mA.}$$

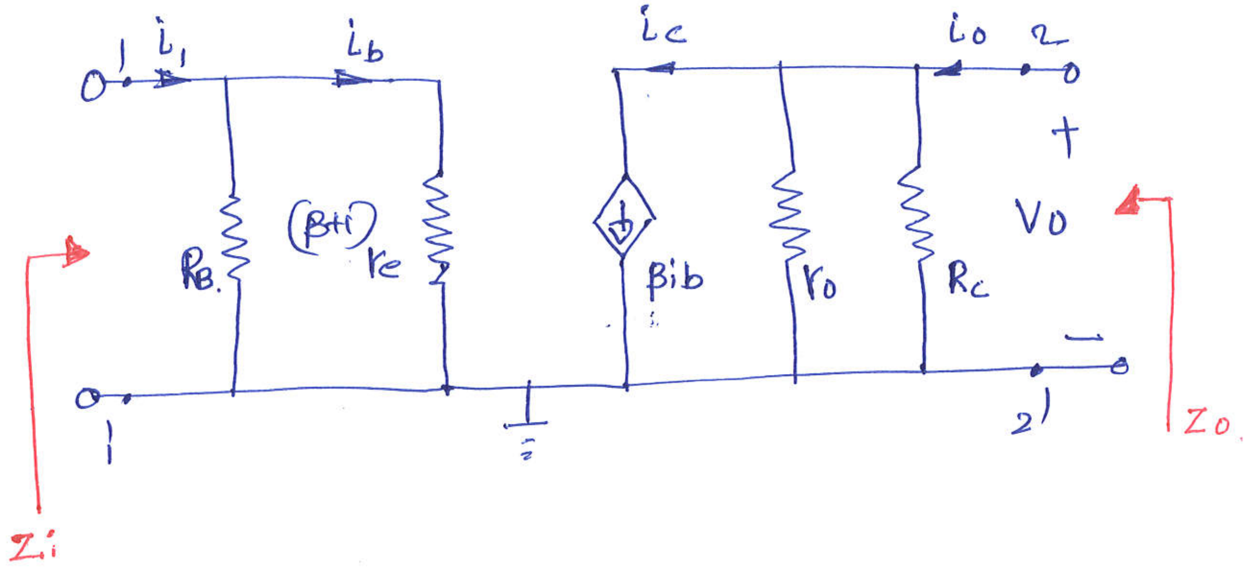
$r_e = ?$

$$r_e = \frac{26mV}{2.553 mA.}$$

$$\boxed{r_e = 10.18\Omega}$$

to find Z_i and Z_o to obtain A.C. equivalent

circuit:



Z_i

$$Z_i = R_B \,||\, (\beta+1) r_e$$

$$(\beta+1) r_e = 0.621\,k\Omega$$

$$= \frac{R_B \cdot (\beta+1) r_e}{R_B + (\beta+1) r_e}$$

$$Z_i = \frac{(270\,k\Omega)(0.621\,k\Omega)}{270\,k\Omega + 0.621\,k\Omega}$$

$$= 0.6195\,k\Omega$$

$$\boxed{Z_i = 619.5\,\Omega}$$

$R_B \geq 10(\beta+1) r_e$

$Z_i = (\beta+1) r_e$

$Z_i = 0.621\,k\Omega$

$\boxed{Z_i = 621\,\Omega}$

Z_o

$$Z_o = r_o \,||\, R_C$$

$$Z_o = 40\,k\Omega \,||\, 2.2\,k\Omega$$

$$\boxed{Z_o = 2.085}\,k\Omega$$

$$A_V = \frac{v_o}{v_i} = \frac{-\cancel{\beta} \cancel{i_b} R_c}{\cancel{i_b}(\cancel{\beta+1}) r_e}$$

$\beta+1 \simeq \beta$

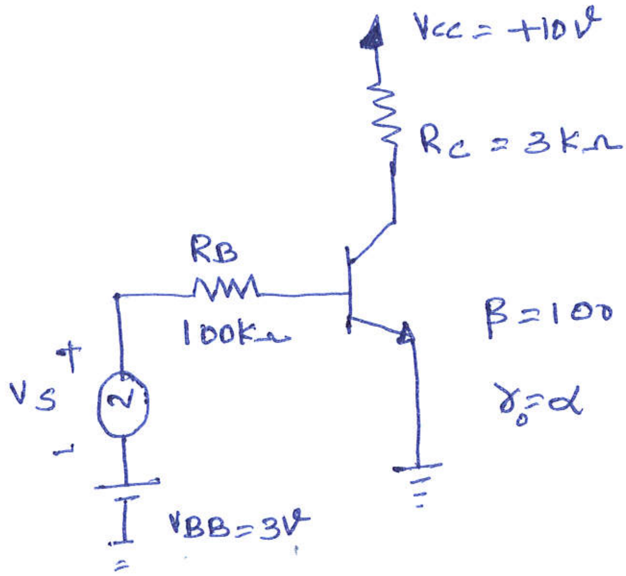
$$A_v = \frac{-R_c}{r_e} = \frac{-2.2\,k\Omega}{10.18\,\Omega}$$

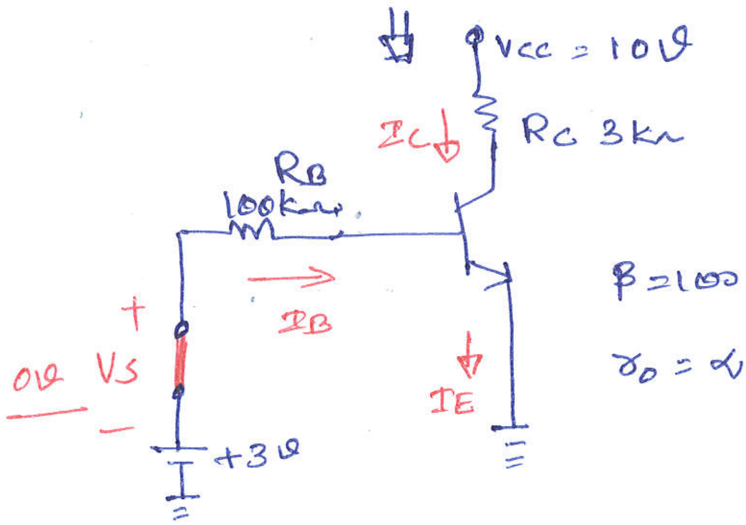
$$\boxed{A_V = -216.1}$$

$$A_i = \frac{i_o}{i_1} = 60.$$

current gain $A_i = \beta = 60$.

11) Determine the ~~voltage gain~~ I_C of the amplifier shown in figure.





Apply KVL Input Side.

$$\boxed{V_{BE} = 0.7\,V}$$

$$0\,V + 3\,V - (100k)I_B - V_{BE} = 0$$

$$I_B = \frac{3\,V - 0.7\,V}{100k}$$

$$I_B = 0.023\,mA \text{ or } \underline{23\,\mu A}$$

$I_C = \beta I_B$

$I_C = 23 NA \times 100$

$\boxed{I_C = 2.3 mA}$

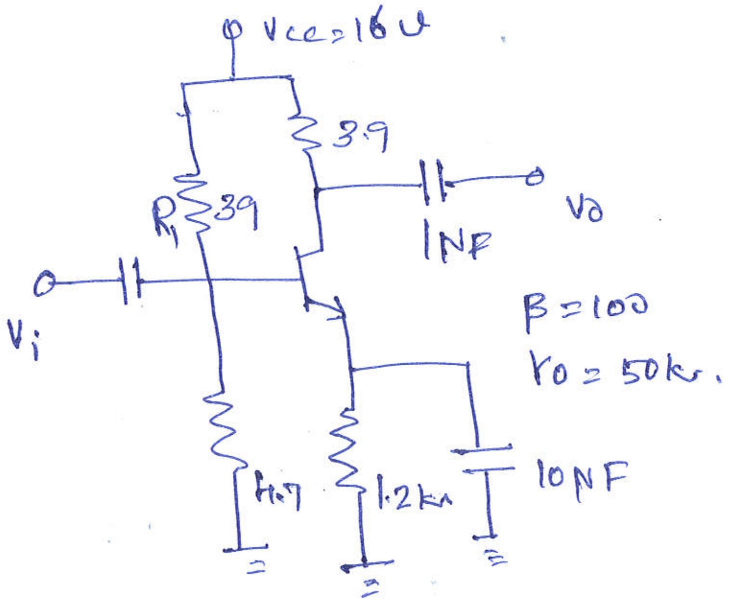
For network shown in figure.

a) Determine r_e

b) calculate Z_i and Z_o

c) find A_v

d) find A_i.



Solutions

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

$R_1 = 39k$, R_2 $4.7k$, $R_C = 3.9K$, $R_E = 1.2k$

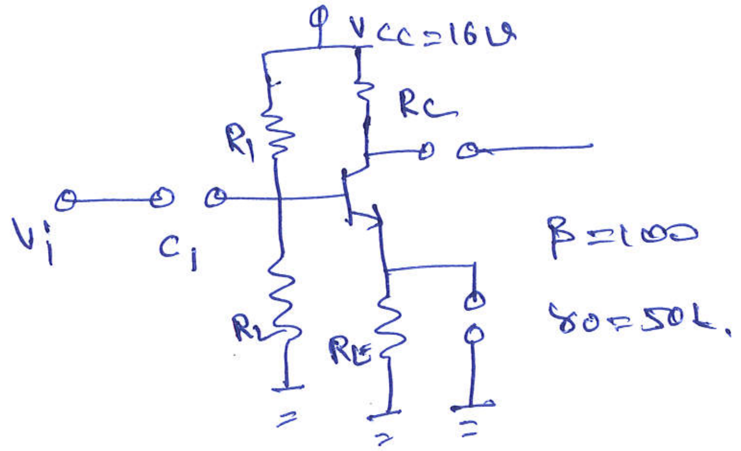
$V_{CC} = 16V$, $C_1 = 1NF$, $C_2 = 1NF$, $C_3 = 10NF$, $\beta = 100$

$r_o = 50k\Omega$.

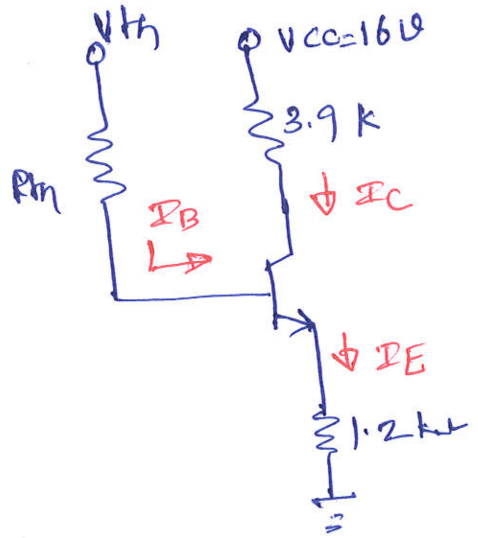
Find r_e = ?

we need to find I_E

D.c. equivalent ckt



voltage divider bias → V_{Th} ckt



$$V_{th} = \frac{R_2 \cdot V_{cc}}{R_1 + R_2}$$

$$R_{th} = R_1 \| R_2$$

$$V_{th} = \frac{4.7k \times 16V}{39k + 4.7k} = 1.72V$$

$$\boxed{V_{th} = 1.72V}$$

$$R_{th} = \frac{R_1 R_2}{R_1 + R_2} = 4.194\,k\Omega$$

Apply KVL in Input loop

$$V_{th} - I_B R_{th} - V_{BE} - \underbrace{I_E}_{(\beta+1)I_B} (1.2k) = 0$$

<u>WKT</u>

$$I_E = I_B + I_C$$

$$I_C = \beta I_B$$

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

$$I_B = \frac{V_{th} - V_{BE}}{R_{th} + (\beta+1)(1.2k)}$$

$$I_B = \frac{1.72V - 0.7V}{4.194\,k\Omega + (101)(1.2\,k\Omega)}$$

$$\boxed{I_B = 8.13\,\mu A}$$

<u>$I_C = ?$</u>

$$I_C = \beta I_B$$

$$I_C = 100 \times 8.134\,\mu A$$

$$\boxed{I_C = 813.4\,\mu A}$$

$$I_E = 8.13\mu A + 813.4\mu A$$

$$\boxed{I_E = 0.821\,mA}$$

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

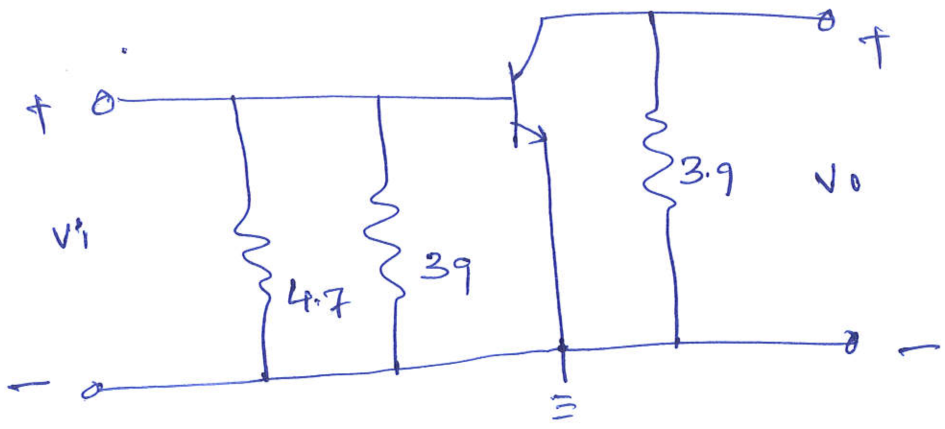
$$r_e = \frac{26mV}{0.821mA}$$

$$\boxed{r_e = 31.6\Omega}$$

to the calculation Z_i and Z_o we need Ac

equivalent circuit. becoz $X_C \approx 0\Omega$

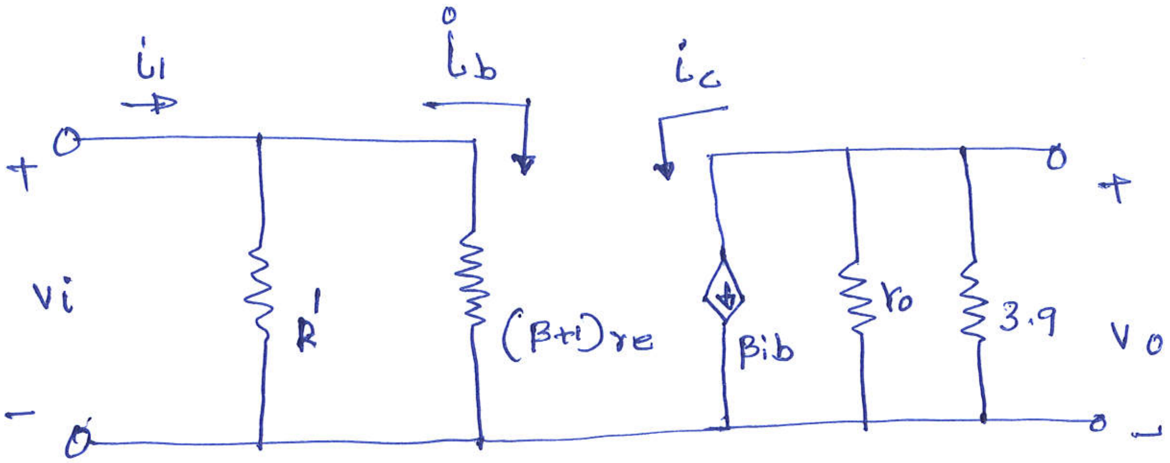
A.C. equivalent ckt.



⇓ r_e model

$R' = 4.7 \| 39$

$R' = 4.19k\Omega = R_{th}.$



$$Z_i = R' \parallel [\beta+1] r_e = \frac{R' [\beta+1] r_e}{R' + [\beta+1] r_e} = 1.811\, k\Omega.$$

$$[\beta+1] r_e = 3.19\, k\Omega$$

$$Z_o = r_o \parallel 3.9$$

$$r_o = 50\, k.$$

H.W

c) A_v

d) A_i.

$$A_i = \frac{O/P_i}{I/P_i}.$$

$$A_v = \frac{R_C}{R_E} = \frac{R_C}{r_e'} = \frac{3.9}{31.6} = 0.123$$

$$A_i = \beta =$$

JFET solved problems.

1 The device parameters for n-channel JFET are

* Maximum drain current $[I_{DSS}] = 10\,mA$.
* Pinch-off Voltage $[V_P] = -4V$

Calculate the drain current for.

a) $V_{GS} = 0V$ b) $V_{GS} = -1V$ c) $V_{GS} = -4V$.

Solutions.

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

Case a] $V_{GS} = 0V$ & $V_{DS} > |V_P|$

$$I_D = I_{DSS}$$

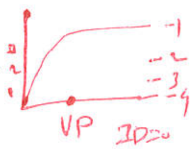
$$\boxed{I_D = 10\,mA}$$

Case c:

$V_{GS} = -4V$

$V_P = -4V \Rightarrow I_D = 0$

$$\boxed{I_D = 0A}$$



Case b]

$V_{GS} = -1V$

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

$$= 10\,mA\left[1 - \left[\frac{-1}{-4}\right]\right]^2 = 10\,mA\,[1 - 0.25]^2$$

$$\boxed{I_D = 5.625\,mA}$$

(2) The reverse gate voltage of JFET when changes from 4.4V to 4.2V the drain current changes from 2.2 mA to 2.6mA, find out the value of transconductance.

Solution

$$g_m = \frac{O/P\ i}{I/P\ V} \Bigg|_{\text{for constant } o/p\ v}$$

$$g_m = \frac{\overset{\Delta I_D}{\text{Change in output } i}}{\underset{\Delta V_{GS}}{\text{Change in Input } v}} \Bigg|_{\text{constant } o/p\ v}$$

$\Delta V_{GS} = 4.4V - 4.2V$

$= 0.2V$

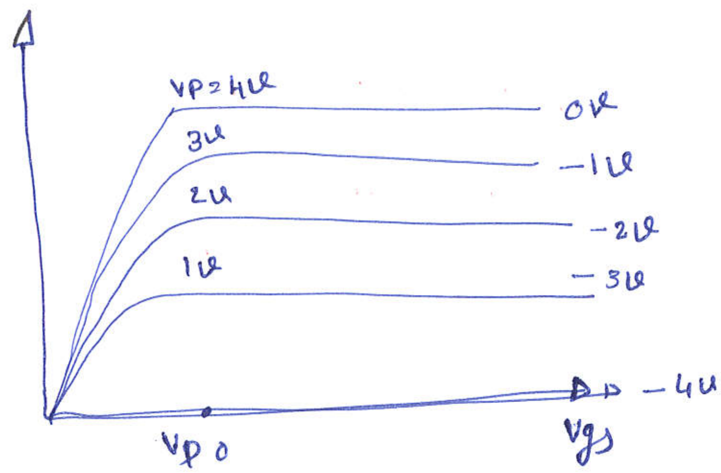
$\Delta I_D = 2.2mA - 2.6mA$

$= \underline{-}\,0.4mA$ — dont want to take → Not Required

$$g_m = \frac{0.4mA}{0.2V} = 2mA/V$$

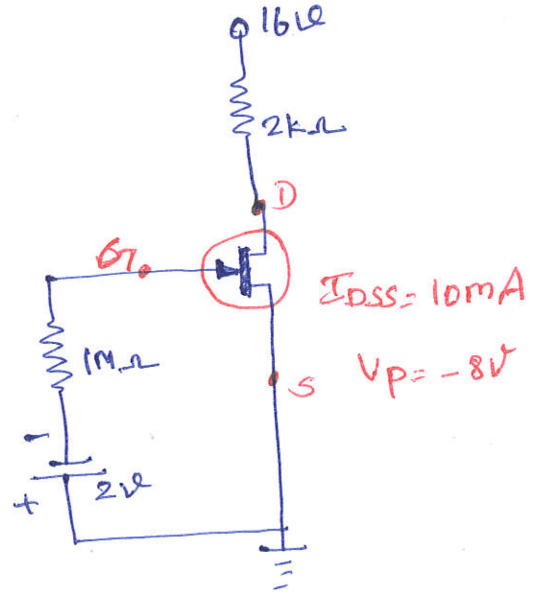
$$\boxed{g_m = 2\ m\,mho.}$$

2. The pinchoff voltage for an n- Channel JFET is 4 volts. then pinch off occurs for V_{DS} when $V_{GS} = -1$ volts is.



$\boxed{V_P = 3V \text{ for } V_{GS} = -1 \text{ Volts.}}$

3. Determine the following for the network shown in figure.



a) V_{GSQ}

b) I_{DQ}

c) V_{DS}

d) V_D

e) V_G

f) V_S.

* in FET $\boxed{I_G \simeq 0A}$

a] → Q,pt = [V_{GSQ}, I_{DQ}]

c] V_{DS} → o/p voltage

d] V_D → pottential of the drain

e) V_G → pottential of the Gate.

f) V_S → pottential at the Source

→ not a pottential diffence
↳ pot at a pt

V_D = p.d between D and ground

D ↓ V_D, ground ↓ 0V

$V_D = V_D - 0V = V_D - V_S$

$\boxed{V_D = V_{DS}}$ → Ans of part c & d as same

$V_G = V_G - 0V$

$\boxed{V_S = 0V}$

$V_G = V_G - V_S$

$\boxed{V_G = V_{GS}}$ → Ans of a part equal to the Ans of e part

already we know that Source is connected to ground

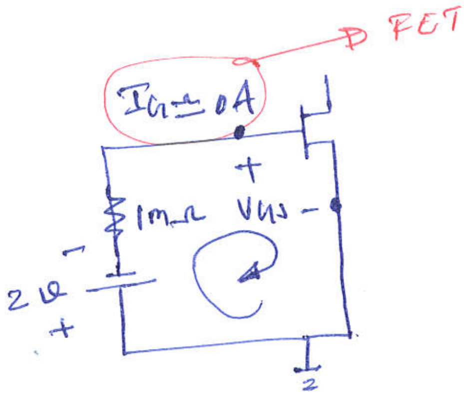
$\boxed{V_S = 0V}$ ← So.

a) V_{GSQ}

Apply KVL

$$-2V - 1M\Omega(0) - V_{GS} = 0$$

$$\boxed{V_{GSQ} = -2V}$$



$V_{GSQ} = V_{GS}$

e) $V_G = V_{GS}$

$\therefore$

$$\boxed{V_G = -2V}$$

WKT → given

$I_{DSS} = 10mA$

$V_P = -8V$

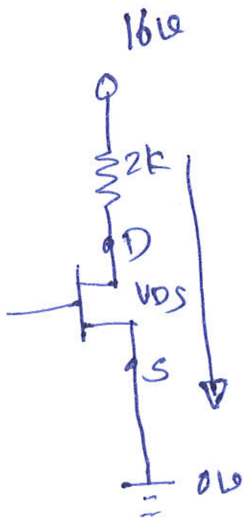
b) $$I_D = I_{DSS}\left[1 - \frac{V_{GS}}{V_P}\right]^2$$

$$I_D = 10mA\left[1 - \frac{[-2]}{[-8]}\right]^2$$

$$\boxed{I_D = 5.62\ mA}$$

d) $V_D = V_{DS}$

$$\boxed{V_D = 4.75V}$$



f) $\boxed{V_S = 0V}$

b] $I_D = I_{DQ}$

$$\boxed{I_{DQ} = 5.62mA}$$

c) V_{GS} = o/p voltage

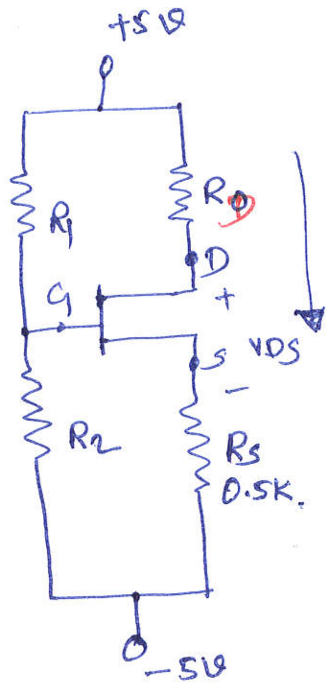
Apply KVL

$$16V - I_D[2k] - V_{DS} = 0$$

$$16V - 5.62[2k] - V_{DS} = 0$$

$$\boxed{V_{DS} = 4.75V}$$

3) Determine the following parameters for the network as shown in figure.



$I_{DSS} = 10mA$

$V_P = -3V$

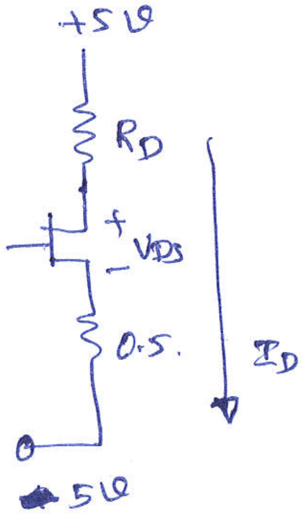
$R_1 + R_2 = 120k$

$I_D = 5mA$

$V_{DS} = 5V$

find. R1, R2, R_D

Apply KVL find R_D in output



$$5 - I_D(R_D) - V_{DS} - 0.5(I_D) + 5 = 0$$

$$5 - 5mA(R_D) - 5V - 0.5(5mA) + 5 = 0$$

$$\boxed{R_D = 0.5k\Omega}$$

We need two equ : 2 unknown : R1 & R2.

i) $R_1 + R_2 = 120k.$

Apply thevenion logic

$$V_G = V_G' + V_G''$$

$V_G' = 5V \to ON$

$V_{44}'' = -5V \to ON$

$\cancel{V_G = V'}$

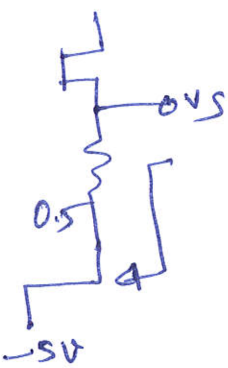
$$V_G = 5 \cdot \frac{R_2}{R_1+R_2} - 5 \cdot \frac{R_1}{R_1+R_2}$$

$\frac{R_2}{R_1+R_2} \to$ Numarator Connected to Gnond

WKT

$$V_{GS} = V_G - V_S$$

$$V_G = V_{GS} + V_S.$$



Apply KVL we will get

$$\frac{V_S+5}{0.5K} = I_D$$

$V_S + 5 - 0.5K - I_D = 0$

$V_S + 5 = 0.5K\, I_D$

$\frac{V_S+5}{0.5K} = I_D$

WKT

$$I_D = 5mA$$

$$\frac{V_S+5}{0.5K} = 5mA$$

$$\boxed{V_S = -2.5V}$$

NO use I_D equations we wil get V_{GS}

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

$$5mA = 10mA\left[1 - \frac{V_{GS}}{-3V}\right]^2$$

finally we wil get

$$\boxed{V_{GS} = -0.87V}$$

$\therefore$

$$V_G = V_{GS} + V_S$$

$$V_G = -0.87 - 2.5V$$

$$\boxed{V_G = -3.37V}$$

NOW we can re-write two equations.

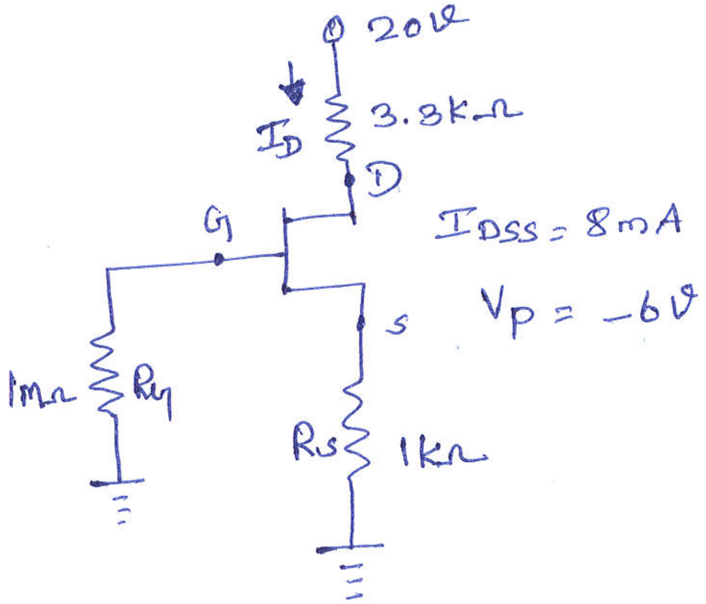
$$R_1 + R_2 = 120k\Omega. \longrightarrow (1)$$

$$5 \cdot \frac{R_2}{R_1 + R_2} - 5\frac{R_1}{R_1 + R_2} = -3.37k \longrightarrow (2)$$

Solving these two equations we will get

R_1 & R_2.

4] Determine the following for the network.



a) V_{GSQ}

b) I_{DQ}

c) V_{DS}

d) V_S

e) V_G

f) V_D.

Solutions.

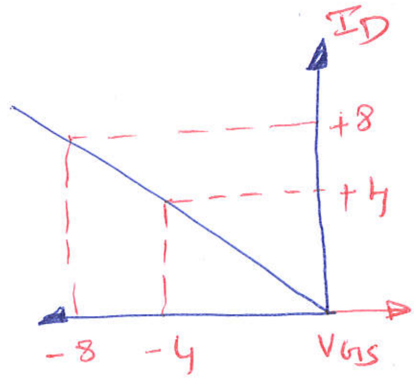
a) The Gate to Source voltage.

$$V_{GS} = -I_D R_S$$

Assume $I_D = 4mA$

$$V_{GS} = -[4mA][1k\Omega]$$

$$\boxed{V_{GS} = -4V}$$



$I_D = 8mA$

$$V_{GS} = -[8mA][1k\Omega]$$

$$\boxed{V_{GS} = -8V}$$

From the Shockly equation.

$$V_{GS} = \frac{V_P}{2} = -3V$$

$$I_D = \frac{I_{DSS}}{4} = 2mA.$$

b) At the Quiesent point

$$I_{DQ} = 2.6mA.$$

c) $V_{DS} = V_{DD} - I_D\ (R_S + R_D)$

$= 20V - (2.6mA)(1k\Omega + 3.3k\Omega)$

$= 8.82V.$

d) $V_S = I_D . R_S$

$= (2.6mA)(1k\Omega)$

$V_S = 2.6V$

e) $V_G = 0$

f) $V_D = V_{DS} + V_S = 11.42V$

(or)

$V_D = V_{DD} - I_D R_D = 11.42V.$