

## 2016 VLSI Final Solution

1. (a) 1. A=1 B=0~1      2. B=1 A=0~1      3. AB=0~1

(b) Body effect

(c) 講義 5-17

(d) NMOS tail 5    NMOS out 5/4     $g_b=7/3$

2. (a) P=3

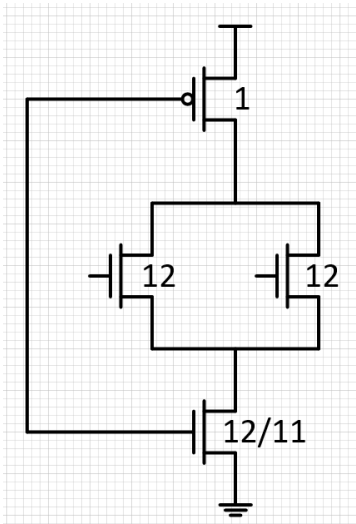
(b)  $3^{0.5}$

3. Leakage, charge average, back-gate coupling, clock feed-through, cascade

4. (a)  $F = GBH = \frac{1}{2} \times 1 \times \frac{64}{2} = \frac{64}{4}$        $D = NF^{\frac{1}{N}} + P = 2 \left( \frac{64}{4} \right)^{\frac{1}{2}} + \left( \frac{193}{2} + 1 \right) =$

105.5

(b)



5. (a) 講義 6-12

(b) 講義 6-13

(c) 講義 6-14

(d) 講義 6-15

6. (a) 0ns

(b)  $\frac{10}{2} - (2 + 1) = 2\text{ns}$

(c)  $4 - 2 = 2\text{ns}$

(d)  $\frac{10}{2} - (2 + 1 + 1) = 1\text{ns}$        $4 - (2 + 1) = 1\text{ns}$

7. (a)  $T_{pd} \leq T_c - (T_{setup} + T_{pcq}) = 20 - (1.5 + 2) = 16.5\text{ns}$  (講義 6-29)

(b) 講義 6-29

(c)  $T_{cd} \geq T_{hold} - T_{ccq} = 3 - 0.4 = 2.6 \text{ ns}$  (w/o clock skew)

$T_{cd} \geq T_{hold} - T_{ccq} + T_{skew} = 3 - 0.4 + 0.5 = 3.1 \text{ ns}$  (w/ clock skew)

(d) 講義 6-42

8. (a) 解釋請參照講義 8.p8,  $M3 > M6$

(b) 解釋請參照講義 8.p9,  $M6 > M4$

(c) 解釋請參照講義 8.p18

(d) 解釋請參照講義 8.p19

9. (a) Race: Direct path from D to Q during the short time when both CLK and !CLK are high (1-1 overlap) (講義 6-56)

(b) Undefined state: Both B and D are driving A when CLK and !CLK are both high (講義 6-56)

(c) Dynamic storage: when CLK and !CLK are both low (講義 6-56)

(d) Using 2-phase latches with big nonoverlap times (講義 6-56)

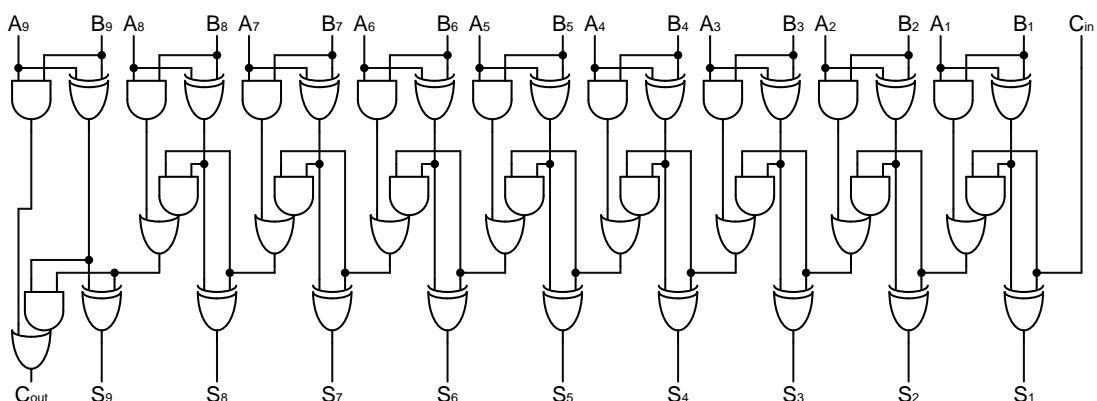
10. (a) (講義 8-32)

(b)  $\Delta V = V_{DD} / 2 * (C_{cell} / C_{cell} + C_{bit}) = 0.078 \text{ V}$

(c) (講義 8-34)

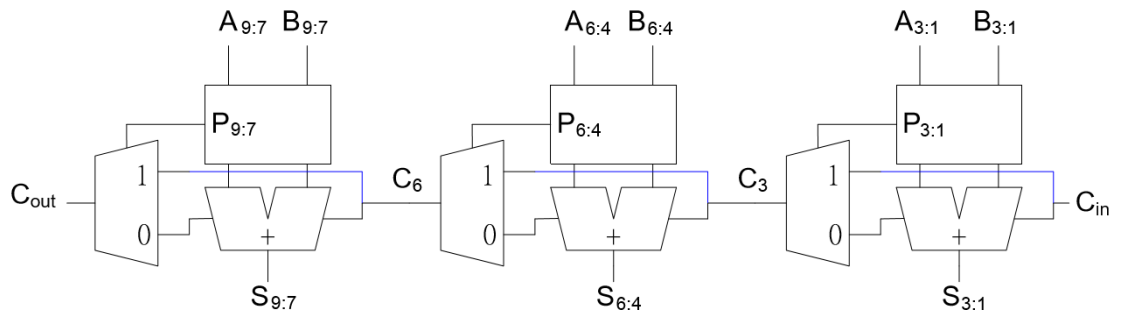
(d) (講義 8-34)

11. (a)



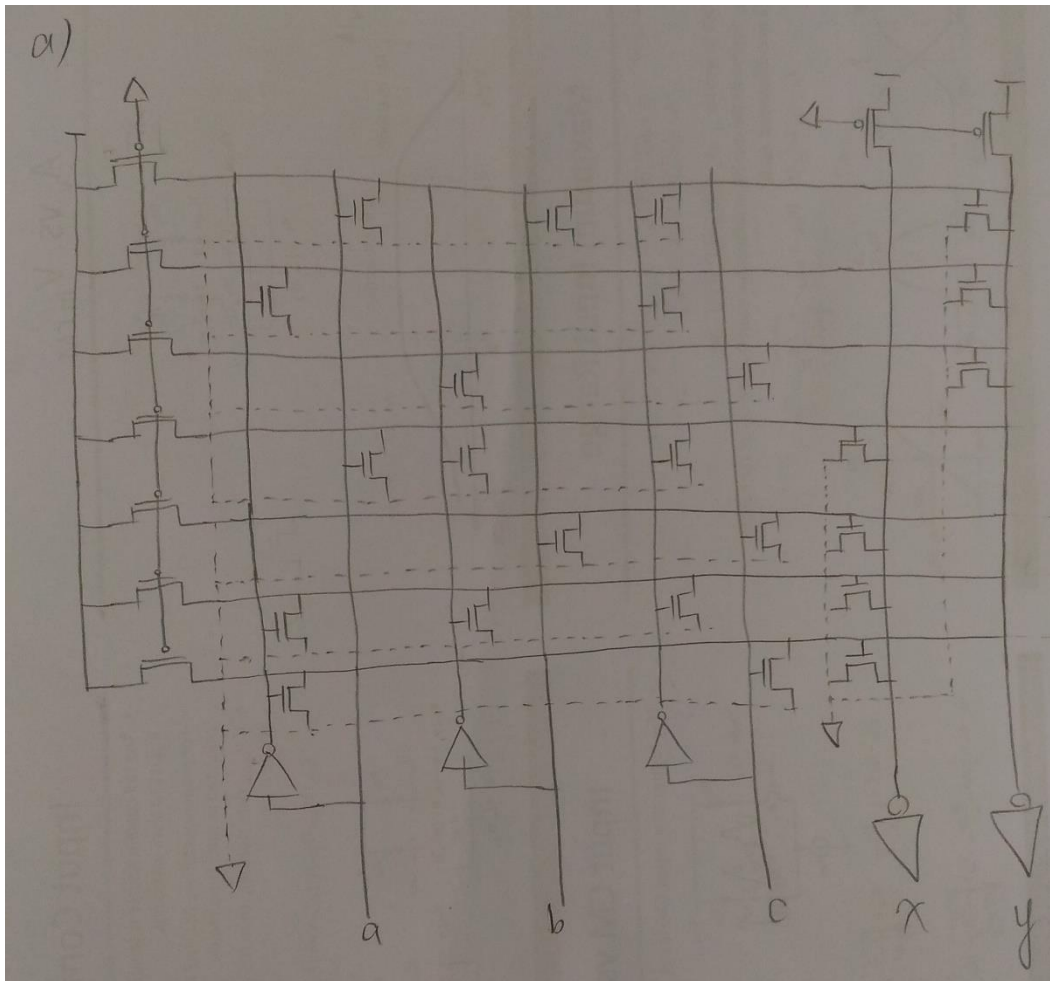
(b)  $t_{ripple} = t_{pg} + 8t_{AO} + t_{XOR}$

(c)

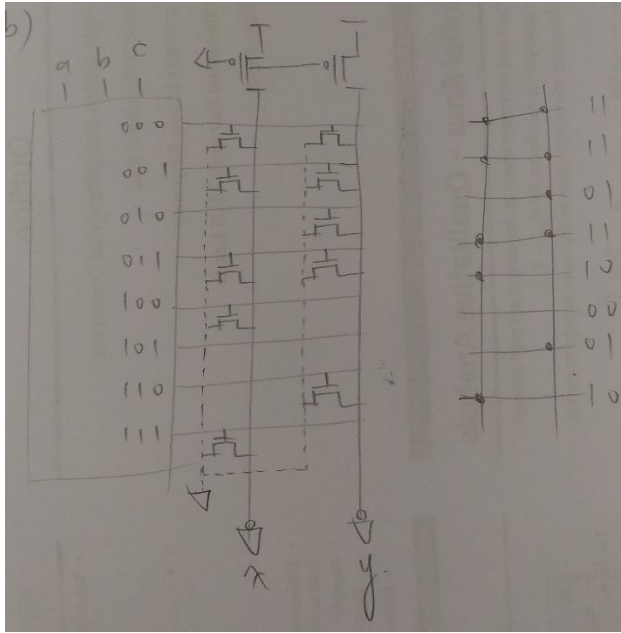


(d)  $t_{skip} = t_{pg} + 6t_{AO} + t_{XOR}$

12. (a)



(b)



13. (a)  $G = 1 \times \frac{4}{3} \times \frac{4}{3} \times \frac{5}{3} = \frac{80}{27}$

$B = 2 \times 2 = 4$

$H = \frac{256}{2} = 128$

(b)  $F = GBH = \frac{40960}{27} \rightarrow f = F^{\frac{1}{4}} = 6.24$

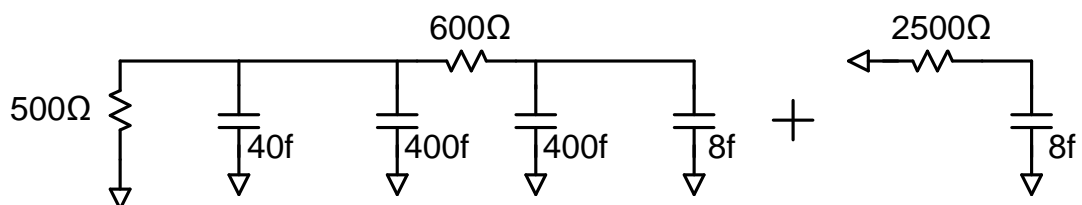
$P = 1 + 2 + 2 + 2 = 7$

$D = NF^{\frac{1}{N}} + P = 6.24 \times 4 + 7 = 31.96$

(c)  $C_{in} = \frac{g \times C_{out}}{f}$

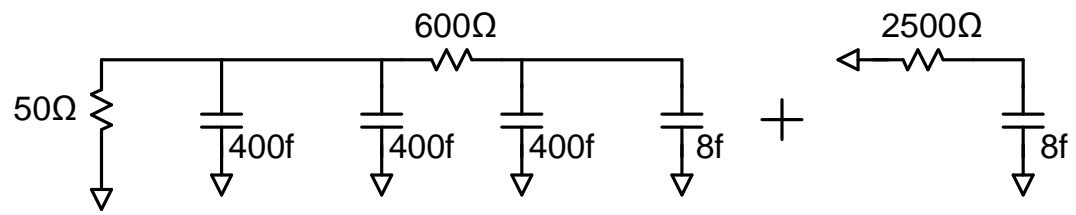
$$\rightarrow \begin{cases} z = \frac{\frac{5}{3} \times 256}{6.24} = 68.3659 \\ y = \frac{\frac{4}{3} \times 68.3659}{6.24} = 14.608 \\ x = \frac{\frac{4}{3} \times 14.608 \times 2}{6.24} = 6.24 \end{cases}$$

14. (a)



$$t_{pd} = (500 \times 440\text{f}) + (600 + 500) \times 408\text{f} + 2500 \times 8\text{f} = 688.8 \text{ ps}$$

(b)



$$t_{pd} = (50 \times 800\text{f}) + (600 + 50) \times 408\text{f} + 2500 \times 8\text{f} = 325.2 \text{ ps}$$

15. TTTFF TFFTT