DIGITAL VLSI DESIGN

Unit 2: Fabrication of MOSFETs & Circuit Design Process

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Constant-voltage scaling of MOSFET dimensions, potentials, and doping densities

Quantity	Before Scaling	After Scaling
Dimensions	W, L, t_{ox}, x_j	reduced by S ($W' = W/S, \ldots$)
Voltages	V_{DD}, V_T	remain unchanged
Doping densities	N_A, N_D	increased by S^2 ($N_A' = S^2 \cdot N_A, \ldots$)

In constant-voltage scaling, all dimensions of the MOSFET are reduced by a factor of *S,* as in full scaling.

The power supply voltage and the terminal voltages, on the other hand, remain unchanged.

The doping densities must be increased by a factor of S^2 in order to preserve the charge-field relations.

Effects of constant-voltage scaling upon key device characteristics

Quantity	Before Scaling	After Scaling
Oxide capacitance	C_{ox}	$C_{ox}' = S \cdot C_{ox}$
Drain current	I_D	$I_D' = S \cdot I_D$
Power dissipation	P	$P' = S \cdot P$
Power density	$P / Area$	$P' / Area' = S^3 \cdot (P / Area)$

$$I_D'(lin) = \frac{k_n'}{2} \cdot \left[2 \cdot (V_{GS}' - V_T') \cdot V_{DS}' - V_{DS}'^2\right]$$

$$= \frac{S \cdot k_n}{2} \cdot \left[2 \cdot (V_{GS} - V_T) \cdot V_{DS} - V_{DS}^2\right] = S \cdot I_D(lin)$$

$$I_D'(sat) = \frac{k_n'}{2} \cdot (V_{GS}' - V_T')^2 = \frac{S \cdot k_n}{2} \cdot (V_{GS} - V_T)^2 = S \cdot I_D(sat)$$

$$P' = I_D' \cdot V_{DS}' = (S \cdot I_D) \cdot V_{DS} = S \cdot P$$

THANK YOU

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