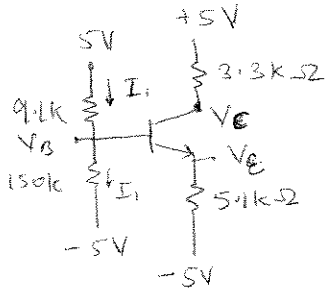
HW3

(1)



Neglecting I_B.

$$\frac{5 - V_B}{9.1K} = \frac{V_B + 5}{150k} \Rightarrow V_B = 1.224\,V$$

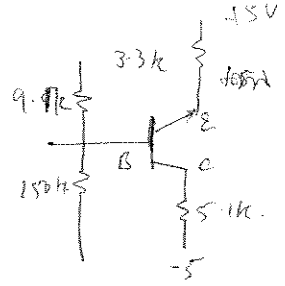
$$V_E = V_B - 0.7 = 0.524\,V$$

$$I_E = \frac{V_E + 5}{5.1K} = 1.083\,mA$$

$$\Rightarrow I_C \approx 1.083\,mA$$

$$\therefore V_C = 5 - 3.3K \times 1.083mA = 1.426\,V$$

(b) With pnp



$$V_E = V_B + 0.7 = 1.924$$

$$I_E = \frac{5 - 1.924}{3.3k} = 0.932mA$$

$$I_C = \frac{\beta}{1+\beta} I_E = 0.926\,mA$$

$$V_C = -5 + 5.1K \times 0.926m = -0.277$$

(3) With $|V_A| \neq 0$ I_C will be greater than what we have assumed here. It would be safer to calculate I_C (without $I_C \approx I_E$).
With $|V_A| \neq 0$ I_C will be more and hence V_C will be less is first case and more in second case. (This is due to change in β_F)

(2)

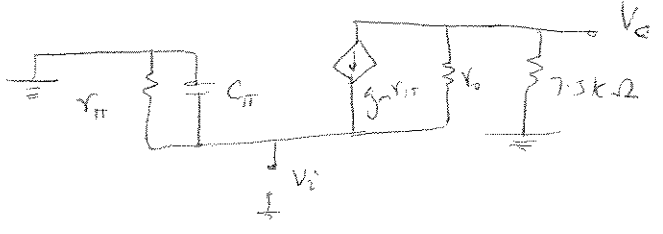
$\beta = 100$ $\quad C_\pi = 10pF$ $\quad r_x = 0$

$|V_A| = 15V$ $\quad C_\mu = 0$ $\quad I_C = \frac{100}{101}(.5mA) = .495mA$

$$r_\pi = \frac{V_T}{I_B} = 5.25k\Omega$$

$$f_T = \frac{1}{2\pi} \frac{\beta}{(C_\pi + C_\mu) r_\pi} = \frac{100}{2\pi \times 10 \times 10^{-12} \times 5.25 \times 10^3} = \frac{1.9 \times 10^9}{2\pi}$$

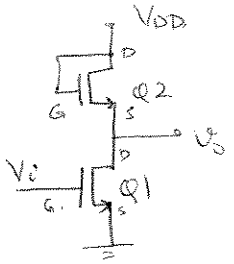
Small signal equivalent



Gain $V_o = -g_m V_{BE}$

$V_o/V_i = g_m (7.5k) = 146$

3)



Saturation.

$$\beta = \frac{\mu C_{ox}}{2} \frac{W}{L}$$

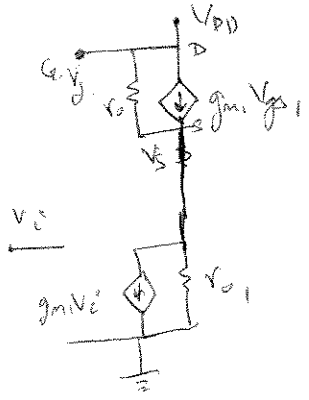
$$\Rightarrow I_{D1} = I_{D2}$$

$$\Rightarrow \frac{\beta_2}{2}\left(V_{GS2} - V_{t2}\right)^2 = \frac{\beta_1}{2}\left(V_{GS1} - V_{t1}\right)^2$$

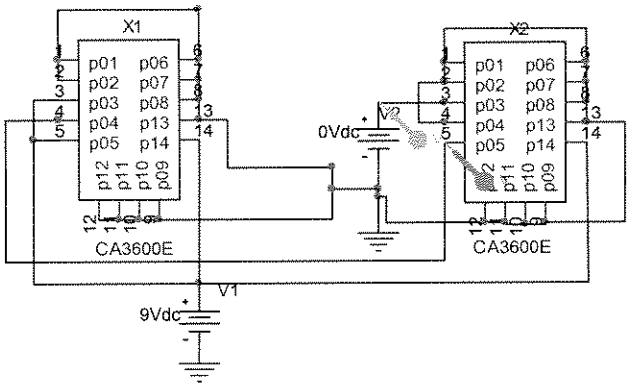
$$\Rightarrow \frac{V_{GS2} - V_{t2}}{V_{GS1} - V_{t1}} = \sqrt{\frac{\beta_1}{\beta_2}} = \sqrt{\frac{W_1/L_1}{W_2/L_2}}$$

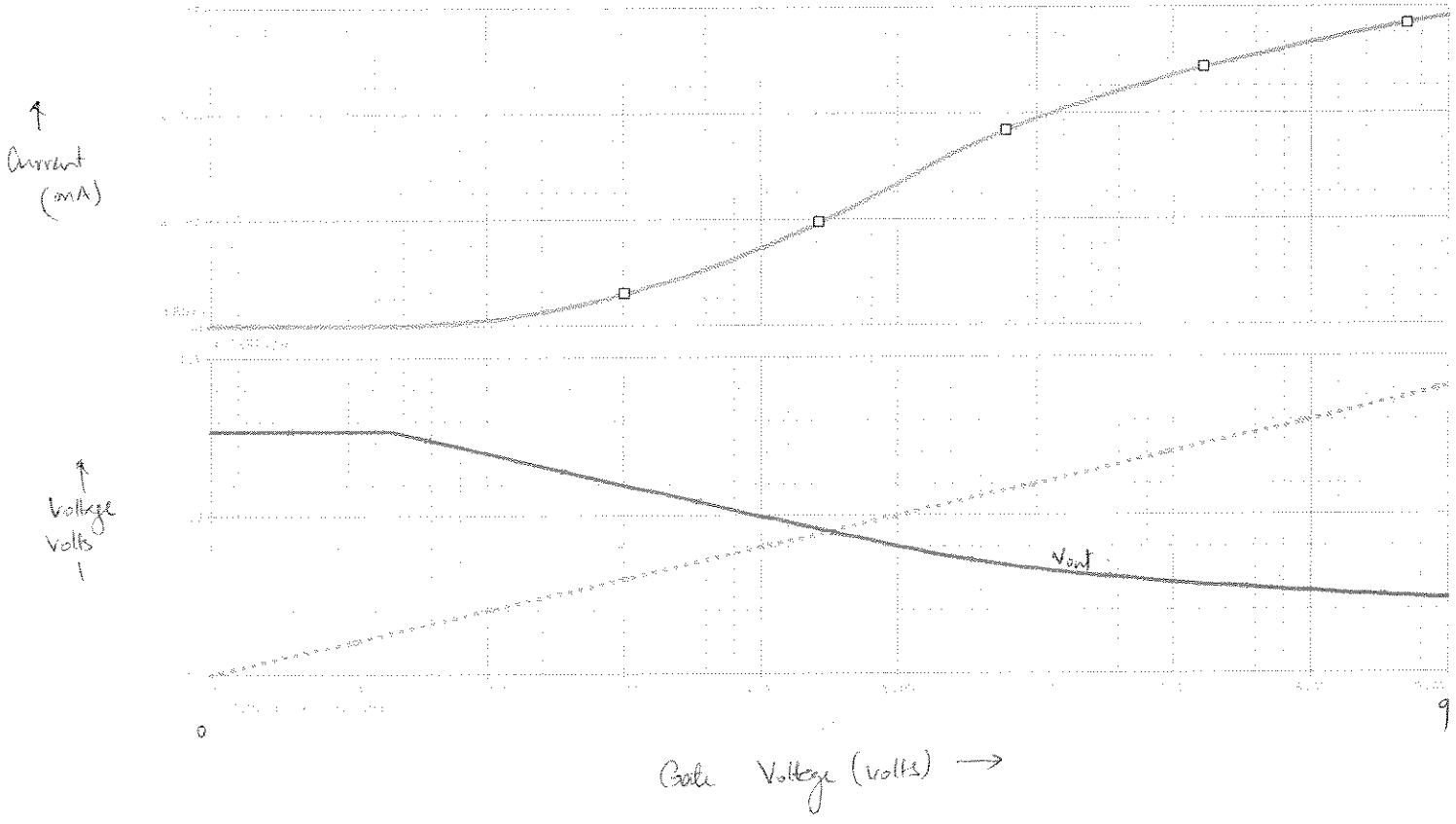
$$\Rightarrow \boxed{V_{GS2} = \sqrt{\frac{(W/L)_1}{(W/L)_2}}\,(V_1 - 0) - \sqrt{\frac{(W/L)_1}{(W/L)_2}}\,V_{t1} + V_{t2}}$$

Small signal



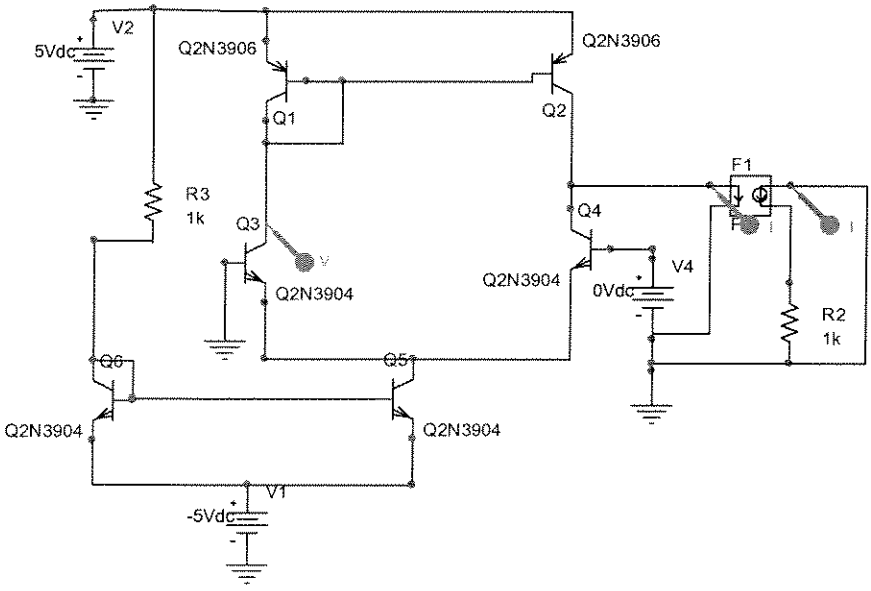
(3)

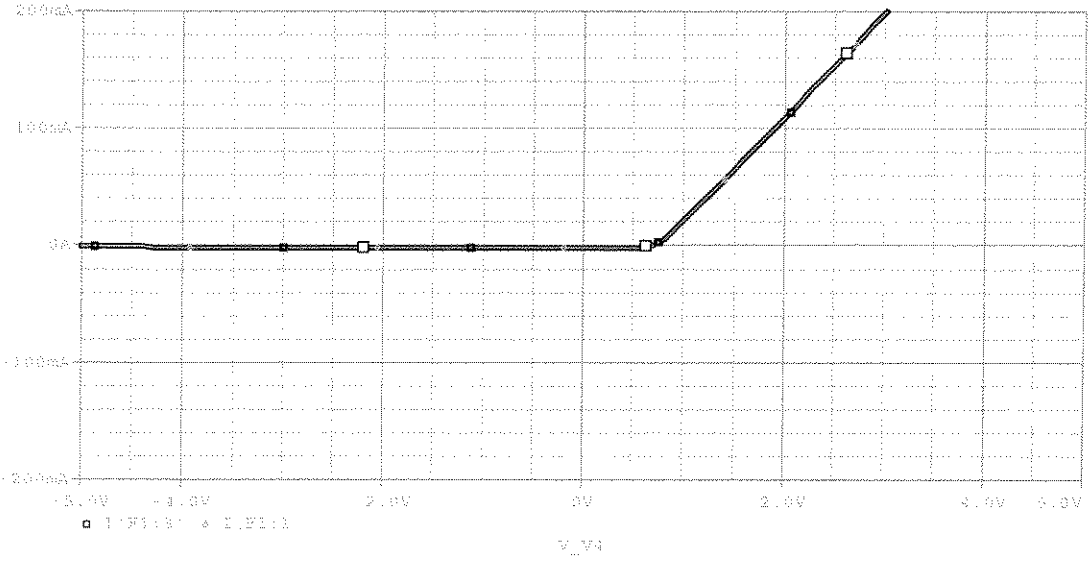

X1
X2
p01 p06
p02 p07
p03 p08
p04 p13
p05 p14
p12 p11 p10 p09
CA3600E
CA3600E
0Vdc
V2
V1
9Vdc


Current (mA)
Voltage Volts
Vout
0
9
Gate Voltage (volts) →

HW4

(1)

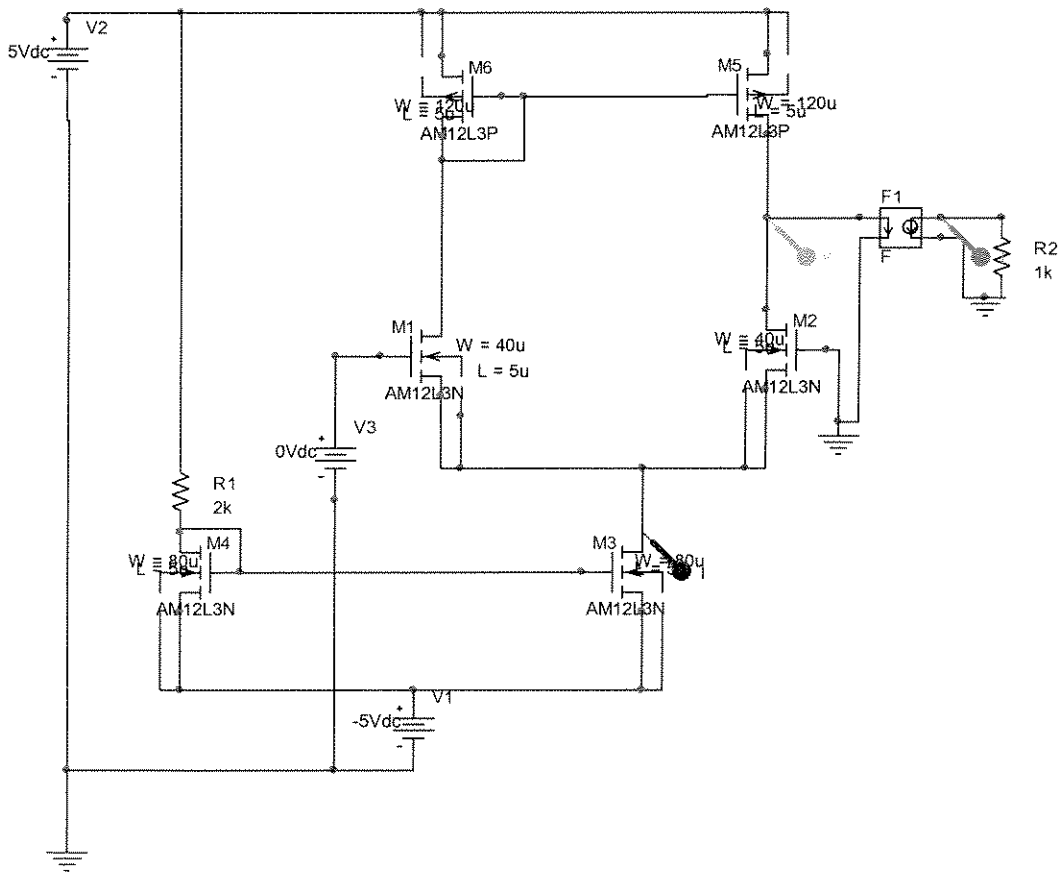


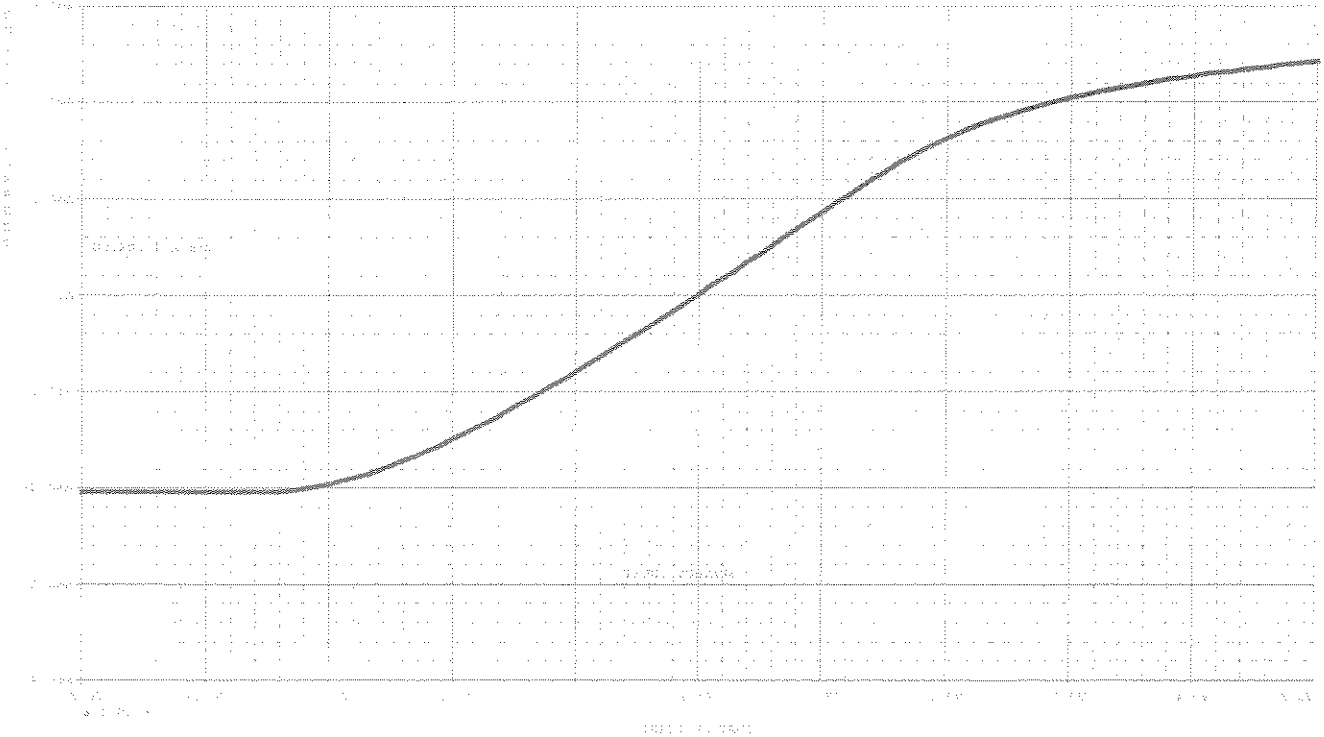


I_{out}

Voltage (V4) →

(2)

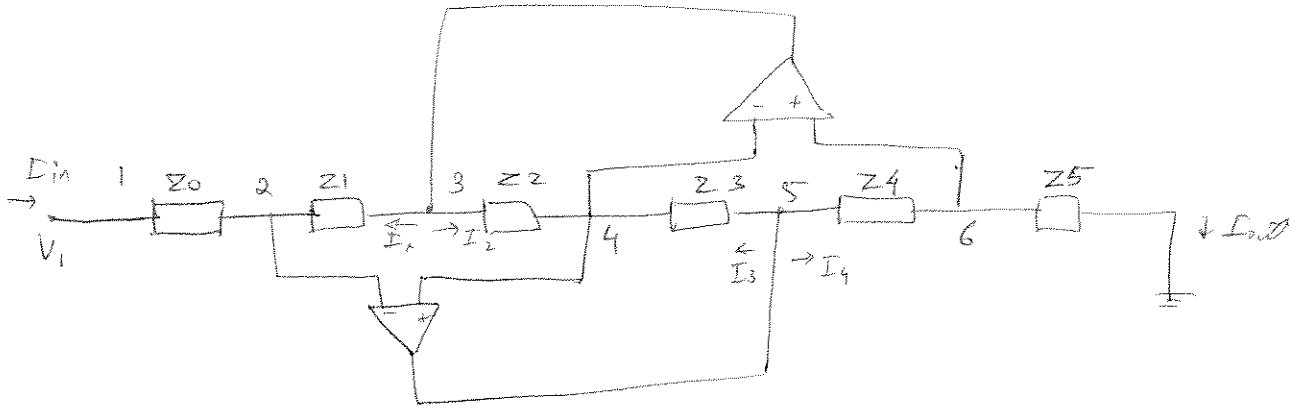




↑
I_{out}

V_3 (Volts) →

(3)



$$V_2 = V_4 \Rightarrow I_1 Z_1 = I_2 Z_2 \Rightarrow -I_{in} = \frac{Z_2}{Z_1} I_1 \quad (1)$$

$$V_4 = V_6 \Rightarrow I_4 Z_4 = I_3 Z_3 \Rightarrow -I_{in} Z_4 = I_3 Z_3 \quad (2)$$

(1) & (2) $\Rightarrow$ $\frac{Z_2}{Z_1} I_1 = \frac{Z_3}{Z_4} I_3 \Rightarrow I_1 = \frac{Z_1 Z_3}{Z_2 Z_4} I_3 \cdot Z_5 \Rightarrow V_6 = \frac{Z_1 Z_3 Z_5}{Z_2 Z_4} I_{in}$

also $V_2 = V_4 = V_6$

$$V_1 = Z_0 I_{in} + V_2 \Rightarrow V_2 = V_1 - Z_0 I_{in}$$

$$\Rightarrow V_6 = V_1 - Z_0 I_{in}$$

$$\frac{V_6}{I_{in}} = \frac{V_1 - Z_0 I_{in}}{I_{in}}$$

$$\frac{Z_1 Z_3 Z_5}{Z_2 Z_4} = Z_{in} - Z_0$$

$$\Rightarrow Z_{in} = Z_0 + \frac{Z_1 Z_3 Z_5}{Z_2 Z_4}$$

(b) Substitute given values to get the results.