power

Handout

(1) $V_{DD} = 1V$ $\lambda = 25nm$ $C_{gen} = 1.8 fF/\mu m$

Logic

$N_L = 50\times10^6$

$\omega_L = 12\times 25\times10^{-9}$

$\alpha_L = 0.1$

$f = 1\times10^9$ Hz

$C_L = 1.8\ fF/\mu m \times \omega_L$

$= \frac{1.8\times10^{-15}}{1\times10^{-6}} \times 12\times25\times10^{-9}$

$= 5.4\times10^{-16}$ F

Memory

$N_M = 950\times10^6$

$\omega_M = 4\times25\times10^{-9}$

$\alpha_M = 0.02$

$C_M = \frac{1.8\times10^{-15}}{1\times10^{-6}} \times 4\times25\times10^{-9}$

$= 1.8\times10^{-16}$

$P_L = \alpha_L N_L C_L V_{DD}^2 f$ ...

$= 0.1\times 50\times10^6 \times 5.4\times10^{-16} \times 1\times1\times10^9$

$= 2.7$ watt

$P_M = \alpha_M N_m C_M V_{DD}^2 f$

$= 0.02\times 950\times10^6 \times 1.8\times10^{-16} \times 1\times10^9$

$= 3.42$ watt

$P = P_L + P_M = 6.12$ watt

(2) Not important

Logic transistor width

Low threshold device $= 0.05\times12\lambda\times50\times10^6$

$= 0.75$ m

High threshold device $= 0.95\times12\lambda\times50\times10^6$

$= 14.25$ m

Memory transistor width

high threshold $= 950\times10^6\times4\lambda$

$= 95$m

$I_{sub} = \frac{1}{2}\left(0.75\times\frac{100\times10^{-9}}{1\times10^{-6}} + (14.25+95)\frac{10\times10^{-9}}{1\times10^{-6}}\right)$

$= 0.58$ A

$I_{gate} = \frac{1}{2}(0.75 + 95\times14.25) \times \frac{5\times10^{-9}}{1\times10^{-6}}$

$= 0.275$A

$P_{static} = (I_{sub} + I_{gate})V$

$= 0.855$ watt

(3) $P = \alpha C V_{DD}^2 f$ $C = 450\times10^{-12}\times70$

$= 0.1\times450\times10^{-12}\times70\times0.9^2\times450\times10^6$

$= 1.15$ watt

$f = 450\times10^6$

$V_{DD} = 0.9$

(4) **Logic**

$\alpha_L = 0.1$

$A_L = 0.6\times200$

$C_L = 0.6\times200\times450\times10^{-12}$

$= 5.4\times10^{-8}$ F

$P_L = 1.97$ watt

Memory

$\alpha_M = 0.05$

$A_L = 0.4\times200$

$C_M = 3.6\times10^{-8}$

$P_M = 0.656$

$\therefore P = P_L + P_M = 2.63$ watt

(5) dynamic power ↓

$f = 1$GHz

$f_{sw} = \frac{1}{T_{sw}}$

$= 0.2$GHz

$T_{sw} = 2\times\frac{10}{4}\times10^{-9}$

$\therefore \alpha = 0.2$

Term solve

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$T_{inA} \rightarrow 1ns$

$\alpha_{inA} = \frac{\frac{1}{1}}{0.1}$

$= 10$

$\alpha_{inB} = \frac{\frac{1}{2}}{0.1} = 5$

$\alpha_{n_1} = \frac{1/4}{0.1} = 2.5$

There are 10 divisions between 0-5

So, per division $\frac{1}{2}$ns

$\alpha_{n_2} = \frac{1/8}{0.1}$

$= 1.25$

$\alpha_Y = \frac{1/16}{0.1} = 0.75$

(6) C_{inA} = A block i/p cap = 6 pF

C_{inB} = 5pF

C_{n_1} = O/p of A + i/p of C

= 19 pF

C_{n_2} = O/p B + i/p of C

= 21 pF

C_Y = 9pF

(c) $f = 0.1G$, $V_{DD} = 3$

$P_{inA} = 10\times6\times10^{-12}\times3^2\times0.1\times10^9 = 0.054$

$P_{inB} = \alpha_{inB}\times C_{inB}\times3^2\times0.1\times10^9 = 0.0225$

$P_{n_1} = \alpha_{n_1} \cdot C_{n_1}\times3^2\times0.1\times10^9 = 0.0428$

$P_{n_2} = 0.024$

$P_Y = 6.075\times10^{-3}$

$P = P_{inA} + P_{inB} + P_{n_1} + P_{n_2} + P_Y$

$= 0.1494$ watt