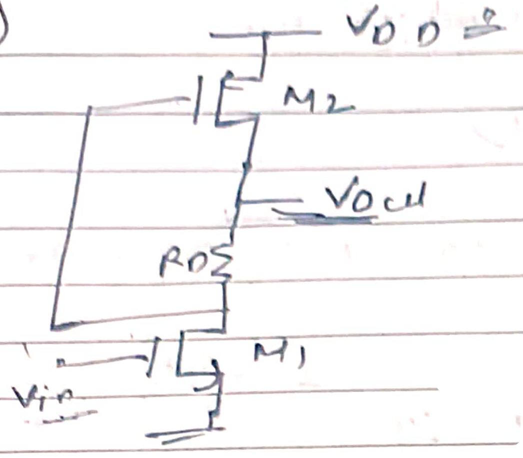
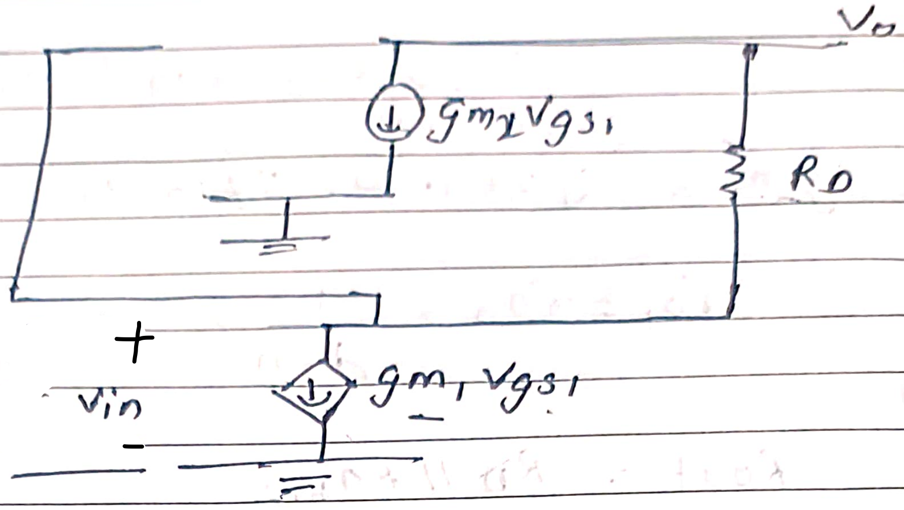
DATE ....

Q1)





$$V_{gs1} = V_{in}$$

$$g_{m2} V_{gs2} = -g_{m1} V_{gs1}$$

$$g_{m2} V_{gs2} = -g_{m1} V_{in}$$

$$V_{gs2} = \frac{-g_{m1}}{g_{m2}} V_{in}$$

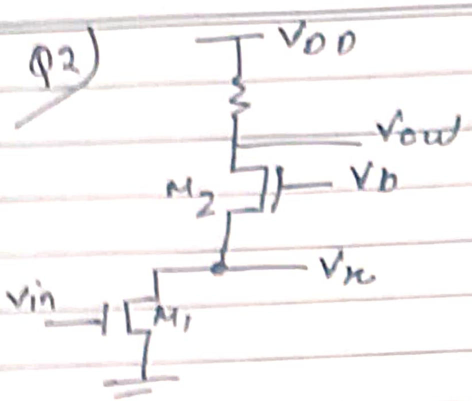
$$V_o = (g_{m1} V_{gs1}) R_D + V_{D1}$$

$$V_o = g_{m1} V_{in} R_D + \left(\frac{-g_{m1}}{g_{m2}}\right) V_{in}$$

$$\boxed{\frac{V_o}{V_{in}} = \left(g_{m1} R_D - \frac{g_{m1}}{g_{m2}}\right)}$$

DATE ....

Q2)



$\left(\frac{W}{L}\right)_1 = \frac{50}{0.5}$ $\left(\frac{W}{L}\right)_2 = \frac{10}{0.5}$

$I_{D1} = I_{D2} = 0.5mA$

$R_D = 1K\Omega$

$V_{th} = 0.77V$

$$V_{Dsat_1} = V_{GS1} - V_{th1} = \left(\frac{2I_{D1}}{\mu_n C_{ox}\left(\frac{W}{L}\right)_1}\right)^{1/2} = \left(\frac{2\times 0.5\times 10^{-3}}{1.34225\times 10^{-4}\times 100}\right)^{1/2}$$

$$\boxed{V_{Dsat_1} = 0.2729V}$$

$$V_{x\,Bias} = 0.2729 + 50\times 10^{-3} = 0.3229\ V$$

$$V_{th2} = 0.770\ V$$

$$V_{GS2} - V_{th2} = \left(\frac{2I_{D2}}{\mu_n C_{ox}(W/L)_2}\right)^{1/2} =$$

$$V_{GS2} \Rightarrow 0.77 + \left(\frac{2\times 0.5\times 10^{-3}}{1.34225\times 10^{-4}\times 20}\right)^{1/2}$$

$$V_{GS2} = 1.3803V$$

$$V_{GS2} = V_b - V_w$$

$$V_b = V_{GS2} + V_w$$

a) $$\boxed{V_b = 1.3803 + 0.2729 = 1.6532\ V}$$

Spiral

DATE ....

D) $gm_1 = \sqrt{2 \times 1.34225 \times 10^{-4} \times 100 \times 0.5 \times 10^{-3}}$

$\Rightarrow 3.6636 \times 10^{-3}$ A/V

$gm_2 = \sqrt{2 \times 1.34225 \times 10^{-4} \times 20 \times 0.5 \times 10^{-3}} = 1.6384 \times 10^{-3}$ A/V

$r_{o1} = r_{o2} = \frac{1}{\lambda I_D} = \frac{1}{0.1 \times 0.5 \times 10^{-3}} = 20k$

$R_{out} = R_D \parallel R_{out1}$

$R_{out1} = [(1 + gm_1 r_{o2}) r_{o1} + r_{o2}]$

$R_{out} = R_D \parallel [(1 + gm_1 r_{o2}) r_{o1} + r_{o2}]$

$R_{out} = 10^3 \parallel [(1 + 1.6384 \times 10^{-3} \times 20 \times 10^3) 20 \times 10^3 + 20 \times 10^3]$

$R_{out} = 998.564\ \Omega$

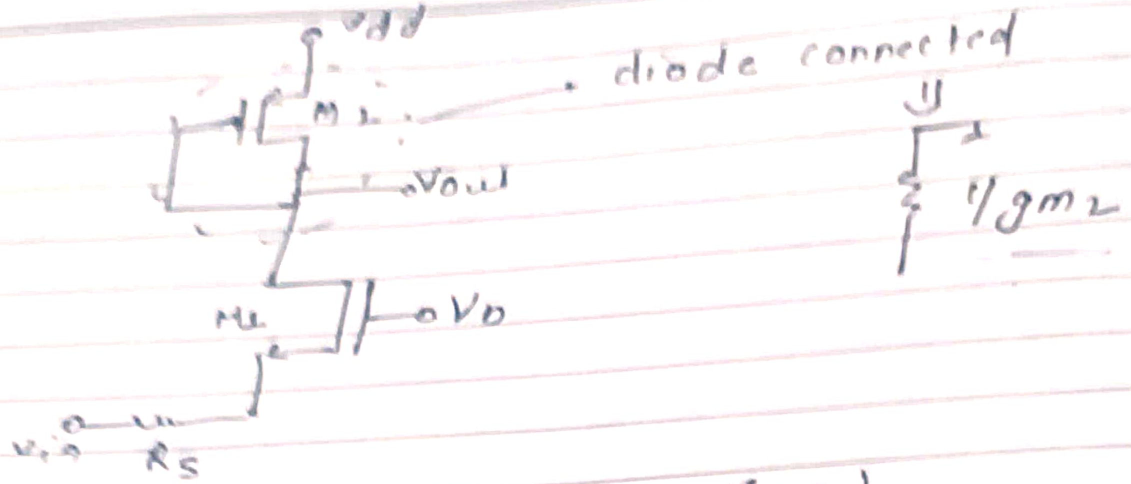
$A_v = -gm_1 R_{out}$

$A_v = -(3.6636 \times 10^{-3}) \times (998.564)$

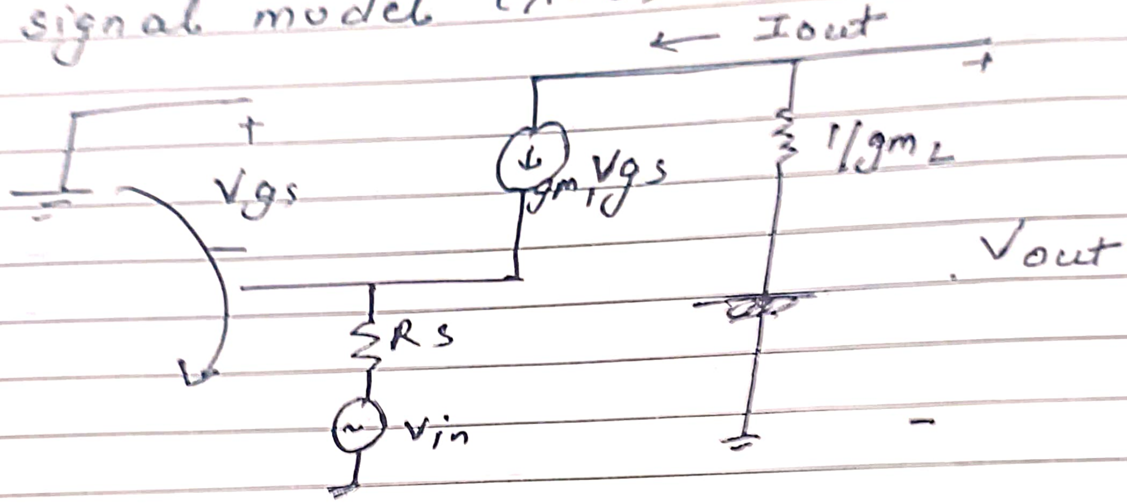
$\boxed{A_v = -3.658}$

Spiral

Q3)



small signal model ($\lambda = 0$, $\gamma = 0$)



using KVL in the i/p loop :-

$$-V_{gs} - R_S g_{m1} V_{gs1} - V_{in} = 0$$

or

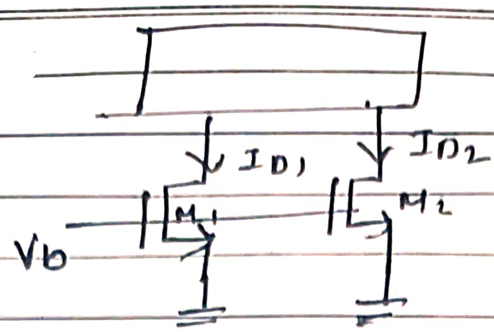
$$V_{in} = -V_{gs1}(R_S g_{m1} + 1)$$

$$V_{out} = -g_{m1} V_{gs1} \times \left(\frac{1}{g_{m2}}\right)$$

$$\boxed{A_V = \frac{V_{out}}{V_{in}} = \frac{(g_{m1}/g_{m2})}{(1 + g_{m1} R_S)}}$$

DATE ....

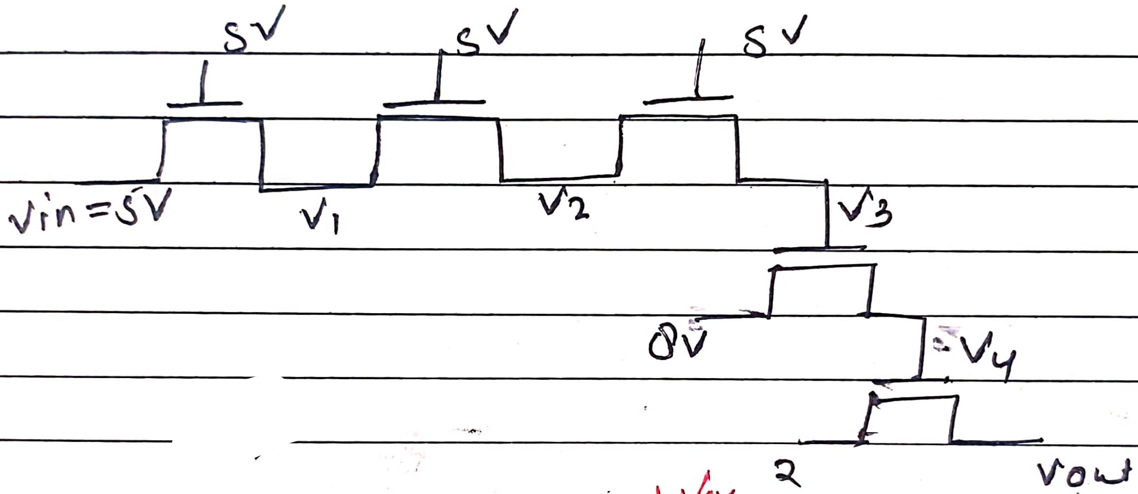
Q4)

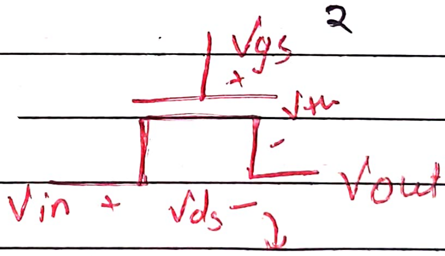


$$I_{D1} - I_{D2} = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_b - V_{th})^2(\lambda V_{DS1} - \lambda V_{DS2})$$

$$= \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_b - V_{th})^2(\lambda \Delta V)$$

Q5)





$$V_{out} = \min(V_{gs} - V_{th},\ V_{ds})$$

$V_1 = 4V$

$V_2 = 4V$

$V_3 = 4V$

$V_4 = 3V$

$\boxed{V_{out} = 2V}$