n-MOSFET(D):: (I-V) Equations

Cut off Mode	**Drain current**	$i_D = 0$
	Gate to Source Voltage	$V_{GS} < V_{TN}$
	Gate to drain Voltage	(.)
Linear Mode	**Linear Drain current (V_{DS} < 1V)**	$i_D \cong k_n\left(\frac{W}{L}\right)\cdot\left(V_{GS}-V_{TN}\right)V_{DS}$
	Triode Drain current	$i_D = k_n\left(\frac{W}{L}\right)\cdot\left[\left(V_{GS}-V_{TN}\right)V_{DS}-V_{DS}^2/2\right]$
	Gate to Source Voltage	$V_{GS} > V_{TN}$
	Gate to drain Voltage	$V_{GD} > V_{TN}$
Saturation Mode	**Drain current**	$i_D = \frac{1}{2}k_n\left(\frac{W}{L}\right)\cdot\left(V_{GS}-V_{TN}\right)^2$
	Drain current with λ	$i_D = \frac{1}{2}k_n\left(\frac{W}{L}\right)\cdot\left(V_{GS}-V_{TN}\right)^2\cdot\left(1+\lambda\cdot V_{DS}\right)$
	Gate to Source Voltage	$V_{GS} > V_{TN}$
	Gate to drain Voltage	$V_{GD} < V_{TN}$
Linear/Saturation Boundary	**Drain to Source Voltage**	$V_{DS} = V_{GS} - V_{TN}$

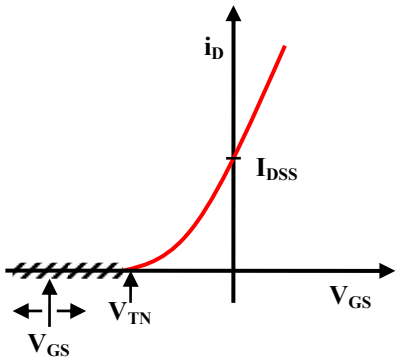
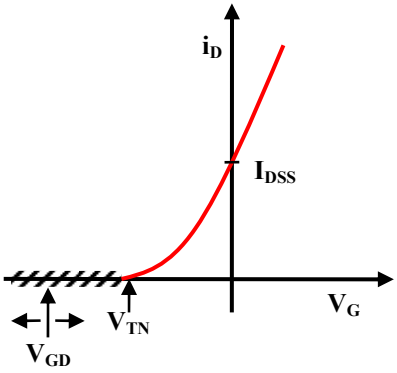
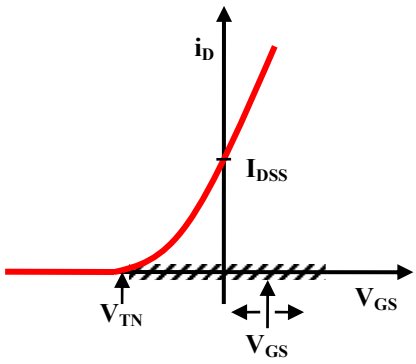
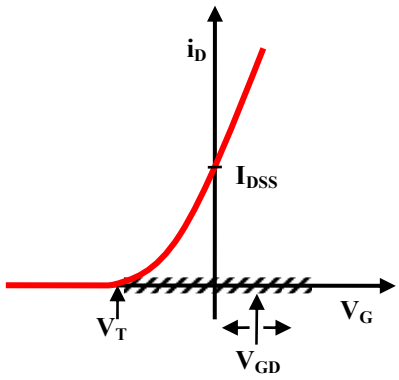
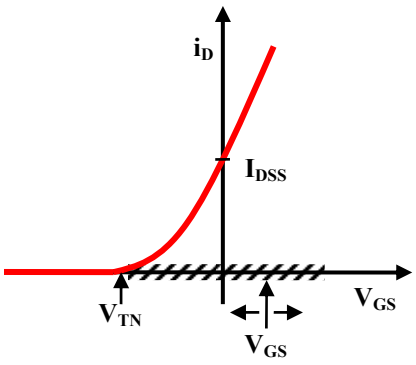
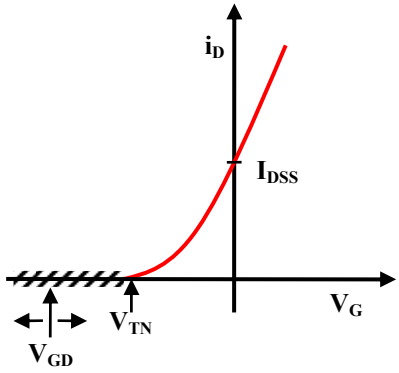
n-MOSFET(D):: Parameters

Process parameter [A/V^2]	$k_n = \mu_n C_{ox}$
Current Gain [A/V^2]	$\beta_n = k_n\cdot\left(\frac{W}{L}\right)$
Early Voltage	$\lambda = \frac{1}{V_A}$
Body Effect Parameter [$\sqrt{V}$]	$\gamma = \sqrt{2qN_a}/C_{ox}$
Oxide Capacitance [F/cm^2]	$C_{ox} = \frac{K_{ox}\in_o}{t_{ox}}$
Threshold Voltage	$V_{TN} = V_{TO} + \gamma\left(\sqrt{2\phi_f + V_{SB}} - \sqrt{2\phi_f}\right)$
Zero Potential Current (V_{GS} = 0)	$I_{DSS} \equiv \frac{\beta_n}{2}\lvert V_{TN}\rvert^2$
Depletion n-MOSFET Threshold Voltage	$V_{TN} < 0$

n-MOSFET(D):: Small Signal Parameters

Transconductance [A/V]	$g_m = \beta_n \cdot (V_{GS} - V_{TN})$
Transconductance [A/V]	$g_m = \sqrt{2k_n(W/L)} \cdot \sqrt{I_D}$
Transconductance [A/V]	$g_m = \frac{2I_D}{V_{GS} - V_{TN}}$
Transconductance of Body [A/V]	$g_{mb} = \chi \cdot g_m$
Body effect	$\chi = \gamma \cdot \left(2\sqrt{2\phi_f + \lvert V_{SB} \rvert}\right)$
Gate to Source capacitance [F/cm^2]	$C_{gs} = \frac{2}{3}(W \times L)C_{ox} + (W \times L_{ov})C_{ox}$
Gate to Drain capacitance [F/cm^2]	$C_{gd} = (W \times L_{ov})C_{ox}$
Source to Body capacitance [F/cm^2]	$C_{sb} = \frac{C_{sbo}}{\sqrt{\left(1 + \frac{\lvert V_{SB} \rvert}{V_o}\right)}}$
Drain to Body capacitance [F/cm^2]	$C_{db} = \frac{C_{dbo}}{\sqrt{1 + \frac{\lvert V_{SB} \rvert}{V_o}}}$
Maximum operating frequency [Hz]	$f_T = \frac{g_m}{2\pi(C_{gs} + C_{gd})}$

n-MOSFET(D):: Input Characteristics

	V_{GS}	V_{GD}
Cut off Mode		
Linear Mode		
Saturation Mode		
Enhancement n-MOSFET	**Shift all curve to positive Threshold Voltage ($V_{TN} > 0$)**	

p-MOSFET(D):: (I-V) Equations

Cut off Mode	**Drain current**	$i_D = 0$
	Gate to Source Voltage	$V_{GS} > V_{TP}$
	Gate to drain Voltage	(.)
Linear Mode	**Linear Drain current ($\|V_{DS}\| < 1V$)**	$i_D \cong k_p\left(\frac{W}{L}\right)\cdot\left(V_{GS}-V_{TP}\right)V_{DS}$
	Triode Drain current	$i_D = k_p\left(\frac{W}{L}\right)\cdot\left[\left(V_{GS}-V_{TP}\right)V_{DS}-V_{DS}^2/2\right]$
	Gate to Source Voltage	$V_{GS} < V_{TN}$
	Gate to drain Voltage	$V_{GD} < V_{TN}$
Saturation Mode	**Drain current**	$i_D = \frac{1}{2}k_p\left(\frac{W}{L}\right)\cdot\left(V_{GS}-V_{TP}\right)^2$
	Drain current with λ	$i_D = \frac{1}{2}k_p\left(\frac{W}{L}\right)\cdot\left(V_{GS}-V_{TP}\right)^2\cdot\left(1+\lambda\cdot V_{DS}\right)$
	Gate to Source Voltage	$V_{GS} < V_{TP}$
	Gate to drain Voltage	$V_{GD} > V_{TP}$
Linear/Saturation Boundary	**Drain to Source Voltage**	$V_{DS} = V_{GS} - V_{TP}$

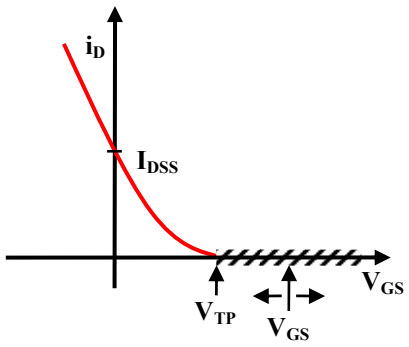
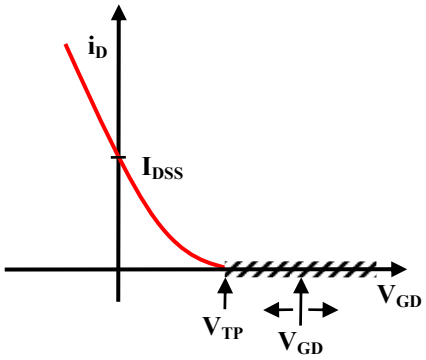
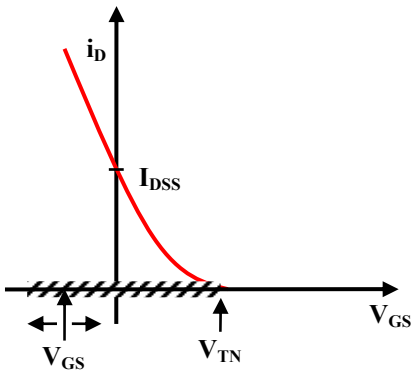
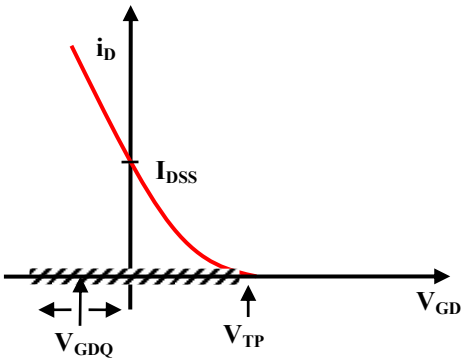
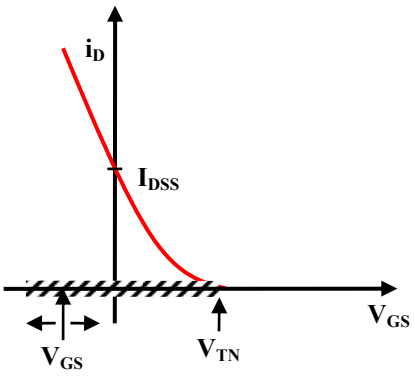
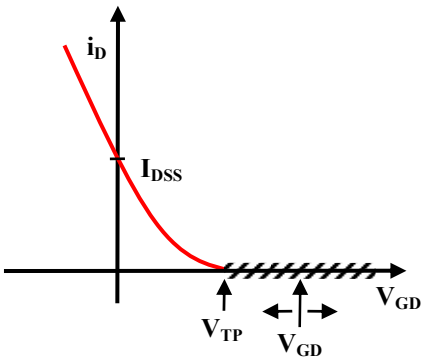
p-MOSFET(D):: Parameters

Process parameter [A/V^2]	$k_p = \mu_p C_{ox}$
Current Gain	$\beta_p = k_p\cdot\left(\frac{W}{L}\right)$
Early Voltage	$\lambda = \frac{1}{V_A}$
Body Effect Parameter	$\gamma = -\sqrt{2qN_d}\,/\,C_{ox}$
Oxide Capacitance	$C_{ox} = \frac{K_{ox}\in_o}{t_{ox}}$
Threshold Voltage	$V_{TP} = V_{TO} + \gamma\left(\sqrt{2\phi_f + \lvert V_{SB}\rvert} - \sqrt{2\phi_f}\right)$
Zero Potential Current ($V_{GS} = 0$)	$I_{DSS} \equiv \frac{\beta_p}{2}\lvert V_{TP}\rvert^2$
Depletion p-MOSFET Threshold	$V_{TP} > 0$

p-MOSFET(D):: Small Signal Parameters

Transconductance [A/V]	$g_m = \beta_P \cdot (V_{GS} - V_{TP})$
Transconductance [A/V]	$g_m = \sqrt{2k_P(W/L)} \cdot \sqrt{I_D}$
Transconductance [A/V]	$g_m = \frac{2I_D}{V_{GS} - V_{TP}}$
Transconductance of Body [A/V]	$g_{mb} = \chi \cdot g_m$
Body effect	$\chi = \gamma \cdot \left(2\sqrt{2\phi_f + \lvert V_{SB} \rvert}\right)$
Gate to Source capacitance [F/cm^2]	$C_{gs} = \frac{2}{3}(W \times L)C_{ox} + (W \times L_{ov})C_{ox}$
Gate to Drain capacitance [F/cm^2]	$C_{gd} = (W \times L_{ov})C_{ox}$
Source to Body capacitance [F/cm^2]	$C_{sb} = \frac{C_{sbo}}{\sqrt{\left(1 + \frac{\lvert V_{SB} \rvert}{V_o}\right)}}$
Drain to Body capacitance [F/cm^2]	$C_{db} = \frac{C_{dbo}}{\sqrt{1 + \frac{\lvert V_{SB} \rvert}{V_o}}}$
Maximum operating frequency [Hz]	$f_T = \frac{g_m}{2\pi(C_{gs} + C_{gd})}$

p-MOSFET(D):: Input Characteristics

	V_{GS}	V_{GD}
Cut off Mode		
Linear Mode		
Saturation Mode		
Enhancement p-MOSFET	**Shift all curve to negative Threshold Voltage ($V_{TP} < 0$)**	