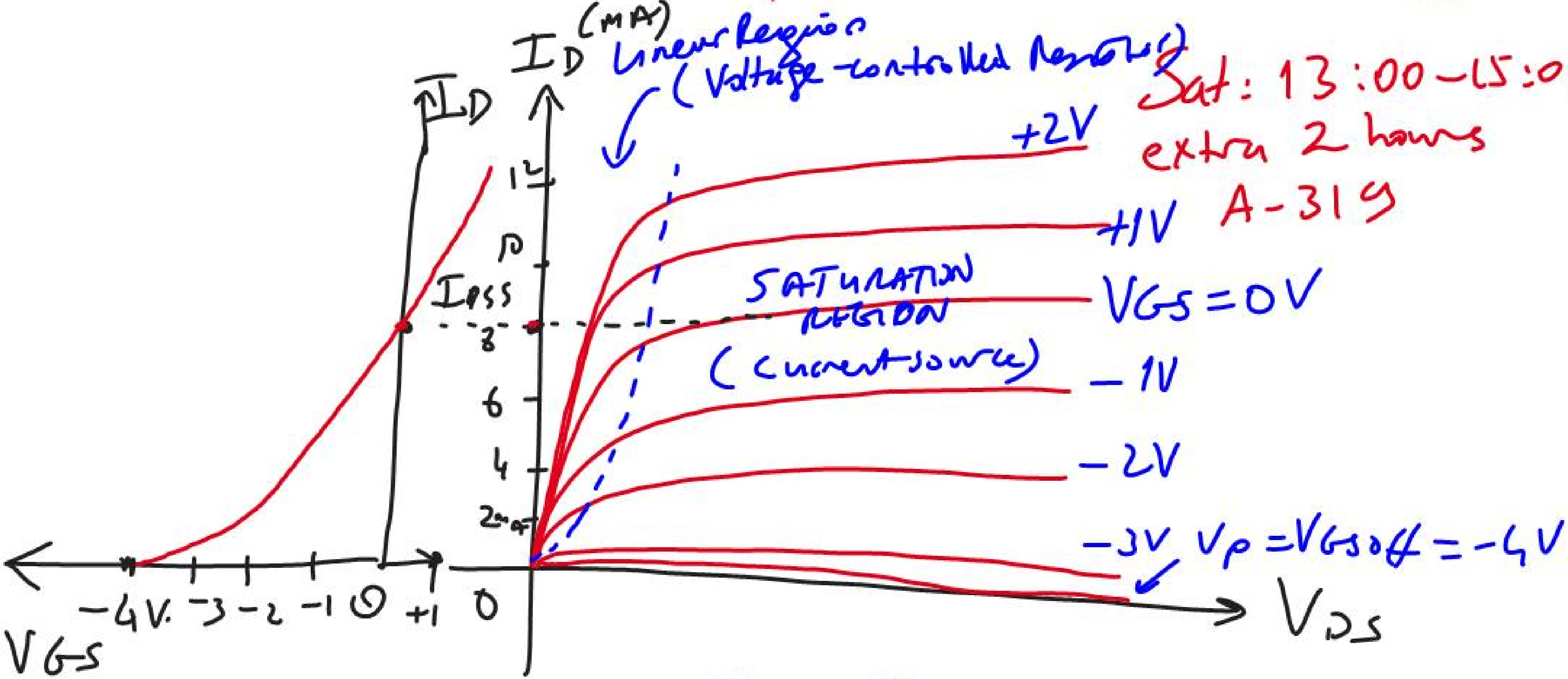
25.04.2011

n-channel Depletion Mode



Sat: 13:00–15:00
extra 2 hours
A-319

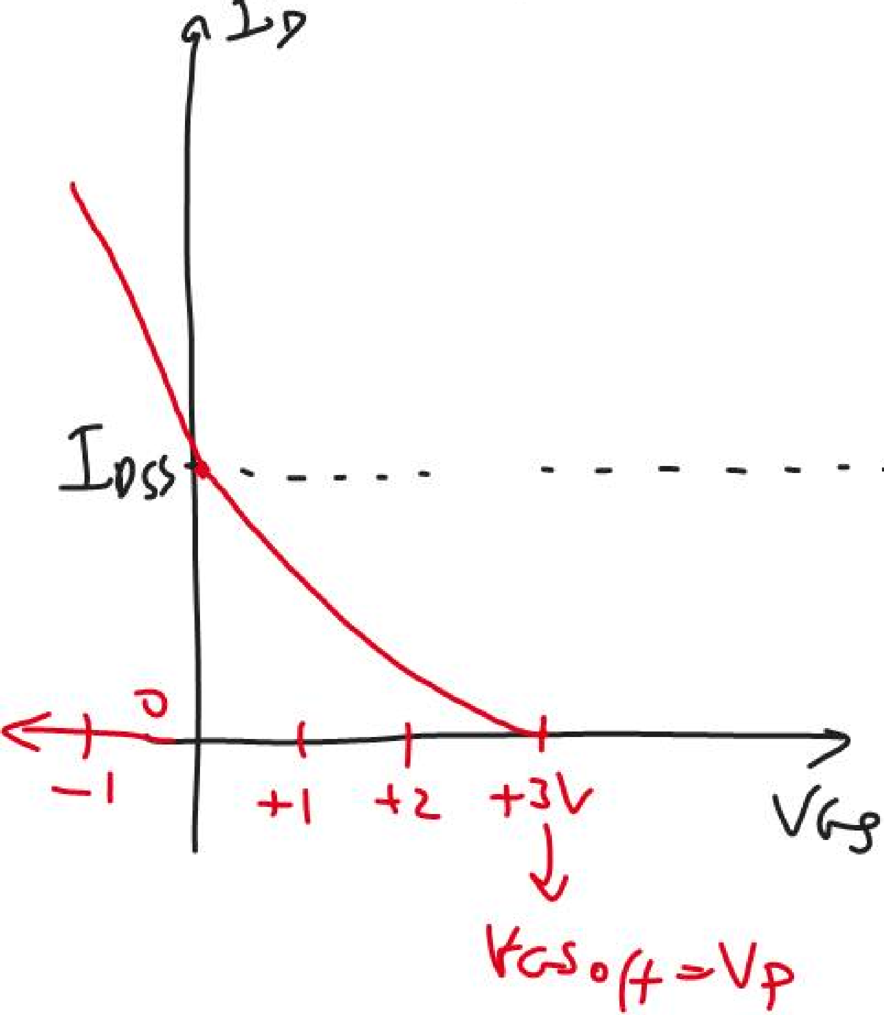
$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$

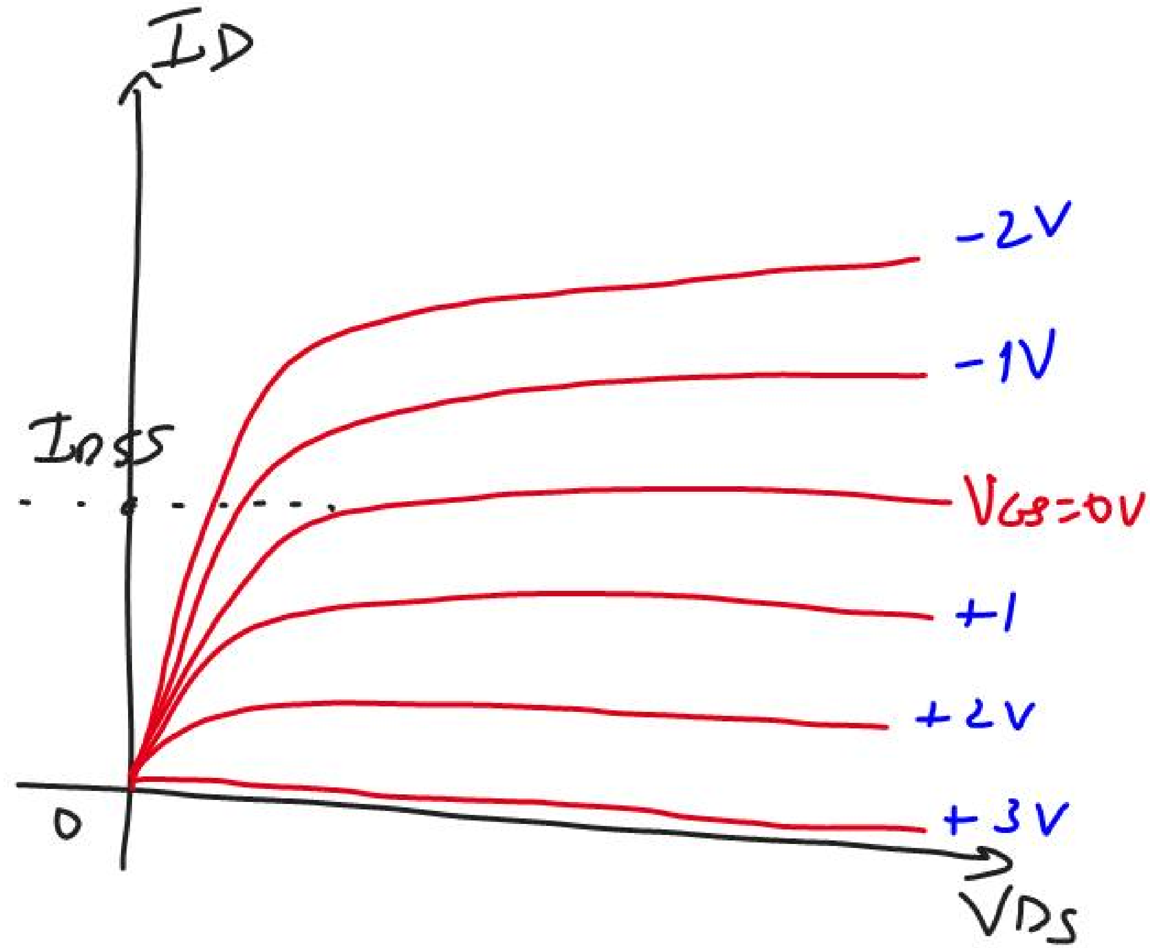
Shockley's eqn.

n-channel
Depletion-mode MOSFET (D-MOSFET)

(Normally-ON)

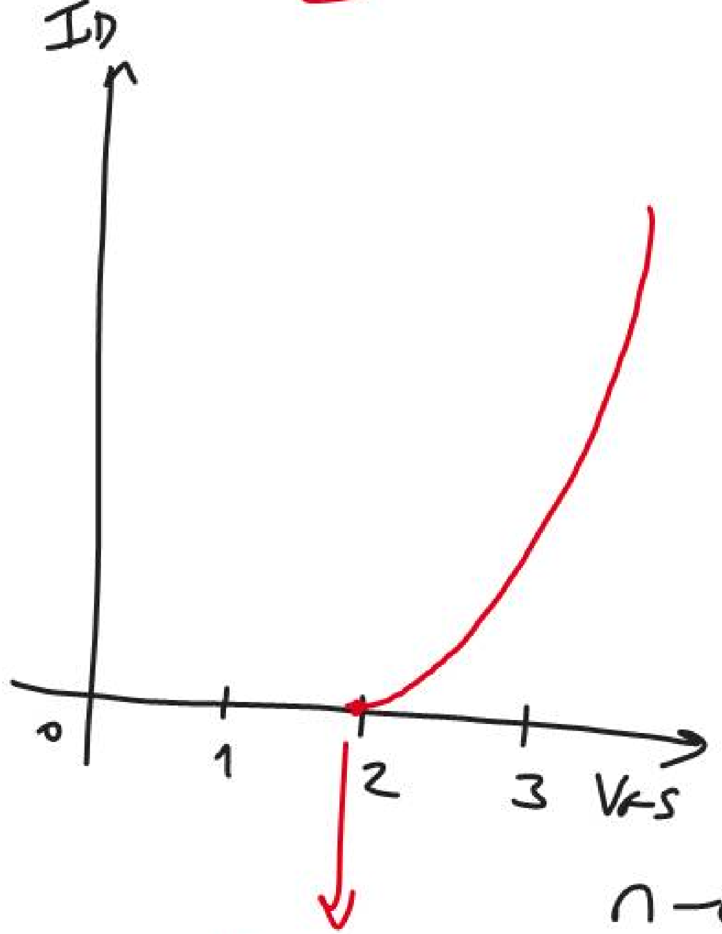
p-channel Depletion mode MOSFET

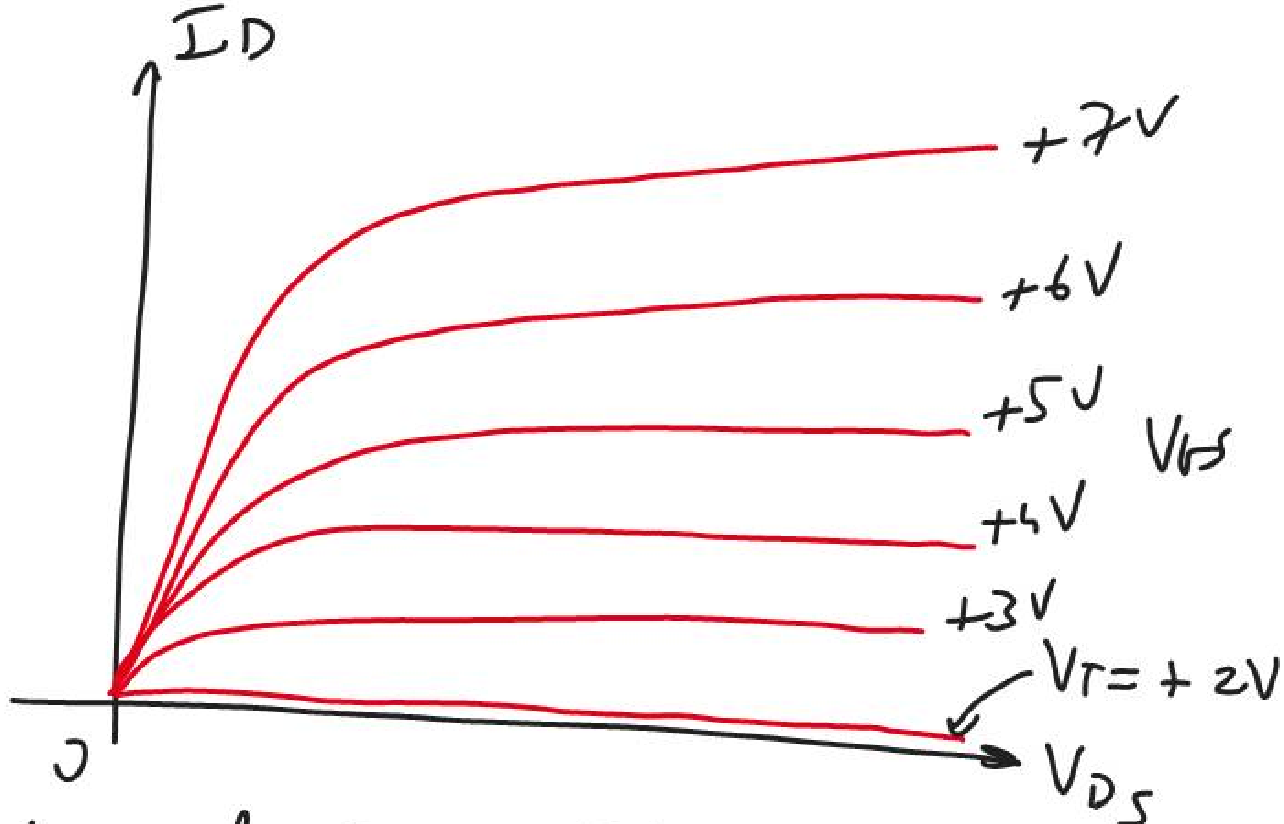




$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$

Enhancement type (normally-off) MOSFETs





n-channel E-MOSFET

$V_{GSoff} = V_T$ → Threshold voltage

$$I_D = k \cdot (V_{GS} - V_T)^2$$

ex $k = 0.5 \times 10^{-3}\ A/V^2$

$$k = \frac{I_{D(on)}}{(V_{GS(on)} - V_T)^2}$$

FET BIASING

Remember that:

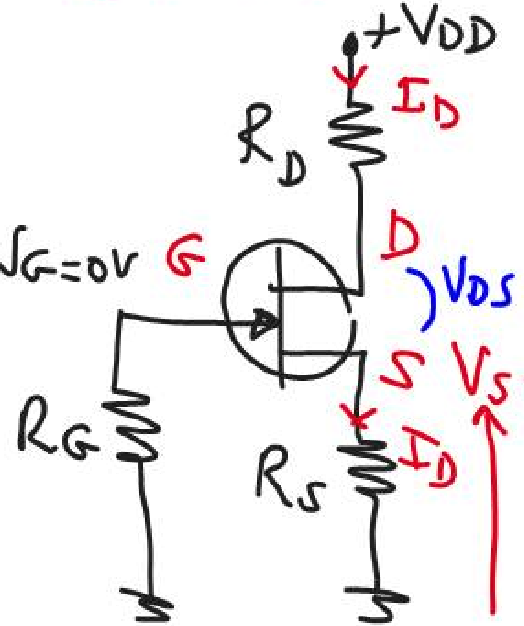
$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$

for JFETs, D-MOSFETs

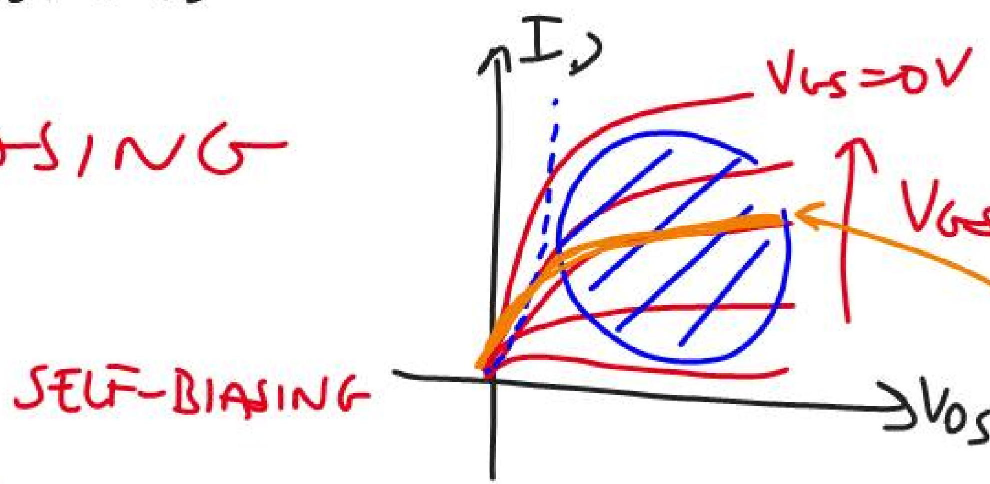
$$I_D = k\,(V_{GS} - V_T)^2$$

for E-MOSFET

① JFET BIASING



$V_S = I_D \cdot R_S$



$$V_{GS} = V_G - V_S$$
$$= 0 - I_D \cdot R_S$$

$$\boxed{V_{GS} = -I_D \cdot R_S}$$

Output KVL

$$V_{DD} - I_D \cdot R_D - V_{DS} - I_D \cdot R_S = 0 \rightarrow V_{DSQ}$$

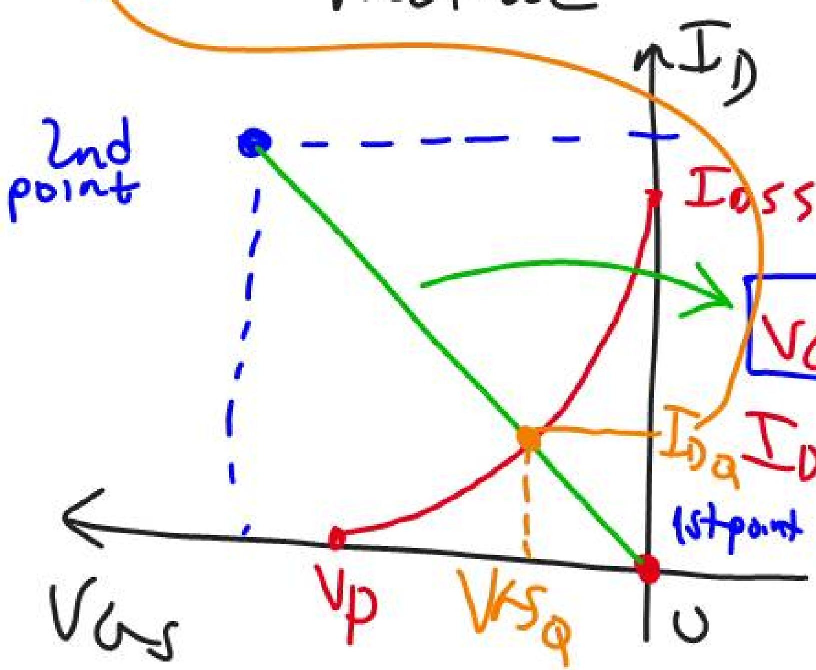
$$V_{GS} = -I_D \cdot R_S$$ Eqn. 1 $\Rightarrow$ 2 unknows I_D, V_{GS}

Graphical method

Equation Method (Analytic method)

$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$ Eqn. 2

I_{DSS} and V_P are known



$V_{GS} = -I_D R_S$ a line equation

$I_D = 0$ $V_{GS} = 0$

give a value to I_D and determine V_{GS} as the second point

For the operation point Q ⇒ V_{GSQ}, I_{DQ}, V_{DSQ}

$V_{DD} - I_D(R_D + R_S) - V_{DS} = 0$

output KVL