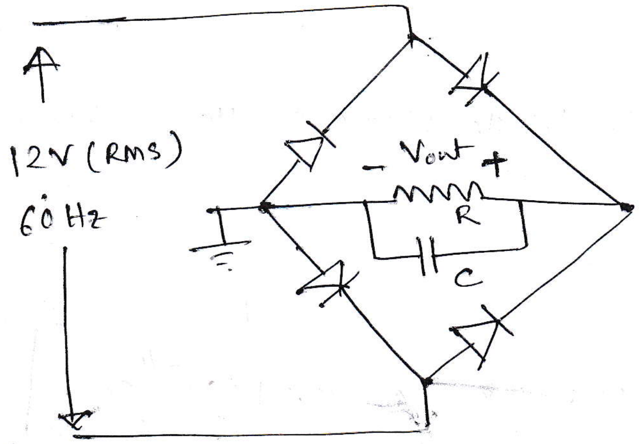
Q.1



$V_\gamma = 0.7\,V.$

input = 12 V (RMS) = V_i

" freq. = 60 Hz.

$R = 100\,\Omega$

Ripple voltage (P-P) = 1V. = V_r

peak i/p voltage, $V_i(max) = 12\sqrt{2}$ V.

$V_{out\text{-}peak} = 12\sqrt{2} - 2V_\gamma = (12\sqrt{2} - 1.4)\,V. = V_m$

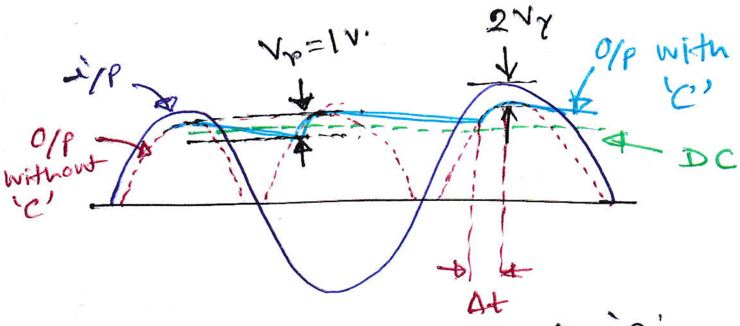
$$V_r = \frac{V_m}{2fRC}$$

$$C = \frac{V_m}{2fRV_r} = \frac{12\sqrt{2}-1.4}{2\times 60\times 100\times 1}$$

$\boxed{= 1.2975\times10^{-3}\,F \quad C = 1297\,\mu F}$ (a)

DC at output (average) $= \left(V_m - \frac{1}{2}V_r\right) = 12\sqrt{2} - 1.4 - \frac{1}{2}\times 1$

$\boxed{= 15.07\,V.}$ (b)



Max. current through 'R' $= \frac{V_m}{R} = \frac{12\sqrt{2}-1.4}{100\,\Omega} = \boxed{0.155\,A.}$ (c)

$PIV = V_i(max) - V_\gamma = (12\sqrt{2} - 0.7)\,V = \boxed{16.27\,V}$ (d)

In the previous page, $\underline{\Delta t}$ is time duration during which diode conducts.

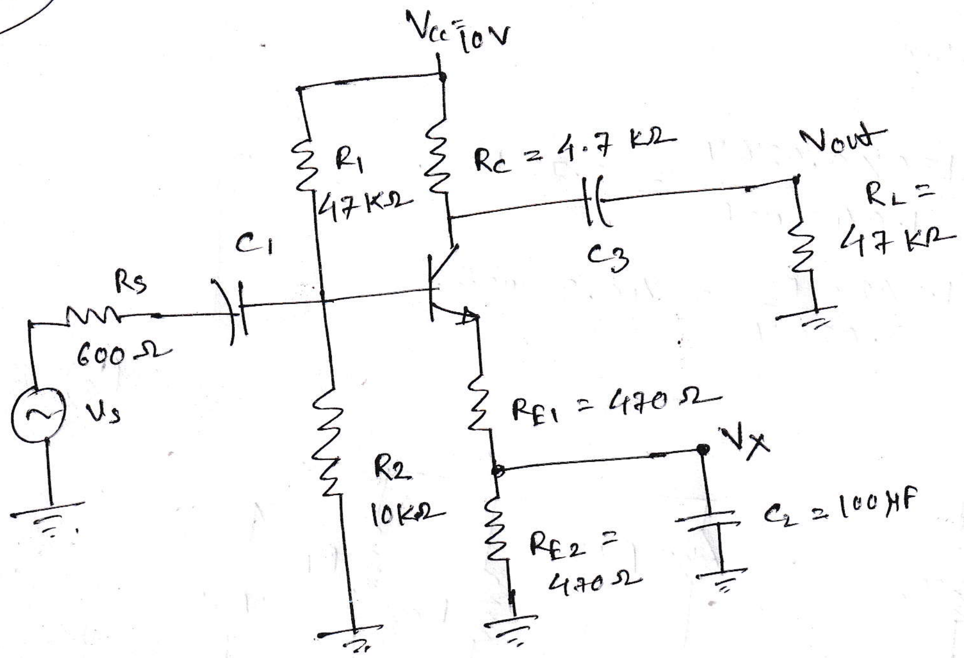
$$\Delta t = \frac{1}{2\pi f}\sqrt{\frac{2V_r}{V_m}}$$; (for details please see Neaman's book).

$$= \frac{1}{2\pi \times 60}\sqrt{\frac{2\times 1}{12\sqrt{2}-1.4}}$$

$$\boxed{\Delta t = 951\ \mu s \quad \text{or} \quad 0.951\ ms \quad \text{or} \quad 9.51\times 10^{-4}\ \text{Sec.}}$$

(e)

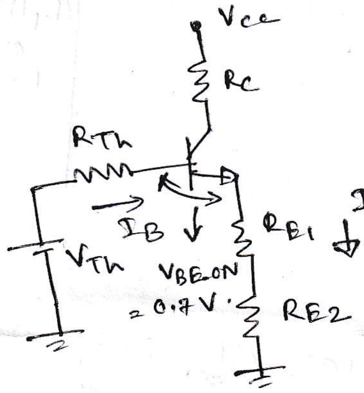
Q.2



$\beta = 150$

Thevenin equivalent at the input,

$$R_{Th} = \frac{R_1 R_2}{R_1 + R_2} = \frac{(47 K\Omega)(10 K\Omega)}{(47+10) K\Omega} = 8.245 \ K\Omega$$



DC equivalent circuit.

$$V_{Th} = V_{cc} \cdot \frac{R_2}{R_1 + R_2} = 10 \times \frac{10 \ K\Omega}{(47+10) K\Omega}$$

$$= 1.75 \ V.$$

$$I_B = \frac{V_{Th} - V_{BE-ON}}{R_{Th} + (1+\beta)[R_{E1} + R_{E2}]} \ ; \ I_E = (1+\beta) I_B.$$

$$= \frac{1.75 - 0.7}{8.245 + (151)(0.470 + 0.470)} \leftarrow \text{in } K\Omega.$$

$$= 6.99 \ \cancel{\mu A} \cdot \times 10^{-3} \ mA = 6.99 \ \mu A.$$

$$I_E = (1+\beta) I_B = (1+150) \times 6.99 \ \mu A = \boxed{1.055 \ mA}$$ (a)

$$I_c = \beta I_B = 150 \times 6.99 \ \mu A = 1.048 \ mA.$$

$$V_c = V_{cc} - I_c R_c = 10 - 1.048 \ mA \times 4.7 \ K\Omega$$

$$\boxed{V_c = 5.074 \ V.}$$ (a)

(4)

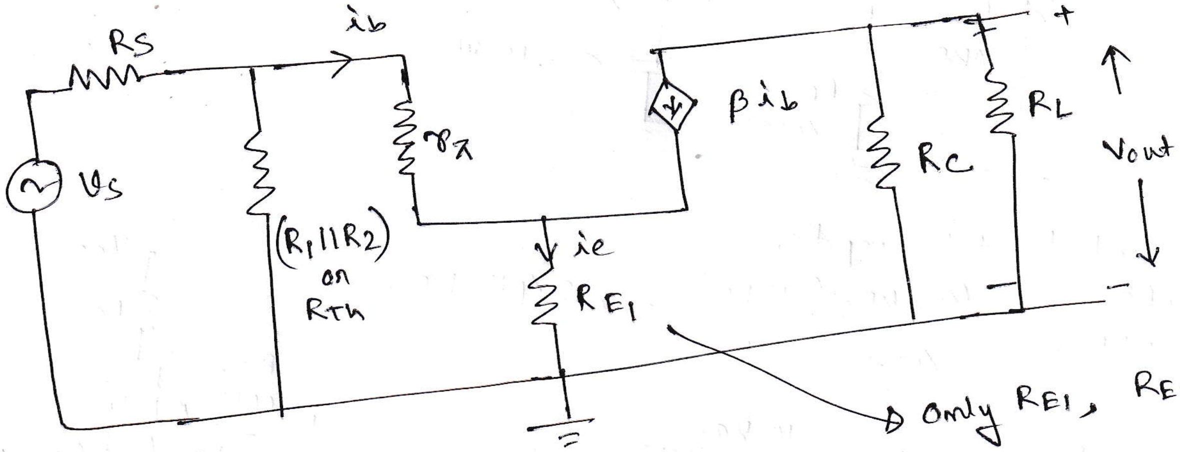
AC analysis

Small signal parameters:

$$r_\pi = \frac{\beta V_T}{I_c} = \frac{150 \times 0.026\,V}{1.048\,mA} = 3.72\,k\Omega .$$

$$g_m = \frac{I_c}{V_T} = \frac{1.048\,mA}{0.026\,V} = 40.3\,mS.$$

(b)



→ Only RE1, RE2 shorted.

For CE Amplifier with emitter resistor,

$$\text{Small-signal voltage gain} = -\frac{R_C \| R_L}{R_{E1}} = -\frac{4.7\,k\Omega \,\|\, 47\,k\Omega}{0.47\,k\Omega} = -\frac{4.27}{0.470}$$

$$\boxed{\text{Voltage gain} = -9.09}$$

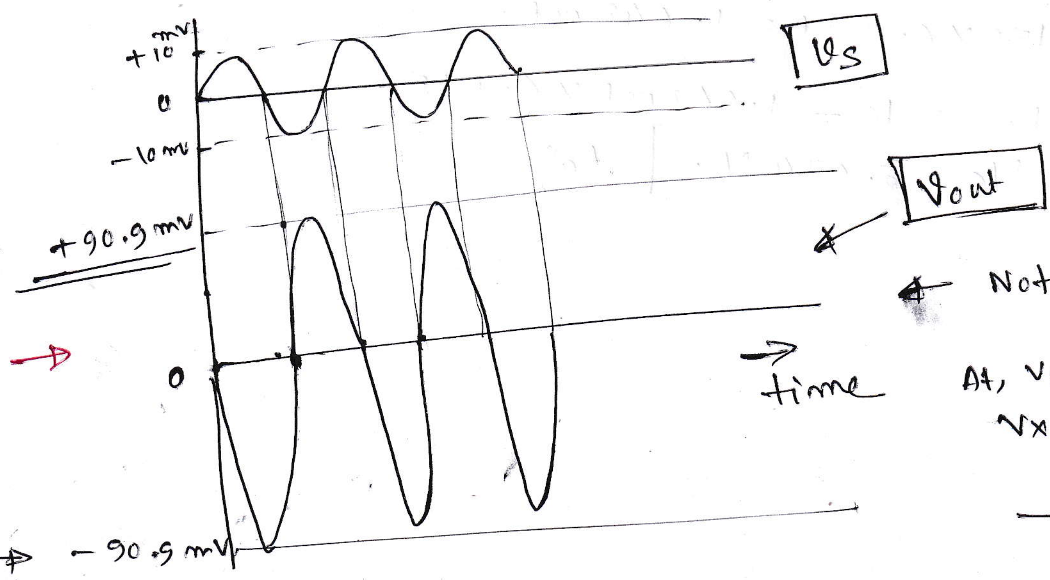
(c)

(d) If C_2 is reduced to 10 nF, then for AC analysis C_2 can't be considered as short, we have to consider the impedance offered by C_2, hence effective R_E increases. Gain reduces.

Input (V_s) = 10 mV (peak) ; C_3 blocks the DC part.

output (V_{out}) = $-10\,mV \times 9.09$ = -90.9 mV

(e) →



← Not in Scale

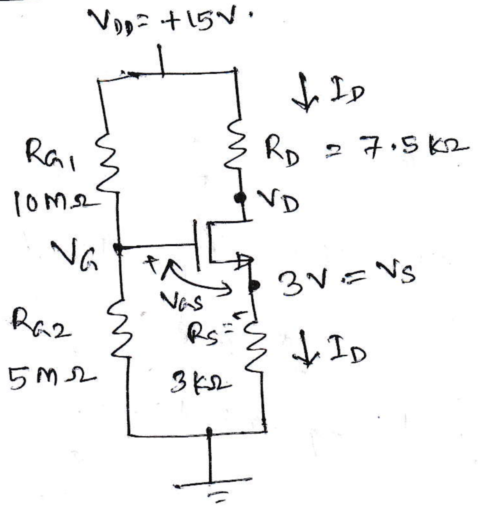
At, Vx only DC bias.

$V_x = I_E \times R_{E2}$

$= 0.495\,V.$ (f)

B. 3

DC equivalent ckt:



Given, $V_{GS} = 2V$.

$V_{Th} = 1V$.

$$V_G = V_{DD} \times \frac{R_{G2}}{R_{G1} + R_{G2}}$$

$$= 15 \times \frac{5}{10+5}$$

$$= 5V.$$

$V_{GS} = 2V$.

$V_G - V_S = 2V$.

$V_S = (V_G - 2)V = (5-2) = 3V$.

again, $V_S = I_D R_S$

$3 = I_D \times 3k\Omega$

$\therefore I_D = 1mA$

$V_D = V_{DD} - I_D \times R_D$

$= 15 - 1mA \times 7.5k\Omega$

$\boxed{V_D = 7.5V.}$ — (a)

So, $V_{DS} = V_D - V_S$

$= (7.5 - 3)V = 4.5V$.

$V_{Dsat} = V_{GS} - V_{Th} = (2-1) = 1V$.

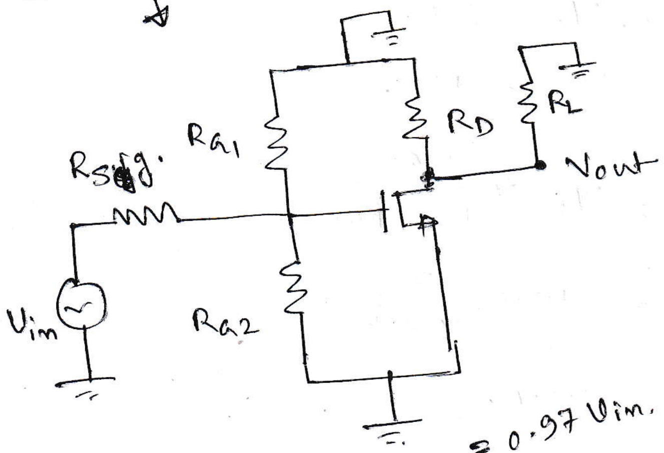
$V_{DS} > V_{Dsat}$, so MOSFET is in saturation.

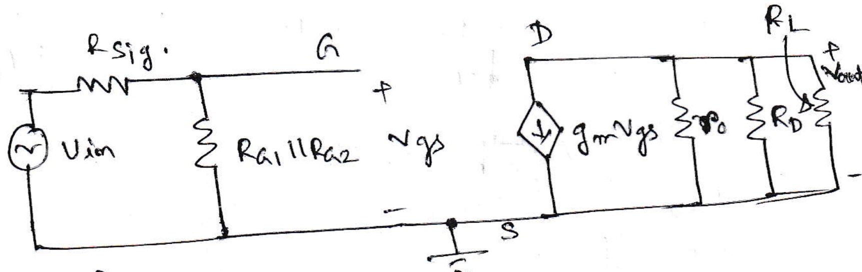
$$I_D = \frac{1}{2}\left(\frac{W}{L}\right) k_n' (V_{GS} - V_{Th})^2$$

$$1\cancel{m}A = \frac{1}{\cancel{2}} \times \frac{W}{L} \times \cancel{2}\,mA/V^2 \times (2-1)^2$$

$$\therefore \boxed{\frac{W}{L} = 1} \text{ — (a)}$$

AC equivalent ckt:





Small-signal equivalent ckt.

(b)

$$V_{gs} = \frac{(R_{G1} \| R_{G2})}{R_{sig} + (R_{G1} \| R_{G2})} \cdot V_{in} \simeq V_{in}. \quad = 0.97\, V_{in}.$$

$$g_m = 2K_n (V_{GS} - V_{Th})$$

$$\cancel{= 2 \times 2\, mA/V^2 \times (2-1)\, V}$$

$$= 2 \times 1 \times (2-1)$$

$$= 2\ mA/V. \text{ or } mS.$$

$$K_n = \frac{1}{2} \frac{W}{L} \cdot k_n'$$

$$= \frac{1}{2} \times 1 \times 2$$

$$= 1$$

$$r_o = \frac{1}{\lambda I_D} = \frac{1}{0.01 \times 1\, mA} = 100\, k\Omega.$$

~~Small-signal voltage gain = $-g_m \cdot (r_o \| R_D \| R_L)$~~

output voltage (V_{out}) $= -g_m V_{gs} \cdot (r_o \| R_D \| R_L)$

$$V_{out} = -g_m \cdot V_{in} \cdot (r_o \| R_D \| R_L)$$

$$\text{Voltage Gain} = \frac{V_{out}}{V_{in}} = -g_m (r_o \| R_D \| R_L) = -2 \times (7.5\, k\Omega \| 10\, k\Omega \| 100\, k\Omega)$$

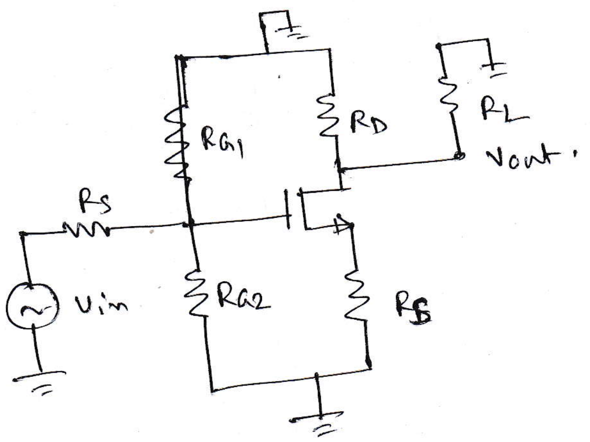
$$= -2 \times 4.109$$

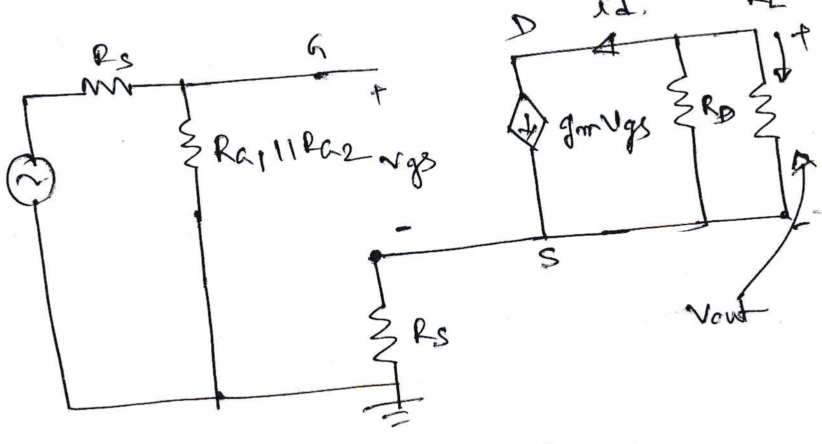
(b) $\boxed{= -8.218}$ if $V_{in} \approx V_{gs}$ is considered

$\boxed{\text{OR} = -7.97}$ if $V_{gs} = 0.97\, V_{in}$ is considered.

If C_s is removed.

then equv. AC. ckt.





Small-signal equv. ckt.

Considering, $\lambda = 0$, $r_o \Rightarrow \infty$.

Voltage Gain $= -\frac{R_D}{R_S} = -\frac{7.5}{3} = \boxed{-2.5}$ ← (c)

If C_1 is reduced drastically, then for the signal freq. ~~imp~~ C_1 then should be can't be considered as short-ckt. Impedence of C_1 then should be considered and $V_{gs} < V_{in}$, so, small-signal gain reduces.

(d)