MOSFET DATA: $\mu_n W/L = 1.2 \times 10^4 \ cm^2 V^{-1} s^{-1}$

$C_{ox} = 3.98 \times 10^{-8}\ F/cm^2$ (87 nm oxide)

$N_a = 2 \times 10^{16}\ cm^{-3}$ $\quad V_{FB} = -0.5\,V$

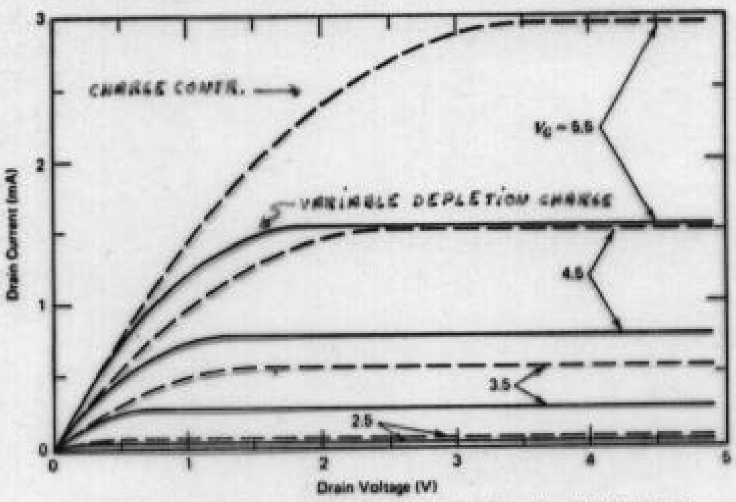


Figure 9.7 Theoretical predictions of I_D versus V_D using Equations 9.1.16 (dashed curves) and 9.1.15 (solid curves) for MOSFET having parameters given in the text. (I_D is taken to be equal to I_{Dsat} for $V_D > V_{Dsat}$.)

$V_S = V_B = 0$

CHARGE CONTROL

$$I_{D_1} = \mu_n \frac{W}{L}\left[C_{ox}\left(V_G - V_{FB} - 2|\phi_p| - \frac{1}{2}V_D\right)V_D - 2V_D\sqrt{\epsilon_s q N_a |\phi_p|}\right]$$

VARIABLE DEPLETION-CHARGE

$$I_{D_2} = \mu_n \frac{W}{L}\left\{C_{ox}\left(V_G - V_{FB} - 2|\phi_p| - \frac{1}{2}V_D\right)V_D - \frac{2}{3}\sqrt{2\epsilon_s q N_a}\left[\left(2|\phi_p| + V_D\right)^{3/2} - \left(2|\phi_p|\right)^{3/2}\right]\right\}$$

EQUATIONS FOR CIRCUIT ANALYSIS

$$I_{DSAT}^{CC} > I_{DSAT}^{VDC}$$

↑ SIMPLE ↑ ACCURATE

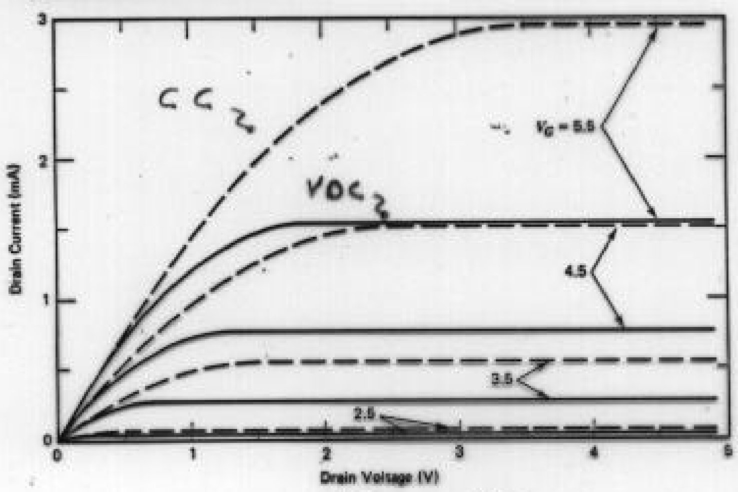
TO BE DETERMINED

$$(\text{NUMER})\ I_{DSAT}^{VDC} = k'\frac{W}{2L}(V_G - V_T)^2 = \frac{k}{2}(V_G - V_T)^2 \qquad (9.1.17)$$

C-C EXPRESSION

$$I_D = k\left[(V_G - V_T)V_{DS} - \frac{V_{DS}^2}{2}\right]$$

NEW PREFACTOR



V_G (V)	VDC $V_{Dsat\,2}$ (V)	VDC $I_{Dsat\,2}$ (mA)
5.5	1.94	1.55
4.5	1.34	0.77
3.5	0.77	0.27
2.5	0.25	0.03

To obtain $k/2$ we must calculate V_T. By applying Equation 8.3.18, we find $V_T = 1.98$ V. We then use Equation 9.1.17 to write

$$\frac{k}{2} = \frac{I_{Dsat\,3}}{(V_G - V_T)^2} = \frac{1.55 \times 10^{-3}}{(5.5 - 1.98)^2} = 1.25 \times 10^{-4}\ \mathrm{AV^{-2}}$$

Using this value of $k/2$ in Equation 9.1.17 at the other gate biases, we find

V_G (V)	$I_{Dsat\,3}$ (mA)
5.5	1.55
4.5	0.79
3.5	0.29
2.5	0.03

} NEW VALUES FROM MODIFIED C-C ANALYSIS.