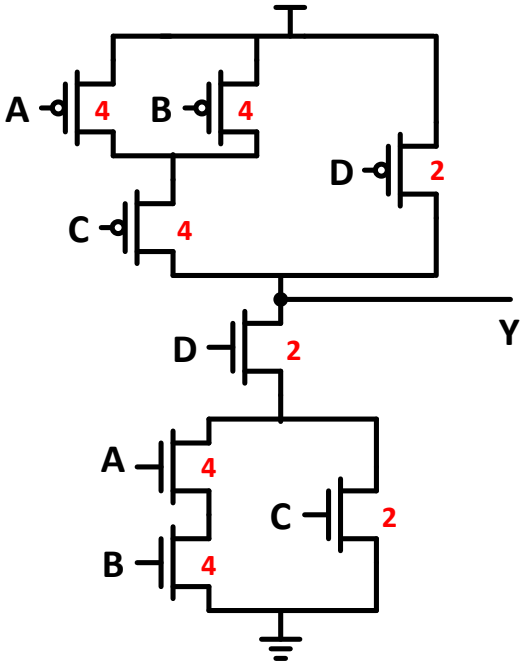
2016 VLSI Midterm Solution

1. (a)

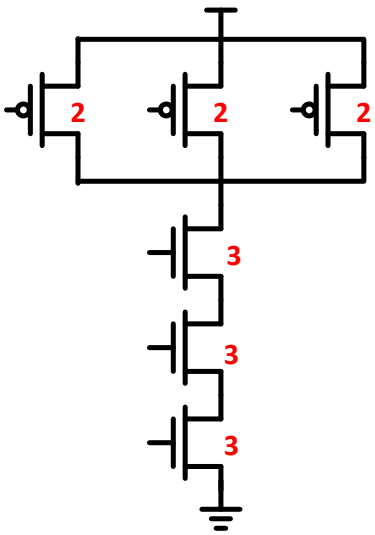


(b) $g_A=8/3$, $g_C=6/3=2$, $g_D=4/3$

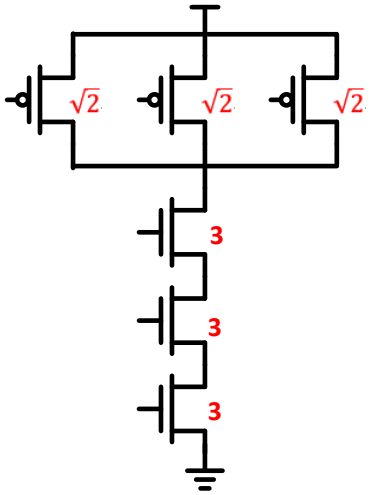
(c) 略

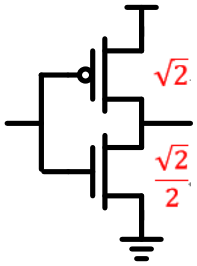
(d) $p_{max}=(4+4+2+4+2)/3=16/3$, $p_{min}=(4+2+2)/3=8/3$

2. (a) $g_{avg}=5/3$

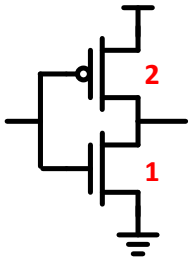


(b)





For g_u



For g_d

Computing Logical Effort

4- 35

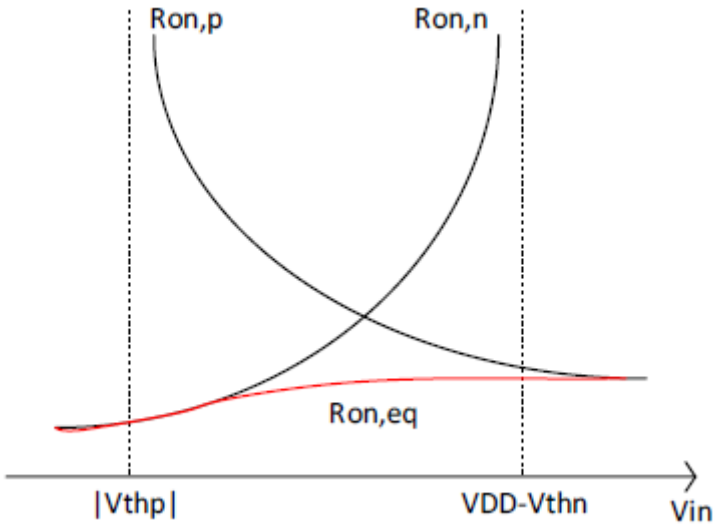
- The ratio of the input capacitance of a gate to the input capacitance of an inverter delivering the same output current

$$g_u = \frac{3+\sqrt{2}}{\sqrt{2}+\sqrt{2}/2} = 2.08,\ g_d = \frac{3+\sqrt{2}}{2+1} = 1.47,\ g_{avg} = 1.775$$

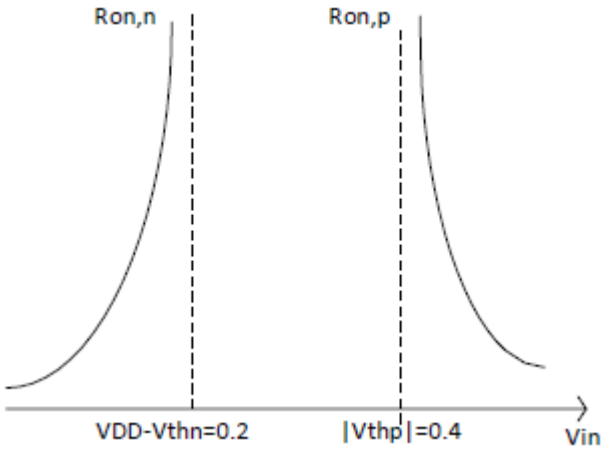
3. (a)(b) F=GBH=1*1*(128/2)=64, $f_i = F^{1/N} = 64^{1/N}$

   For N=3, f_i=4, D=N*$F^{1/N}$+N=15

4. (a)



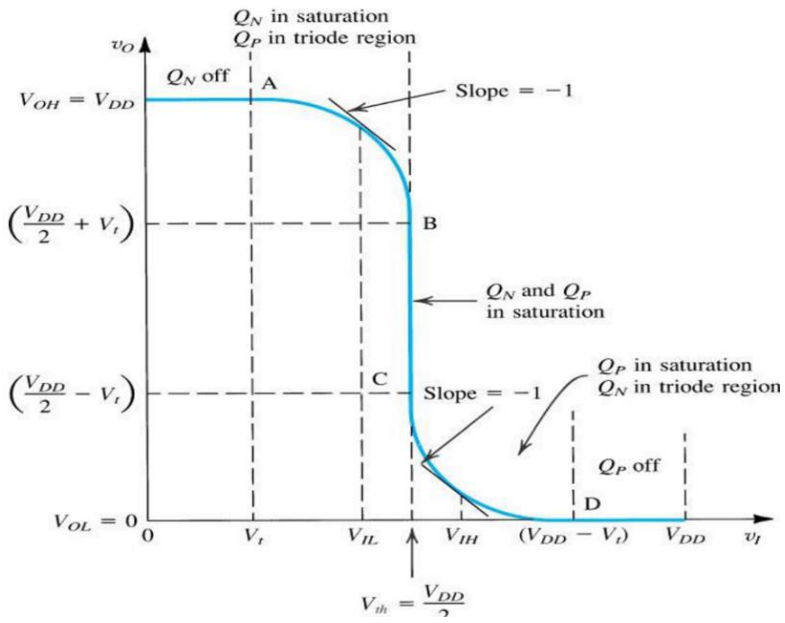
(b)



Comment：Both N/PMOS turn off when 0.2<Vin<0.4, and Ron→∞

The transmission gate switch as open circuit.

5. (a)



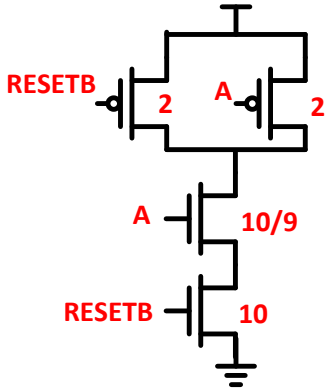
(b) NM_H=VOH-VIH, NM_L=VIL-VOL

(c) High-skewed：NM_H↓, NM_L↑ ； Low-skewed：NM_H↑, NM_L↓

(d) W_P/W_N=3/1, with the same L

(e) Both in saturation region.

6. (a)



(b) g_A=28/27 , g_{RESETB}=4 (RESETB would be non-critical input)

7. (a) $\mathrm{G} = 1 \times \frac{5}{3} \times \frac{4}{3} \times \frac{5}{3} = \frac{100}{27}$

$\mathrm{B} = 2 \times 2 = 4$

$\mathrm{H} = \frac{120}{2} = 60$

(b) $\mathrm{F} = \mathrm{GBH} = \frac{8000}{9} \rightarrow \mathrm{f} = F^{\frac{1}{4}} = 5.46$

$\mathrm{P} = 1 + 3 + 2 + 2 = 8$

$\mathrm{D} = NF^{\frac{1}{N}} + \mathrm{P} = 5.46 \times 4 + 8 = 29.84$

(c) $\mathrm{Cin} = \frac{g \times Cout}{f}$

$$\rightarrow \begin{cases} \mathrm{z} = \frac{\frac{5}{3} \times 120}{5.46} = 36.63 \\ \mathrm{y} = \frac{\frac{4}{3} \times 36.63}{5.46} = 8.945 \\ \mathrm{x} = \frac{\frac{5}{3} \times 8.945 \times 2}{5.46} = 5.46 \end{cases}$$

8. (a) $\mathrm{d} = \mathrm{gh} + \mathrm{p} = 2$

$d' = \mathrm{d} \times \mathrm{R} \times \mathrm{C} = 1\mathrm{k} \times 10\mathrm{f}$

$f_{osc} = \frac{1}{2Nd'} = \frac{1}{2 \times 9 \times 1k \times 10f} = 5.556\ GHz$

(b) Down-sized inverter $g_{avg} = 1$

$f_{osc} = \frac{1}{2Nd'} = \frac{1}{2 \times 9 \times 1k \times 10f} = 5.556\ GHz$

9. (a) $\mathrm{D} = NF^{\frac{1}{N}} + \sum_{i=1}^{n1} p_i + (\mathrm{N} - \mathrm{n1})p_{inv}$

   (b) $\mathrm{N} = 6 \rightarrow \mathrm{D} = 6 \times 2048^{\frac{1}{6}} + 6 \times 2 = 33.38$

10. (a) $T_{pdr} = (9 + 4\mathrm{h})\mathrm{RC}$

$$T_{pdf} = \left(3\mathrm{C} \times \frac{R}{3}\right) + \left(3C \times \frac{2R}{3}\right) + \mathrm{R} \times (9 + 4\mathrm{h})\mathrm{C} = (12 + 4\mathrm{h})\mathrm{RC}$$

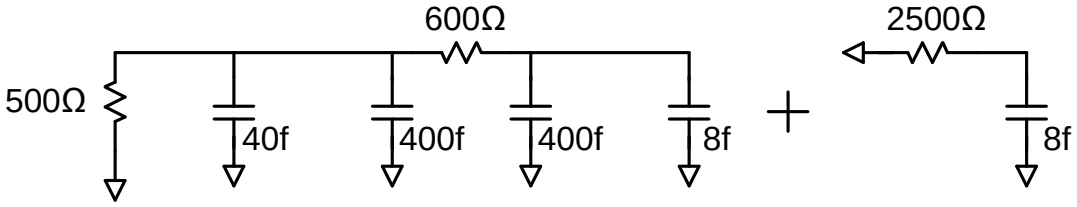
$$T_{pd} = (10.5 + 4\mathrm{h})\mathrm{RC}$$

   (b) $T_{cdr} = \frac{R}{3} \times (9 + 4\mathrm{h})\mathrm{C}$

$$T_{cdf} = (9 + 4\mathrm{h})\mathrm{RC}$$

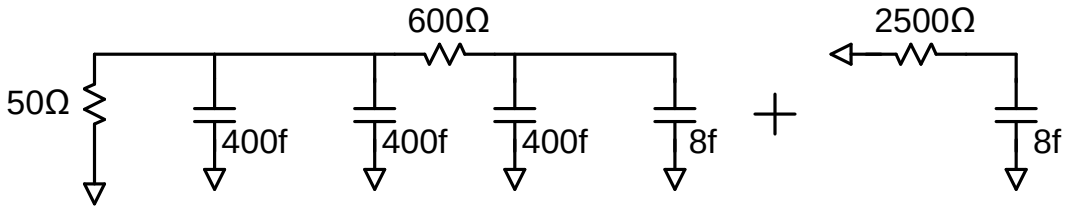
$$T_{cd} = \frac{2}{3} \times (9 + 4\mathrm{h})\mathrm{RC} = (6 + \frac{8}{3}\mathrm{h})\mathrm{RC}$$

11. $\mathrm{g} \rightarrow \mathrm{l} \rightarrow \mathrm{i} \rightarrow \mathrm{f} \rightarrow \mathrm{k} \rightarrow \mathrm{b} \rightarrow \mathrm{h} \rightarrow \mathrm{c} \rightarrow \mathrm{d} \rightarrow \mathrm{a} \rightarrow \mathrm{j} \rightarrow \mathrm{e}$
12. (a)



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

   (b)



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

13. $C_{wire} = 400f$

$C_{adj} = 800f$

   (a) $\Delta V_Y = 1.8 \times \frac{800f}{1200f} = 1.2\ V$

(b) Shielding, Increase the loading Cap, Put two wire away

14.

A. 講義 3-11
B. 講義 3-11
C. 講義 2-62
D. 講義 3-11
E. 講義 3-11
F. 講義 4-15
G. 講義 4-14
H. 講義 4-12
i. 講義 4-13
j. 講義 4-19

15.

A. 講義 2-27
B. 講義 2-27
C. 講義 2-34
D. 講義 2-30
E. 講義 2-28

16. $P=[(0.1\times20M\times0.5)+(0.04\times60M\times0.25)]\times2f\times1.8^2\times100M=1.0368W$

17.

TFTTT
FTFTF