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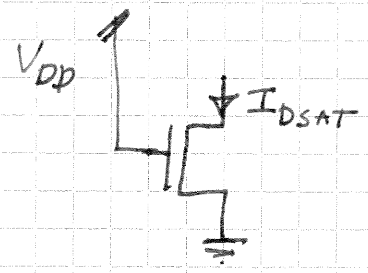
2.6 We know $k = 900 \frac{\mu A}{V^2}$

$V_T = 0.30\ V$

ⓐ Calculate the gate voltage overdrive, V_{GT}, if $V_{DD} = 1.2V$

In the general case $V_{GS} - V_T$ cannot be determined. Here we assume that transistor is used as a switch and when the transistor i ON $V_G = V_{DD}$



Then $V_{GT} = 1.2 - 0.3\ V = 0.9\ V$

ⓑ $I_{DSAT} = \frac{k}{2} V_{GT}^2$

so $I_{DSAT} = \frac{900}{2} \left[\frac{\mu A}{V^2}\right] \cdot (0.9)^2 [V^2] = 450 \cdot 0.81\ \mu A =$

$= 364.5\ \mu A$

ⓒ V_{DSAT} is the drainsource voltage for which the transistor is at the border between linear region and saturation region: $\underbrace{V_{DS} \geq V_{GS} - V_T}_{\text{saturation requirement}} \Rightarrow V_{DSAT} = V_{GS} - V_T$

So $V_{DSAT} = 0.9V$ in our case

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2.7 The quadratic current equation:

$$I_{DS} = \frac{k}{2} \frac{W}{L} (V_{GS} - V_T)^2$$

The subthreshold current equation:

$$I_{DS} = I_{OFF}\, e^{\frac{V_{GS}}{n \cdot V_{TH}}}$$

At V_{ON} the two currents are equal:

$$(1) \quad I_{OFF} \cdot e^{\frac{V_{ON}}{n \cdot V_{TH}}} = \frac{k}{2} \frac{W}{L} (V_{ON} - V_T)^2$$

And the $\underbrace{\text{derivatives}}_{\text{w.r.t } V_{ON}}$ are also equal

$$(2) \quad \frac{1}{n V_{TH}} I_{OFF}\, e^{\frac{V_{ON}}{n \cdot V_{TH}}} = k \frac{W}{L} (V_{ON} - V_T)$$

Use (1) in (2):

$$\frac{1}{n \cdot V_{TH}} \cdot \frac{\cancel{k}}{2} \frac{\cancel{W}}{\cancel{L}} (V_{ON} - V_T)^{\cancel{2}} = \cancel{k} \frac{\cancel{W}}{\cancel{L}} \cancel{(V_{ON} - V_T)}$$

$$\Rightarrow \quad V_{ON} - V_T = 2 \cdot n \cdot V_{TH}$$

$$\boxed{V_{ON} = V_T + 2n \cdot V_{TH}}$$