Mos I-V characteristics

2) Short-channel NMOS ($L < 1\mu m$)

① linear (triode) region

$$I_{DS} = \mu_n C_{ox} \frac{W}{L} \left\{ (V_{GS} - V_{th}) V_{DS} - \frac{1}{2} V_{DS}^2 \right\} \times \frac{1}{1 + \frac{V_{DS}}{E_c \cdot L}}$$

(the braced term: same as in long-channel case)

⇒ E_c: critical field where carrier velocity will be saturated to $v_{sat} = 8 \times 10^6$ cm/s

(ex) · for electron, $E_{cn} = 6 \times 10^4$ V/cm
· for hole, $E_{cp} = 24 \times 10^4$ V/cm
· $v_{sat} = 8 \times 10^6$ cm/s → same for electron and hole.

(ex) NMOS
$L = 1\mu m \rightarrow E_c \cdot L = 6V$
$L = 0.2\mu m \rightarrow E_c \cdot L = 1.2V$
$L = 0.1\mu m \rightarrow E_c \cdot L = 0.6V$
$L = 50nm \rightarrow E_c \cdot L = 0.3V$

⇒ $$g_{do} = \left(\frac{\partial I_{DS}}{\partial V_{DS}} \right)_{@V_{DS}=0} = \mu_n C_{ox} \frac{W}{L} (V_{GS} - V_{th})$$

⇒ g_{do} is same as in ~~short~~ long channel case.