VE311 HW7 周[illegible] 518021911039

(a). For circuit (i). $g_{m_1} = \mu_n C_{ox} \frac{W}{L_{eff}} (V_{in} - 0.7) = 1.094 \times 10^{-3}$

$A_{v_1} = -g_m \cdot R_D = -10.94$

For circuit (ii). $A_v = -g_{m_1}(R_D \parallel R_L) = -1.82$

For circuit (iii). $I_{D1} = \frac{1}{2} \mu_n C_{ox} \left(\frac{W}{L_{eff}}\right)_1 (V_{in} - 0.7)^2 = 1.639 \times 10^{-4} A$

$V_{in2} = V_{DD} - I_{D1} \cdot R_D = 3.36\,V$

$\frac{1}{2} \mu_n C_{ox} \left(\frac{W}{L_{eff}}\right)_3 (V_b - 0.7)^2 + \frac{V_{out}}{R_L} = \frac{1}{2} \mu_n C_{ox} \left(\frac{W}{L_{eff}}\right)_2 (V_{in} - V_{out} - 0.7)^2$

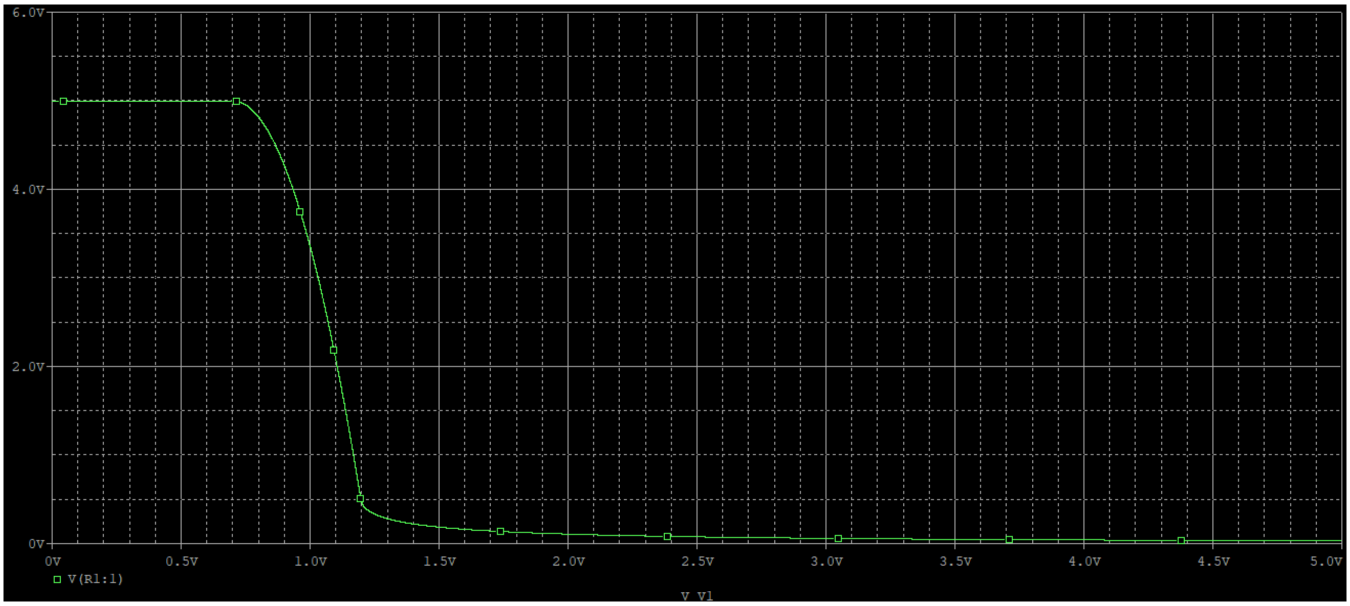
$V_{out} = 4.428$ (x) or 1.578

$g_{m_2} = \mu_n C_{ox} \left(\frac{W}{L_{eff}}\right)_2 (V_{in2} - V_{out} - 0.7) = 1.58 \times 10^{-3}$

$A_{v_2} = \frac{g_{m_2} R_L}{1 + g_{m_2} R_L} = 0.76$

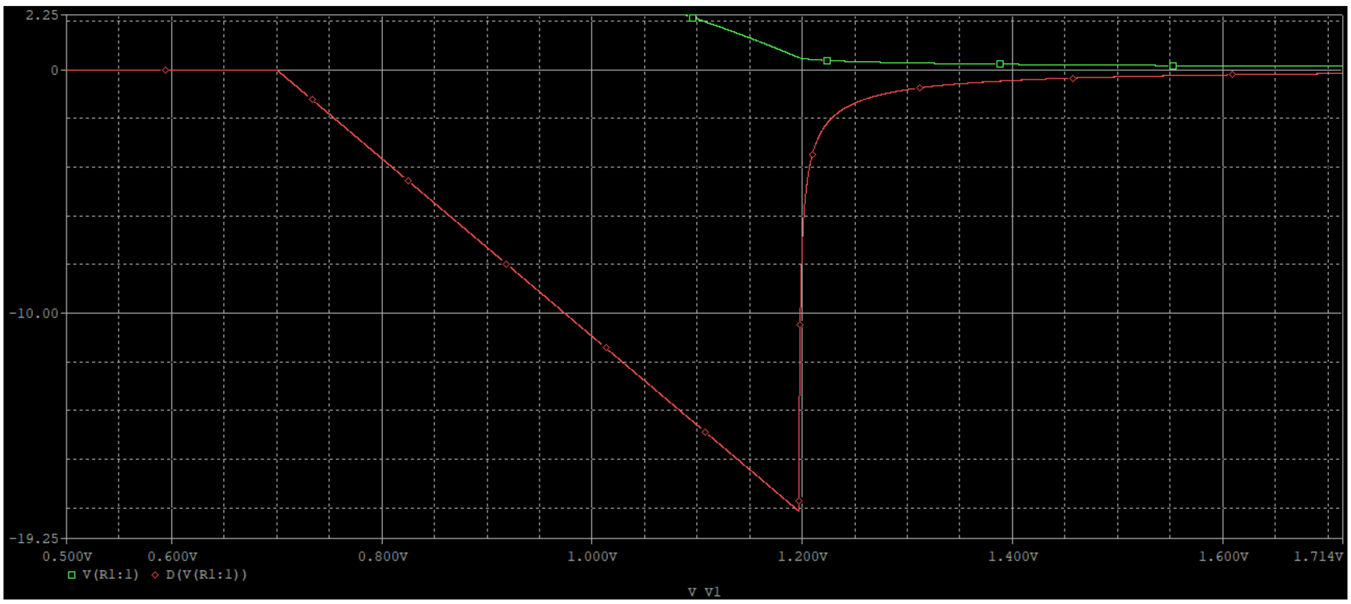
$A_v = A_{v_1} \cdot A_{v_2} = -10.94 \times 0.76 = -8.31$

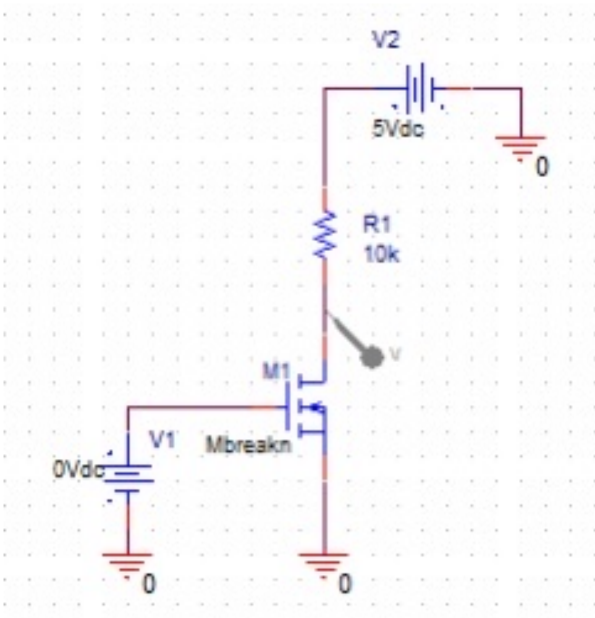
(b). Circuit (i):



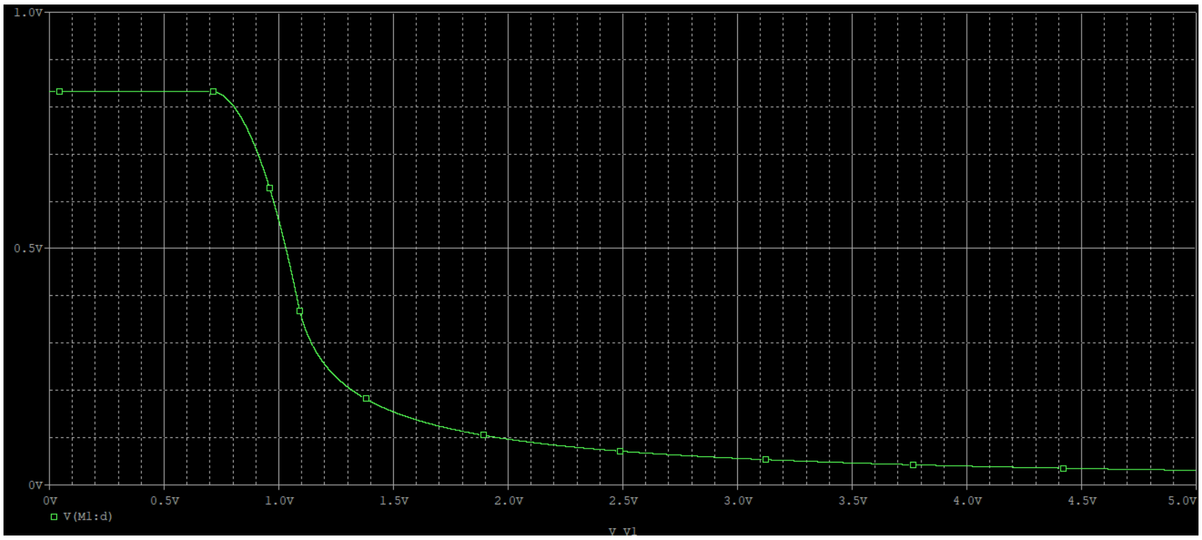
From the figure, we know (0.99, 3.4655) (1.01, 3.2477)

slope = -10.89, which is close to the value calculated in (a).

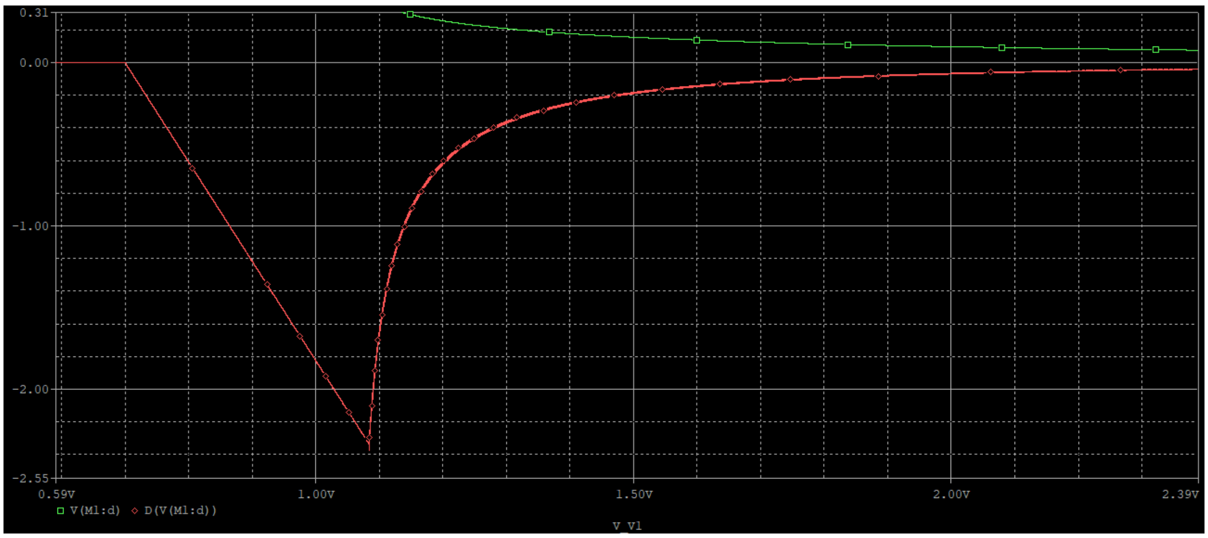


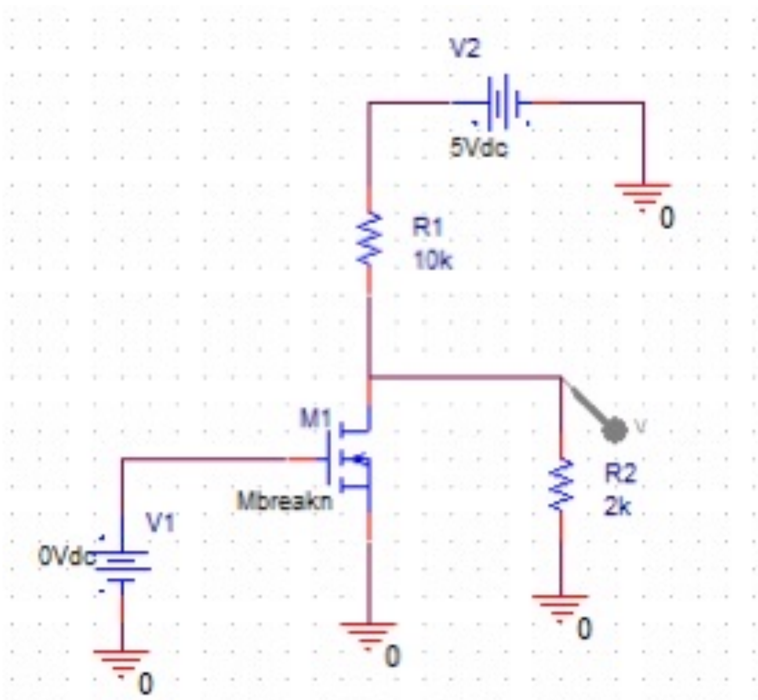


For circuit(ii)

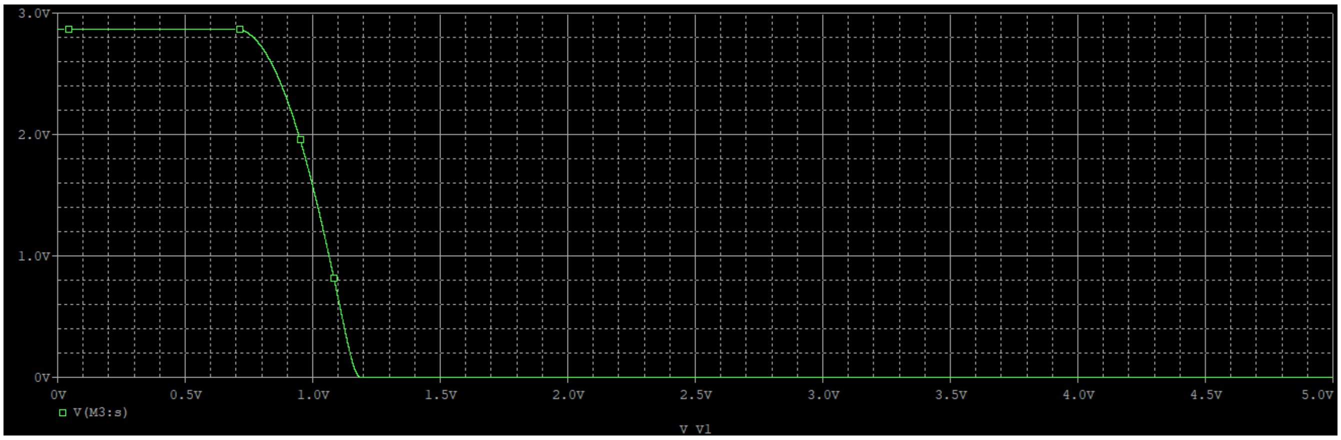


From the figure, we know (0.99, 0.577588) (1.01, 0.541116)
slope = −1.8236, which is close to the value calculated in (a).



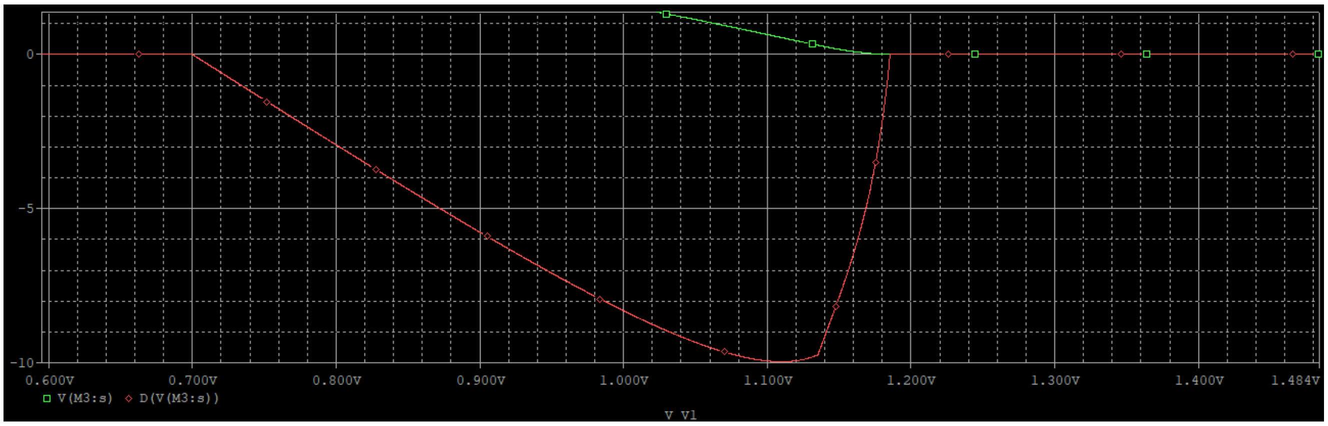


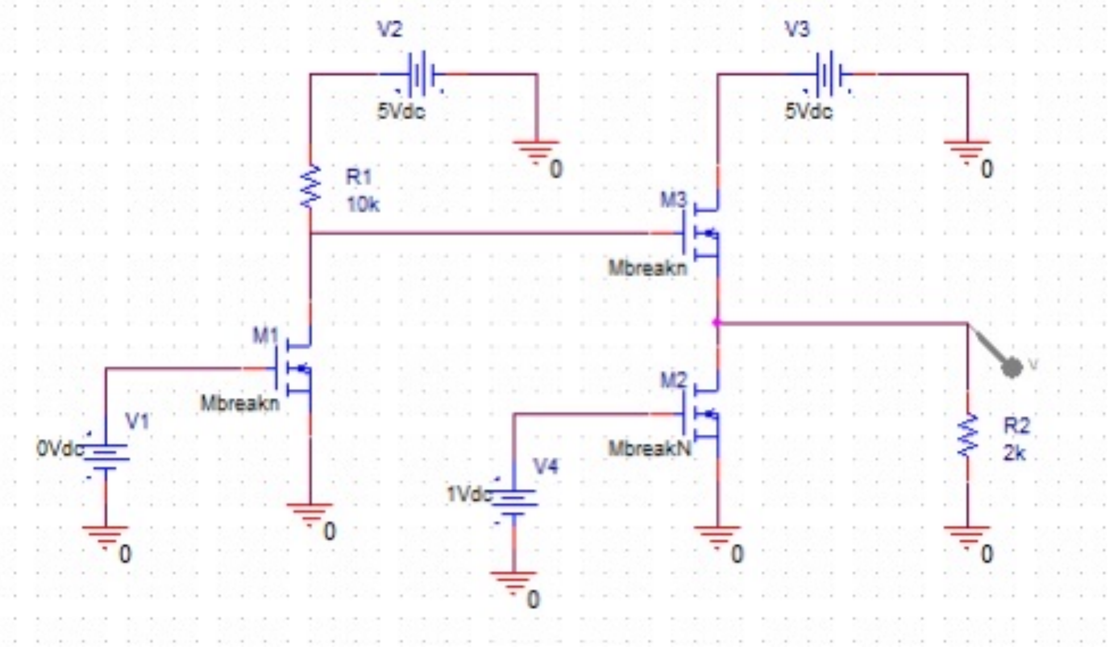
For circuit (iii)



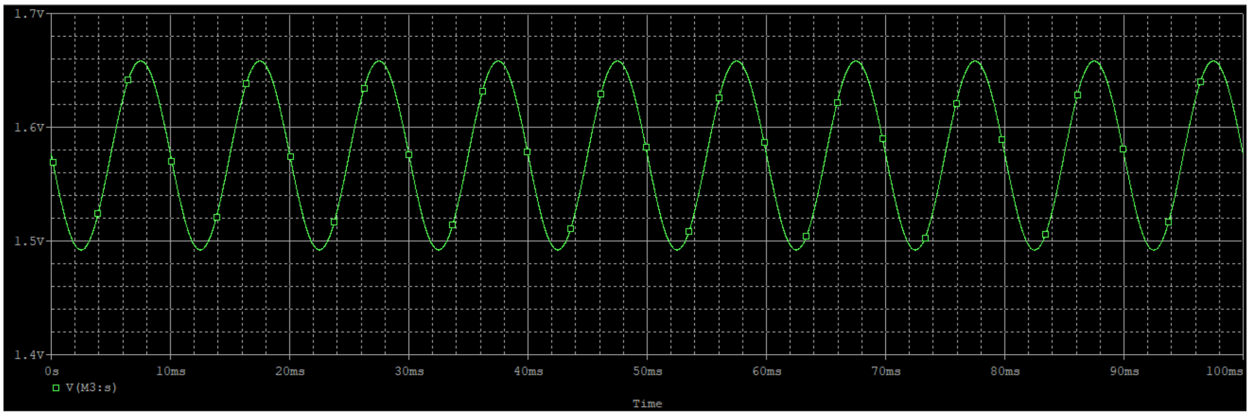
From the figure, we know (0.99, 1.6583) (1.01, 1.4921)

slope = −8.31, which is close to the value calculated in (a).



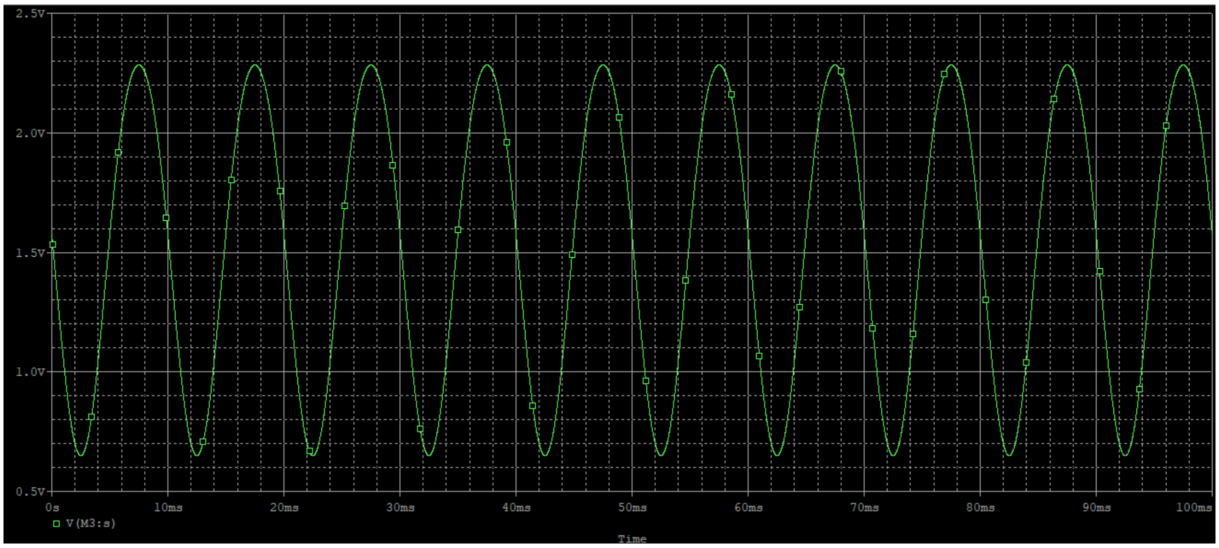


(c)、 $A = 0.01\,V$



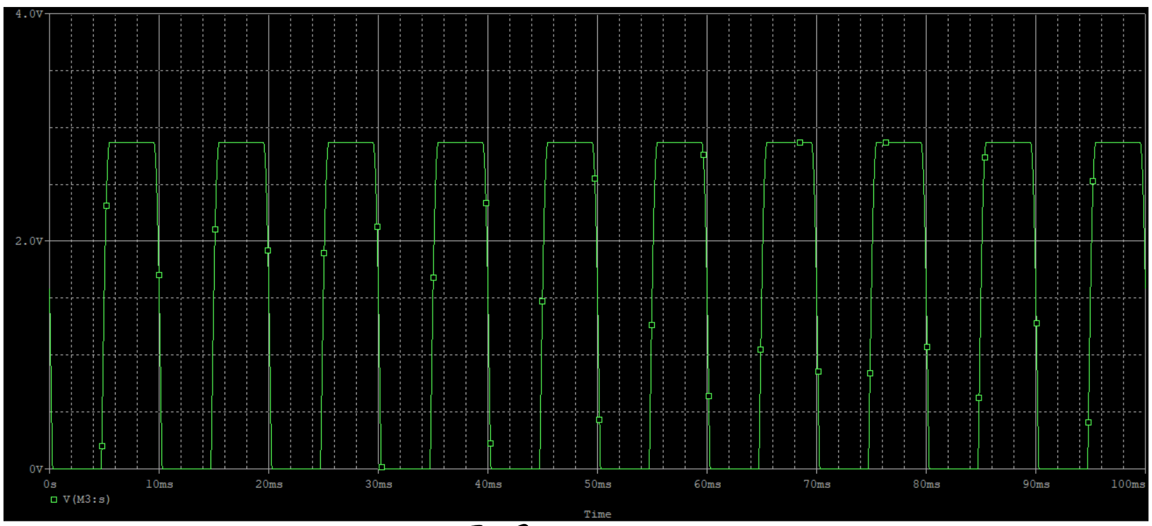
$$A_v = -\frac{0.166209}{0.01 \times 2} = -8.31045$$

$A = 0.1\,V$



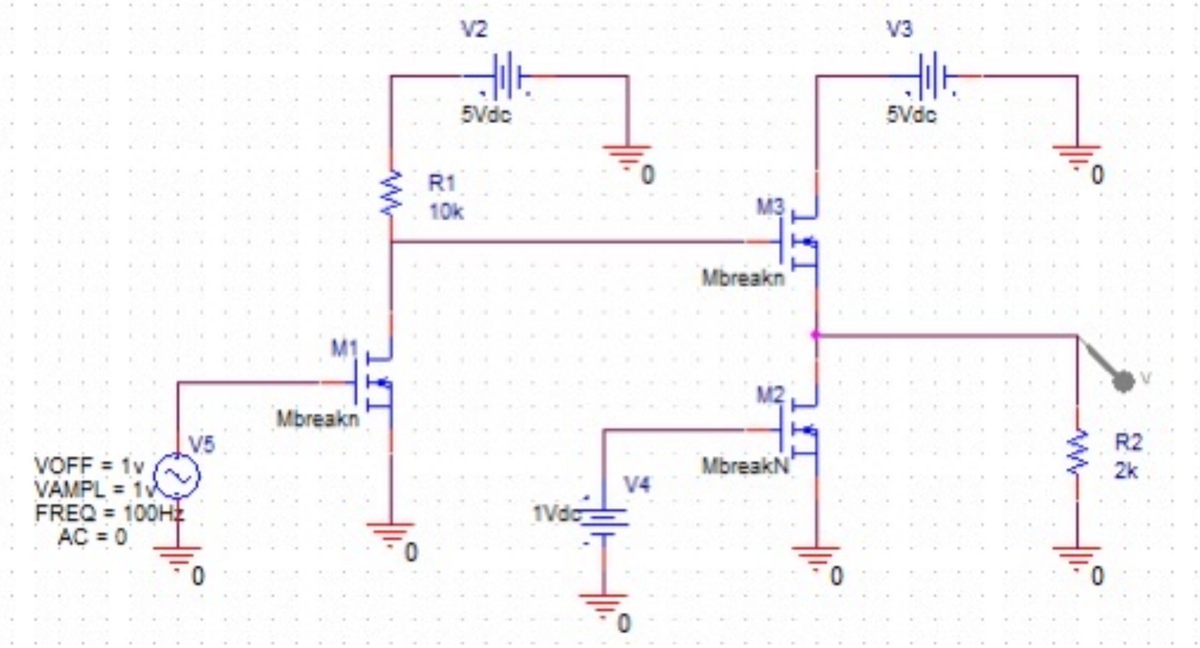
$$A_v = -\frac{1.6341}{0.1 \times 2} = -8.1705$$

$A = 1\,V$



$$A_v = -\frac{2.8668}{1 \times 2} = -1.433$$

When $A = 0.01\,V$ and $0.1\,V$, it is in saturation region. However, when A grows larger, like $1\,V$, sometimes it is not in saturation region and V_{out} changes abruptly.



V2
5Vdc
0
V3
5Vdc
0
R1
10k
M3
Mbreakn
M1
Mbreakn
V5
VOFF = 1v
VAMPL = 1v
FREQ = 100Hz
AC = 0
0
0
M2
MbreakN
V4
1Vdc
0
0
V
R2
2k
0