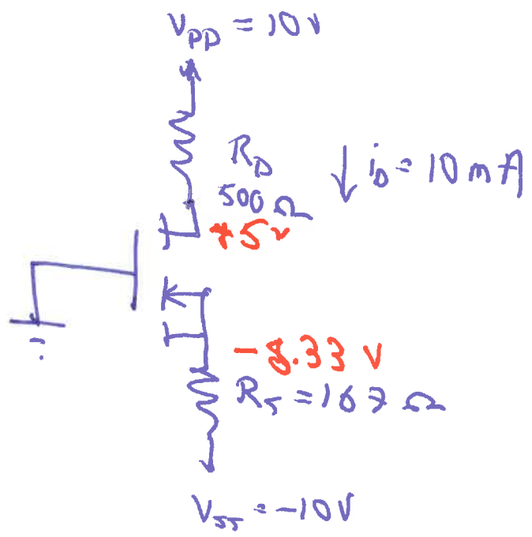
10 Nov 2016



$V_{DS} = 5v - (-8.33V) = 13.33\,V$

Power $i_D V_{DS} = 10^{-2}A \times 13.33V = 130mW$

Volume

$L \times W \times T = 10^{-5}m \times 10^{-4}m\ 10^{-5}m$

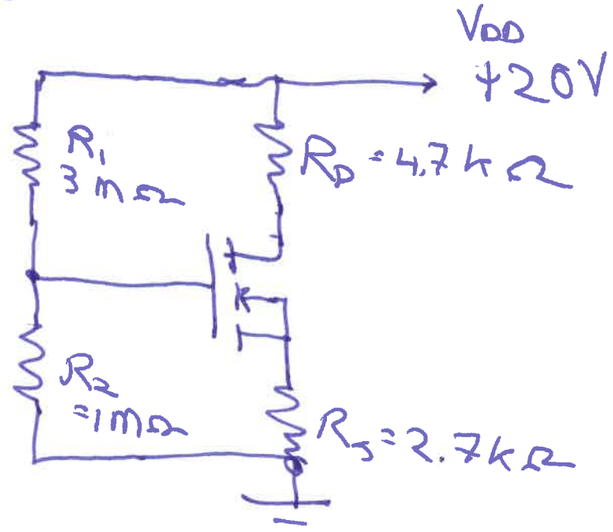
$= 10^{-14}\,m^3$

$10^{-8}\,cm^3$

$\frac{Power}{Volume} = 1.3 \times 10^{7}\ \frac{J}{5 \cdot cm^3}$

4.18 J = 1 Calorie

DC Bias



$KP = 50\,\mu A/V^2$, $W = 400\,\mu m$ $L = 10\,\mu m$

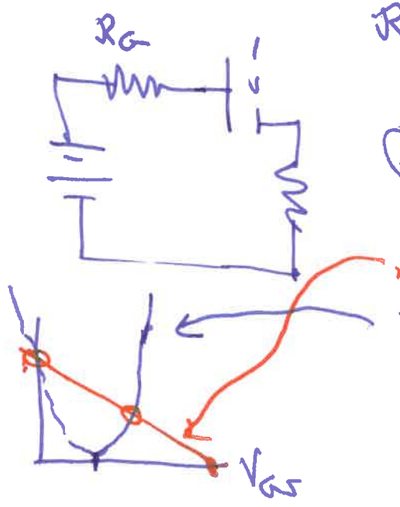
$V_{TO} = 2V$ $\lambda = 0$

① $K = \frac{W}{L}\frac{KP}{2} = 1\,mA/V^2$ (Large)

② $I_G = 0$

$V_G = V_{DD}\,\frac{R_2}{R_1+R_2}\,20V\,\frac{1M}{3M+M}$

$R_G = R_1 \| R_2 = 750K$



③ $V_{GS} = ?$

$V_G = V_{GS} + I_D R_S$

$I_D = K\cdot(V_{GS} - V_{TO})^2$

Assumes Saturation

$$V_G = V_{GS} + K(V_{GS} - V_{TO})^2 R_S$$

Solve for V_{GS} Remember $V_G = 5$ Volts

$$V_G = V_{GS} + K V_{GS}^2 R_S - K 2 V_{GS} V_{TO} R_S + K V_{TO}^2 R_S$$

$$K V_{GS}^2 R_S + V_{GS} - 2K V_{TO} V_{GS} R_S + K V_{TO}^2 R_S - V_G = 0$$

$$a V_{GS}^2 + b V_{GS} + C = 0$$

$a = K R_S$

$b = 1 - 2K V_{TO} R_S$

$C = K V_{TO}^2 R_S - V_G$

$\frac{A}{V^2} \frac{V}{A} = V^{-1}$

$\frac{A}{V^2} V \frac{V}{A} = 1$ (dimensionless)

$\frac{A}{V^2} V^2 \frac{V}{A} = V$

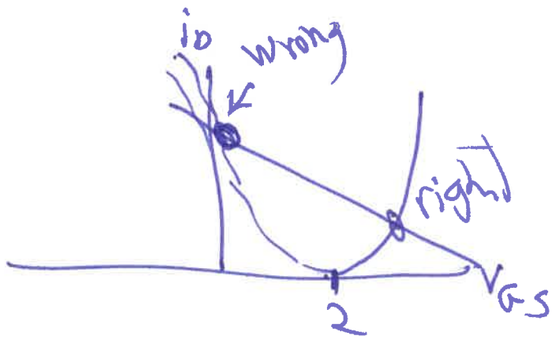
$$a = 1 \frac{mA}{V^2} \times 2.7k\Omega = 2.7\ V^{-1}$$

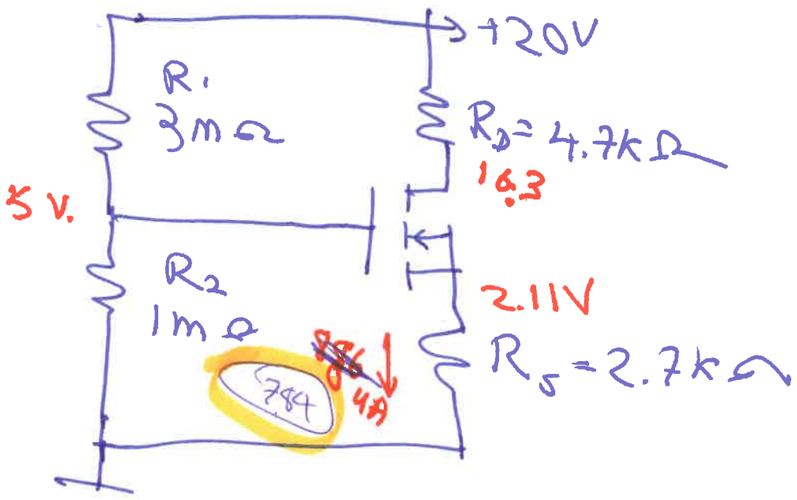
$$b = 1 - 2 \times 1 \frac{mA}{V^2} 2V \times 2.7k\Omega = -9.8$$

$$C = 1 \frac{mA}{V^2} \times 4V^2 \times 2.7k\Omega - 5V = 5.8V$$

$$V_{GS} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$= [0.744, 2.886] \text{ volts}$$





$V_{GS} = 2.886\,V$

$V_S = 2.11\,V$

$i_D = k(V_{GS} - V_{TO})^2$

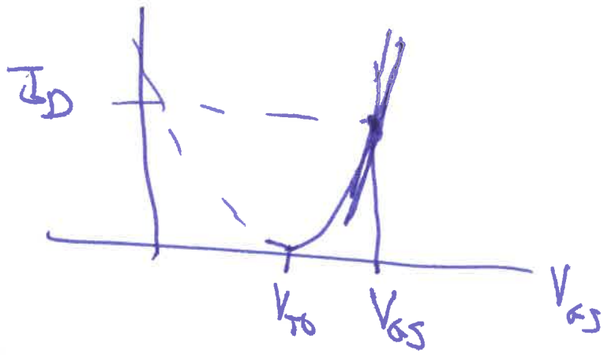
$= 1\,\frac{mA}{V^2}(0.886\,V)^2$

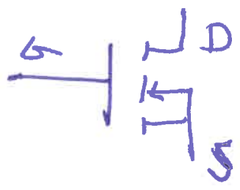
$= \cancel{784\,mA}\ 886\ \mu A$

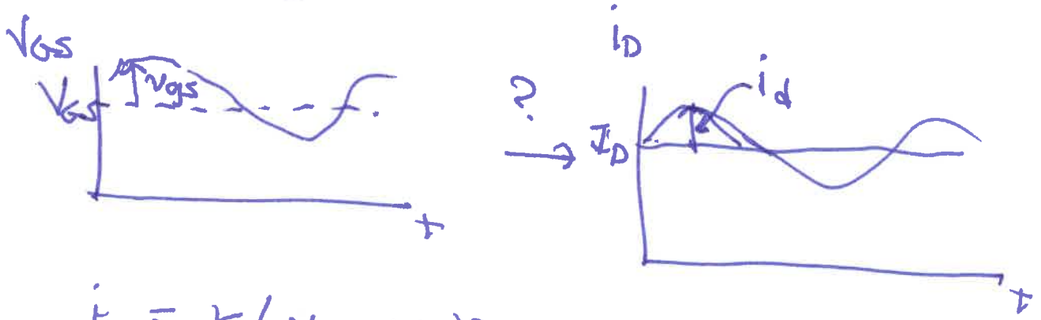
784

$V_D = 20V - I_D R_D$

$= 20\,v - \cancel{886\,\mu A}\ 784 \times 4.7k = 16.3\,V$







$$i_D = K(V_{GS} - V_{TO})^2 = I_D + i_d$$

$$\approx I_D + \left.\frac{di_D}{dV_{GS}}\right|_{V_{GS}=V_{GS}} v_{gs}$$

$$i_d = g_m v_{gs} \qquad \text{where } g_m = \frac{di_D}{dV_{GS}}$$

$$g_m = 2K(V_{GS} - V_{TO}) = 2\sqrt{K I_D}$$