VE311 HW 6 周[illegible] 518021911039

1.(a). $A_v = -\sqrt{\dfrac{\mu_n (W/L)_1}{\mu_p (W/L)_2}} = -\sqrt{\dfrac{350\ (x/1.84)}{100\ (5/1.82)}} = -6$

$x = 51.99$

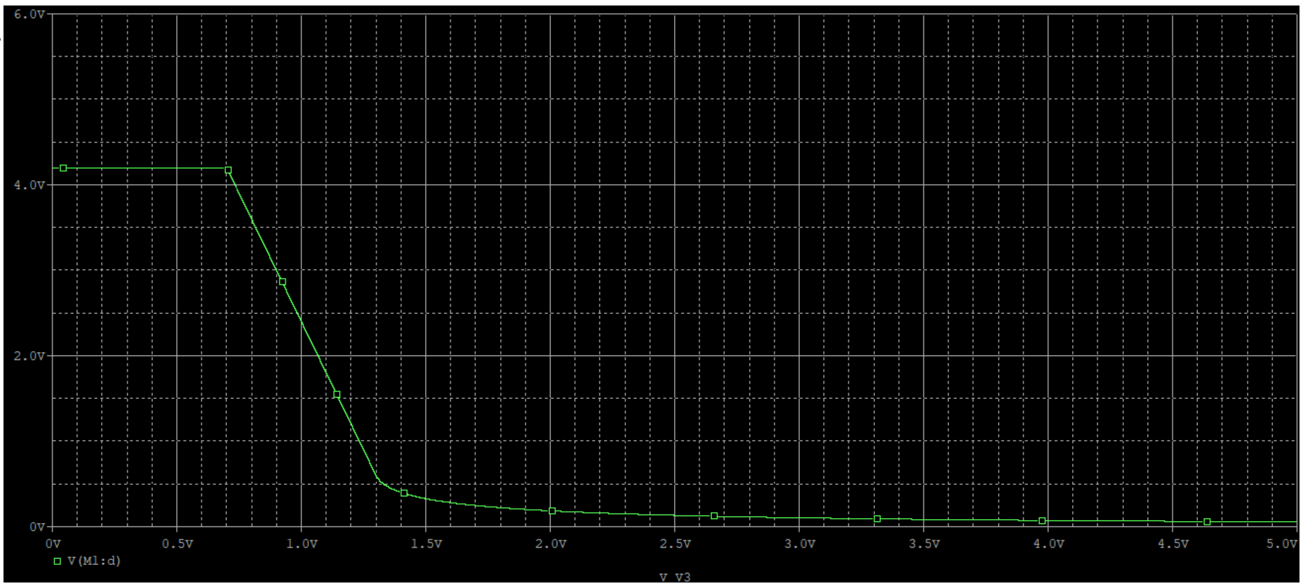
For M_1 to stay in saturation region, we know $V_{in} > 0.7V$.

$$\frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)_1 (V_{in} - V_{TH1})^2 = \frac{1}{2}\mu_p C_{ox}\left(\frac{W}{L}\right)_2 \left(V_{DD} - (V_{in} - V_{TH1}) - |V_{TH2}|\right)^2$$

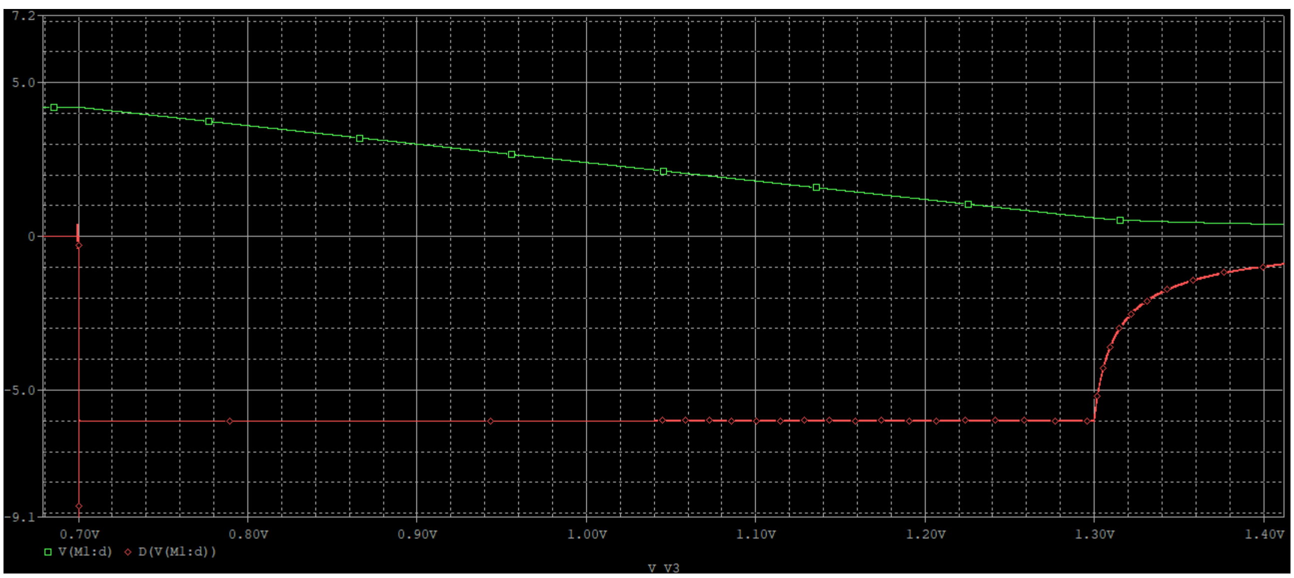
$$V_{in} = 1.3\ V$$

Therefore, $0.7V < V_{in} < 1.3\ V$

(b).

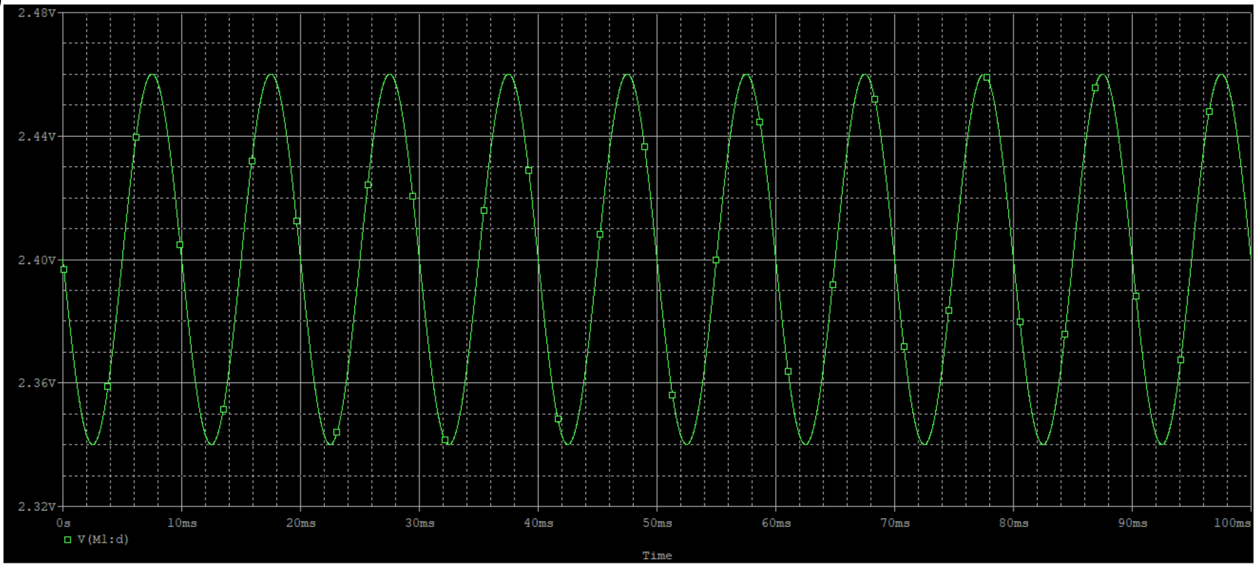


$\text{slope} = \dfrac{1.8525 - 3.6619}{1.0913 - 0.78969} = -5.9991 \approx -6$

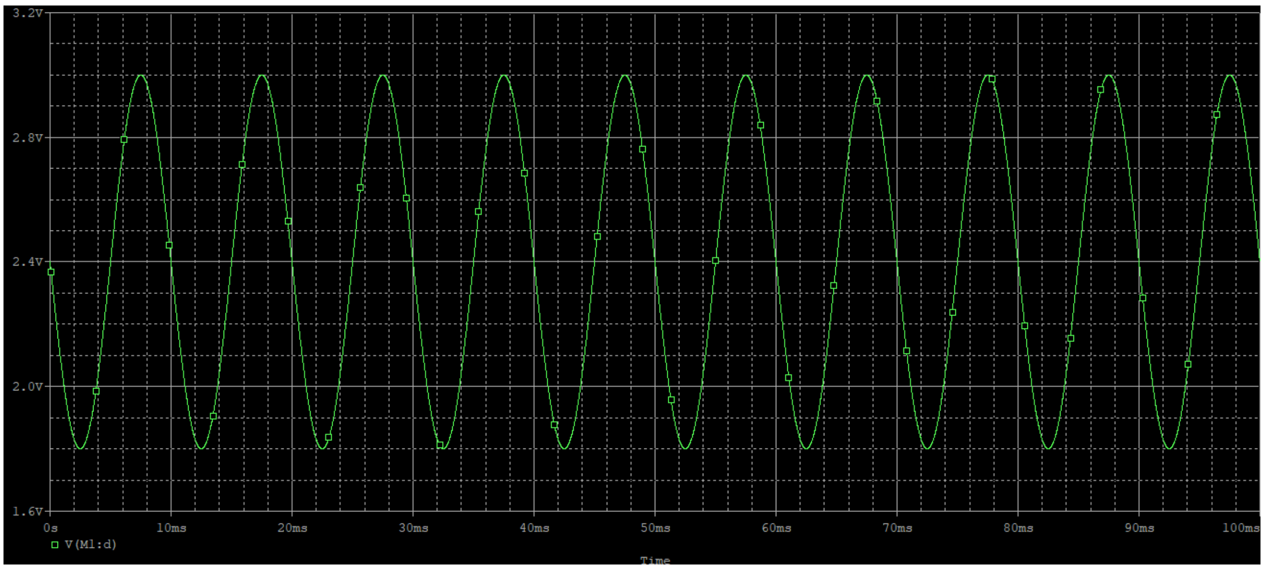


From A_v vs V_{in}, we know the range is about $0.7V \sim 1.3V$

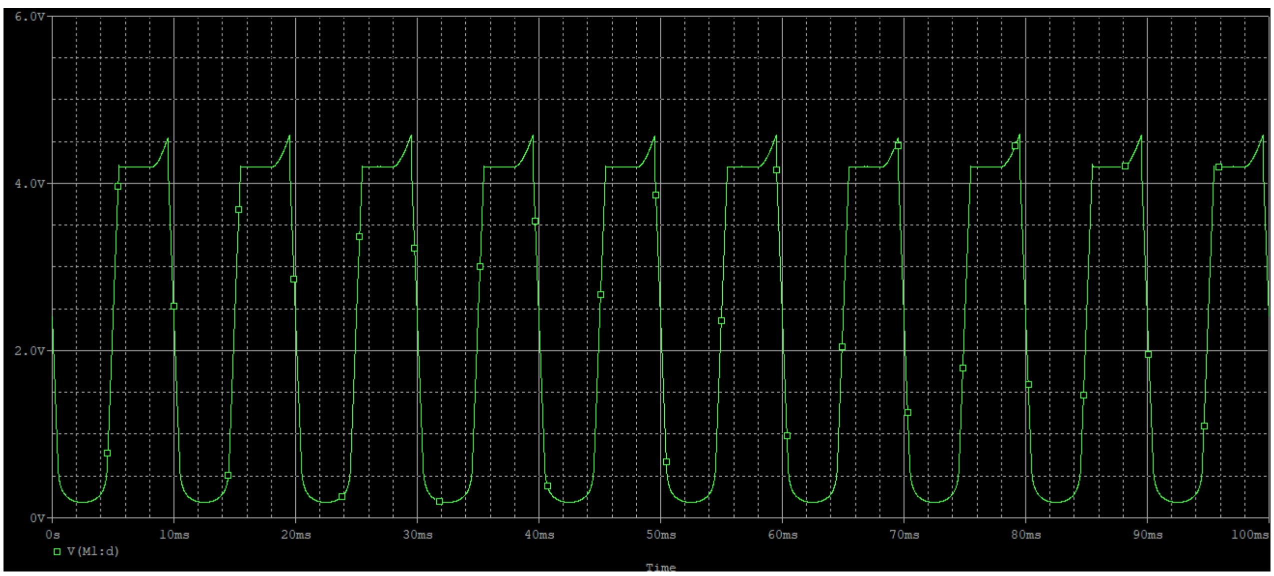
(c)



$A = 0.01\ V$



$A = 0.1 V$



$A = 1V$

When $A = 0.01\ V$ and $0.1\ V$, it is in saturation region, when $A = 1V$, sometime it is not in saturation region and Vout changes abruptly.

2. (a).

$$\begin{cases} i_o = \dfrac{-v_a}{R_s} \\ (v_{in}-v_a)\, g_{m1} + i_o = \dfrac{v_a}{r_{o1}} + v_a\, g_{mb1} \end{cases}$$

$$G_m = \frac{i_o}{v_{in}} = -\frac{1}{R_s + \frac{1}{g_{m1}}}$$

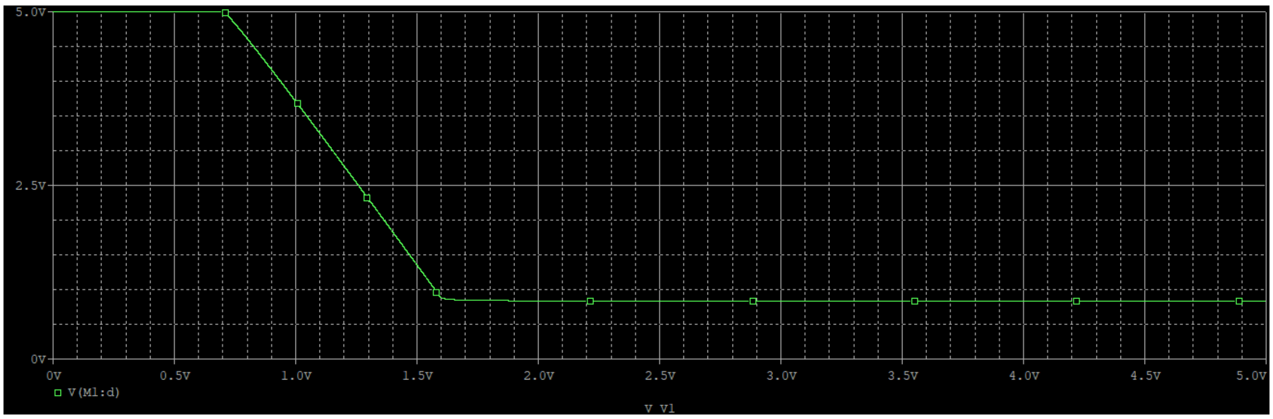
$$g_{m1} = \mu_n C_{ox} \frac{W}{L_{eff}} (V_{GS} - V_{TH}) = 8.17\times 10^{-4}$$

$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L_{eff}}\left(V_{in} - I_D\cdot R_s - V_{TH}\right)^2$$

$I_D = 2.22\times10^{-5}$ A or 2.84×10^{-5} A (This doesn't satisfy).

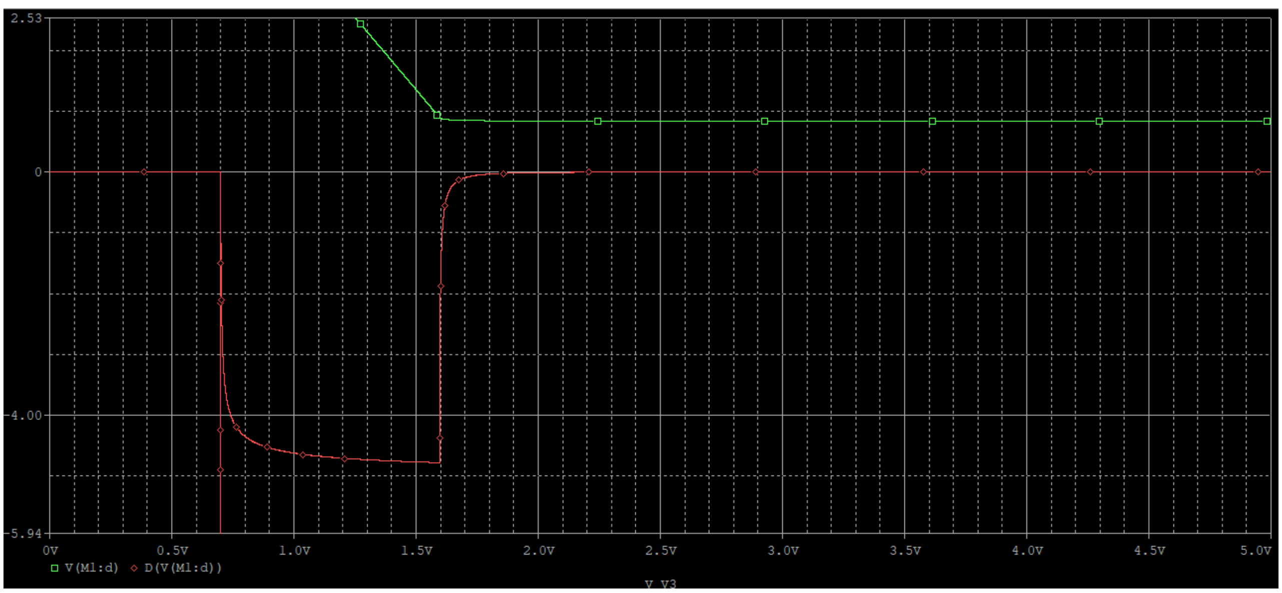
$$A_v = G_m R_{out} = -4.7 \approx -\frac{R_D}{R_s}$$

(b).

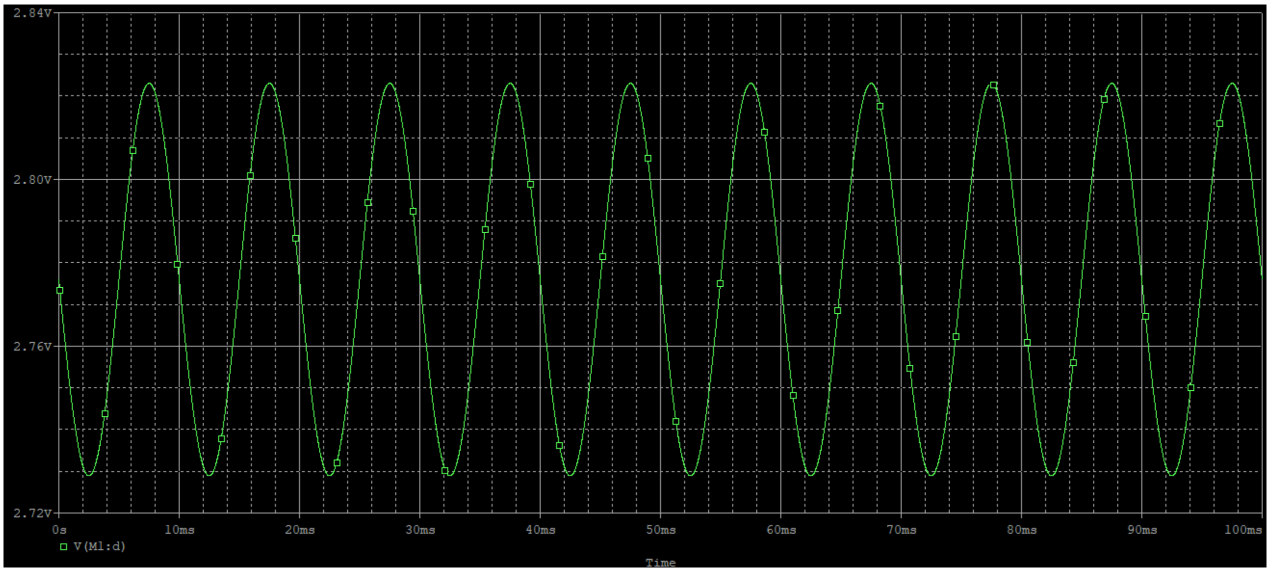


We know that (1.199, 2.7807) (1.201, 2.7714)

slope = −4.65, which is close to the result calculated in (a).



(c).


2.84V
2.80V
2.76V
2.72V
0s
10ms
20ms
30ms
40ms
50ms
60ms
70ms
80ms
90ms
100ms
V(M1:d)
Time