Assignment -3

AV212 - Digital Electronics and VLSI Design

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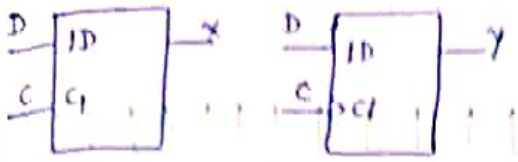
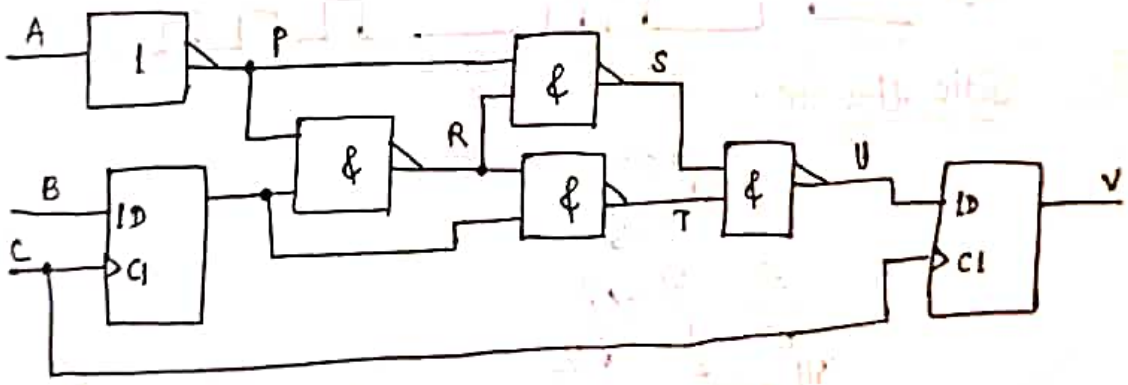
SC22B146

(1)



(2)



Given: $t_{SU_{FF}} = 6ns$; $t_{h_{FF}} = 2ns$

$5ns < t_{P_{FF}} < 8ns$

$3ns < t_{P_{gates}} < 7ns$.

C → U: $(t_{clock})_{min} = (t_{D,SU}) + (\max t_{P,D}) + (\max t_{P4}) + (\max t_{P4})$

(C → [illegible] → 4 → 4 → U)

$= 6 + 8 + 7 + 7$

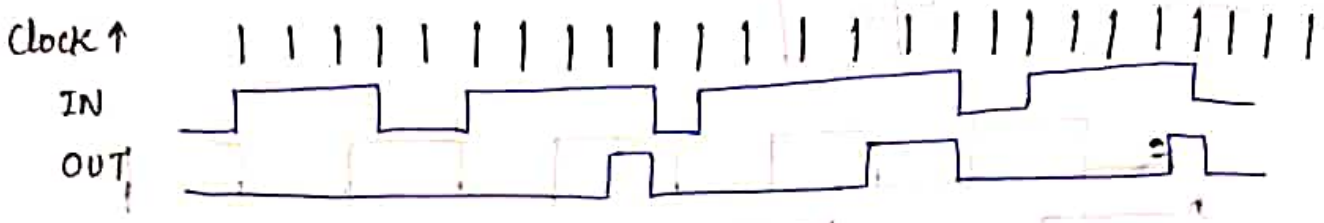
$= 28\ ns$

By another path of C → 4 → 4 → U : $(t_{clock})_{min} = 28ns$ (same)

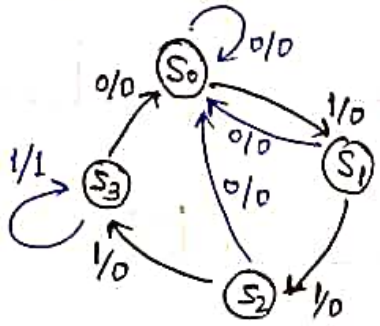
$\therefore$ Minm clock period = 28ns.

$\therefore$ Maximum frequency of clock $= \frac{1}{(t_{clock})_{min}} = \frac{1}{28\,ns} = 35.7\,MHz$

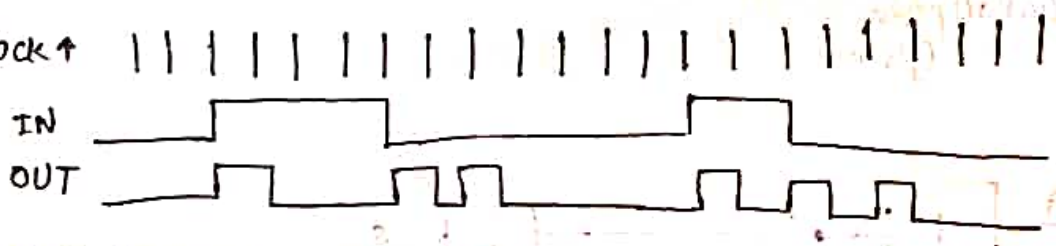
③



State diagram:



④



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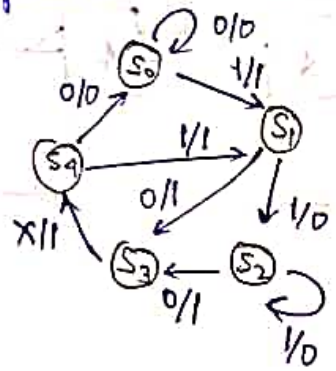
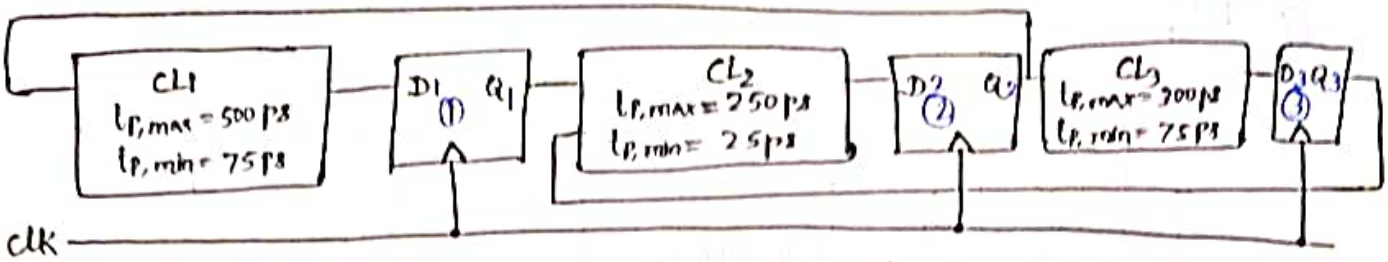


⑤



Path $Q_2 \rightarrow Q_1$: $t_{pcq}(t_{clock})_{min}$ = ~~max t_{pcq_2}~~ + max t_{pCL_1}

= ~~250p~~ + 500ps

= ~~750 ps~~

Path Q_3 to Q_2 : $(t_{clock})_{min}$ = ~~max t_{pcq_3}~~ + max t_{pCL_2}

= ~~300~~ + 250 ps

= ~~550 ps~~

Path Q_2 to Q_3 : $(t_{clock})_{min}$ = ~~max t_{pcq_2}~~ + max t_{pCL_3}

= ~~250~~ + 300 ps

= ~~550 ps~~

Path Q_3 to Q_1 : $(t_{clock})_{min}$ = max t_{pCL_2} + max t_{pCL_1}

= 250 + 500

= 750 ps

Path Q_1 to Q_2 : $(t_{clock})_{min}$ = max t_{pCL_2}

= 250 ps

Path Q_1 to Q_3 : $(t_{clock})_{min}$ = max t_{pCL_2} + max t_{pCL_3}

= 250 + 300

= 550 ps.

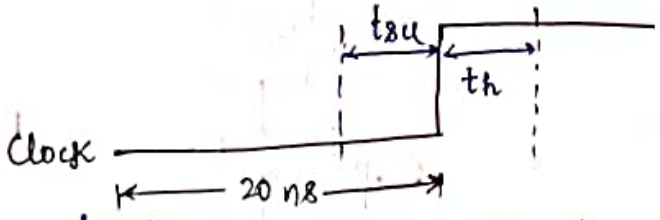
$\therefore t_{clock} \geq 750$ ps.

$\Rightarrow (t_{clock})_{min} = 750$ ps.

⑥ $t_{su\,FF} = 5$ ns

$t_{h\,FF} = 3$ ns

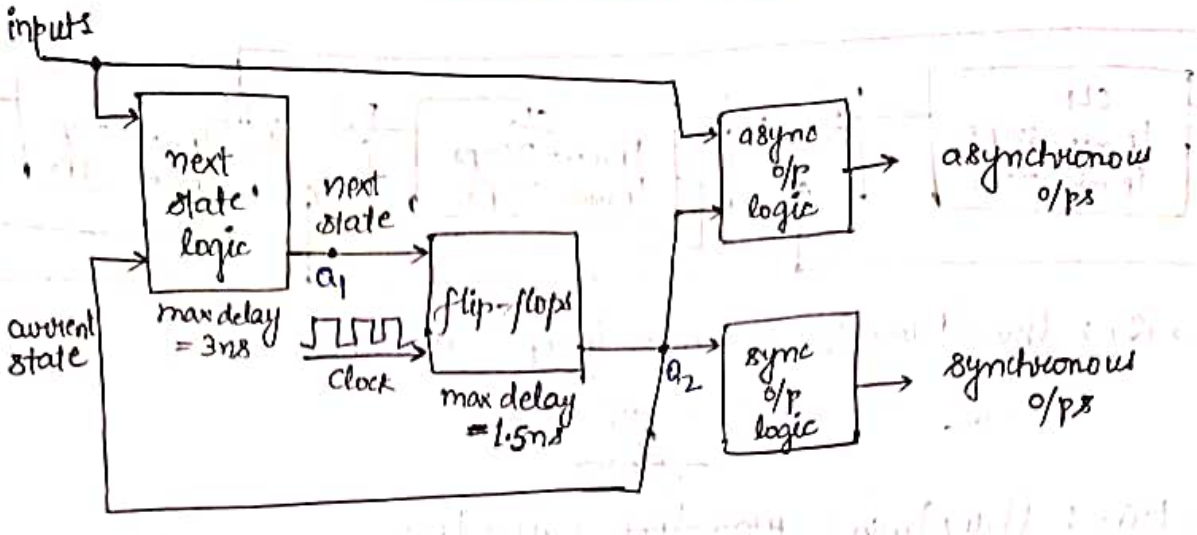
clock cycle : 20 ns



The ~~need~~ input needs to be stable ~~for~~ atleast t_{su} amount of time before the clock edge.

$\therefore$ latest time D can change = 20 − t_{su} = 20 − 5 = 15 ns.

⑦



$t_{su_{FF}} = 1.5ns$

$\max t_{sk} = 0.5ns$

$t_{PFF} = 1.5ns$

$t_{PNS} = 3ns$

Path $Q_2 \rightarrow Q_1$: $(t_{clock})_{min} = t_{suFF} + t_{sk} + t_{PFF}$.

$= 0 + 0.5 + 1.5$

$= 2ns$

Path $Q_1 \rightarrow Q_2$: $(t_{clock})_{min} = t_{PNS} + t_{suFF} = 3 + 1.5$

$= 4.5ns$.

$\therefore (t_{clock})_{smallest} = 4.5ns$.

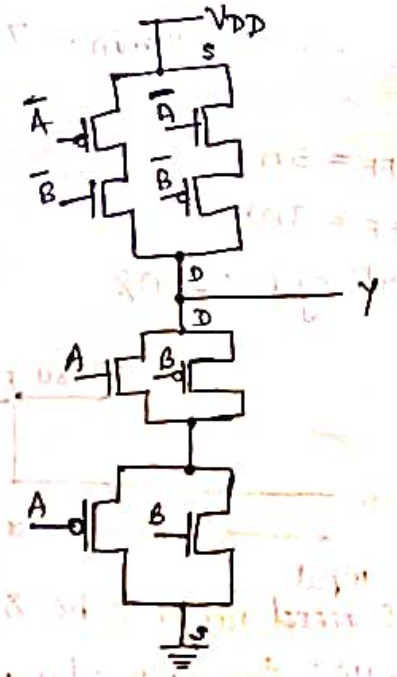
⑧ @ XOR gate:

$Y = A\bar{B} + \bar{A}B$

$\bar{Y} = \overline{A\bar{B} + \bar{A}B}$

$= \overline{A\bar{B}} \cdot \overline{\bar{A}B}$

$= (\bar{A}+B)(A+\bar{B})$



⑥ Full adder circuit:

$S = A \oplus B \oplus C = A\bar{B}\bar{C} + \bar{A}B\bar{C} + \bar{A}\bar{B}C + ABC$

$C = AB + BC + AC$

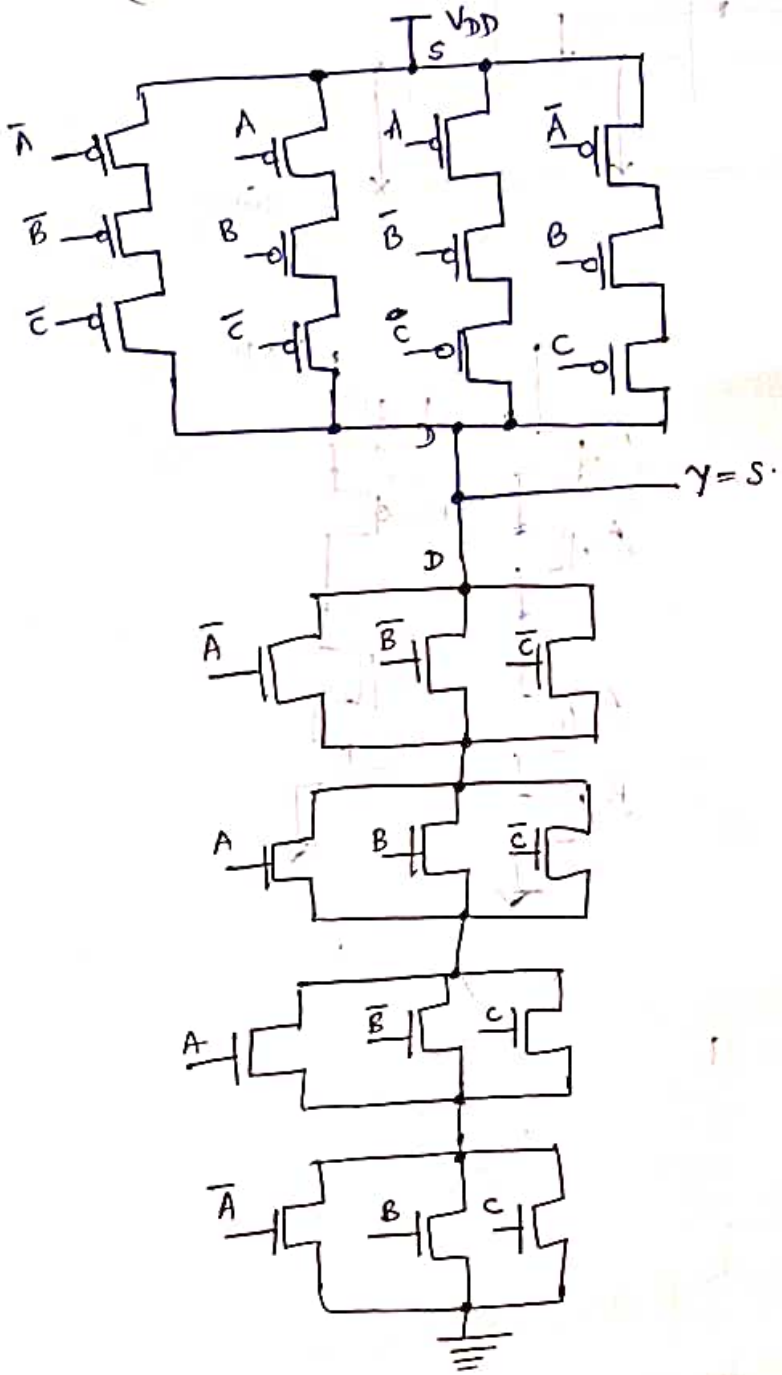
(carry) $= AB + C(A \oplus B)$

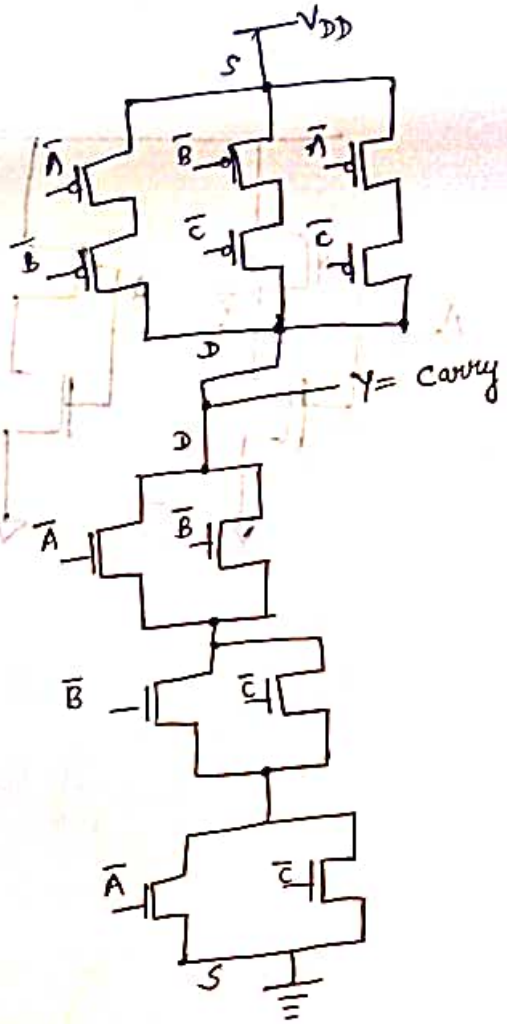
$\bar{S} = (\overline{A\bar{B}\bar{C}})(\overline{\bar{A}B\bar{C}})(\overline{\bar{A}\bar{B}C})(\overline{ABC})$

$= (\bar{A}+B+C)(A+\bar{B}+C)(A+B+\bar{C})(\bar{A}+\bar{B}+\bar{C})$

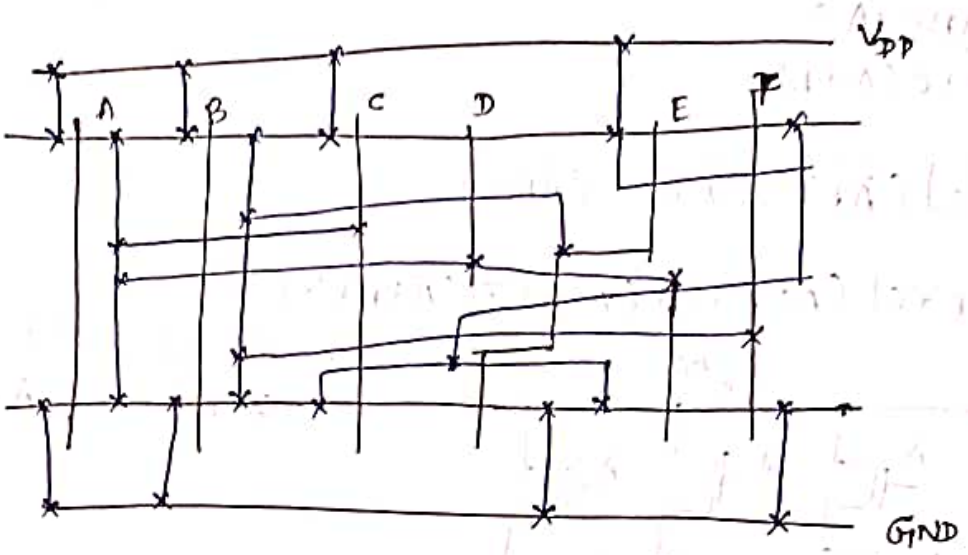
$\bar{C} = (\overline{AB})(\overline{BC})(\overline{AC})$

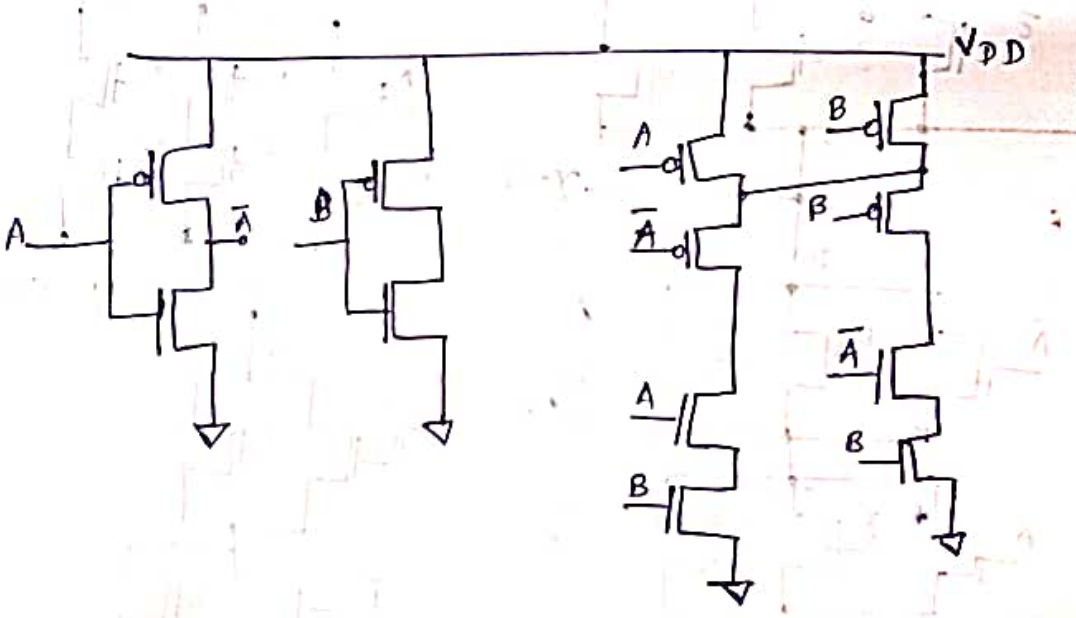
$= (\bar{A}+\bar{B})(\bar{B}+\bar{C})(\bar{A}+\bar{C})$





⑨ Stick diagram:





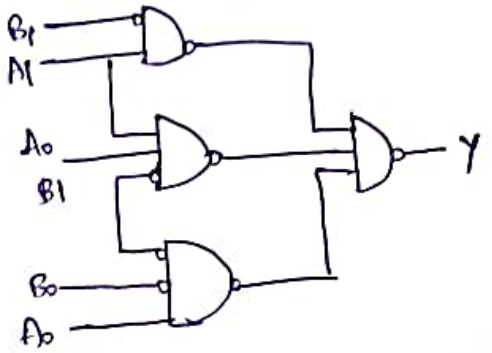
(10) $A = A_1 A_0$

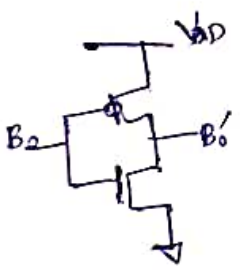
$B = B_1 B_0$

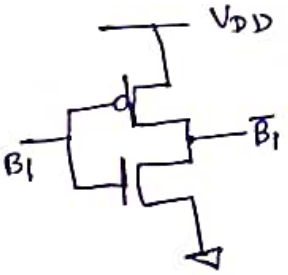
$Y(A>B) = A_1 \overline{B_1} + (A_1 B_1 + \overline{A_1} \overline{B_1})(A_0 \overline{B_0})$

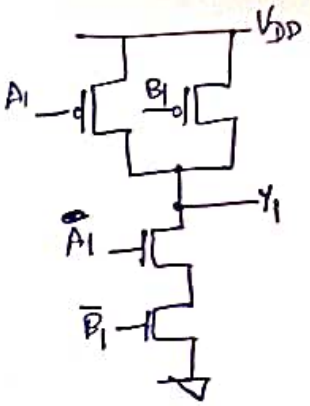
$\overline{Y} = (\overline{A_1 \overline{B_1}}) \left[(\overline{A_1 B_1 + \overline{A_1} B_1}) + (\overline{A_0 \overline{B_0}}) \right]$

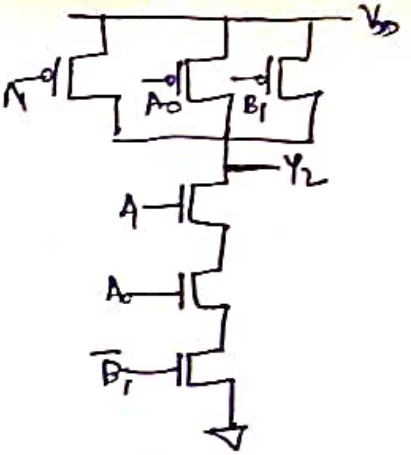
$Y = \overline{\overline{Y}} = \overline{\overline{A_1 \overline{B_1}} \cdot \overline{A_1 A_0 \overline{B_1}'} \cdot \overline{A_0 \overline{B_1} \overline{B_0}}}$

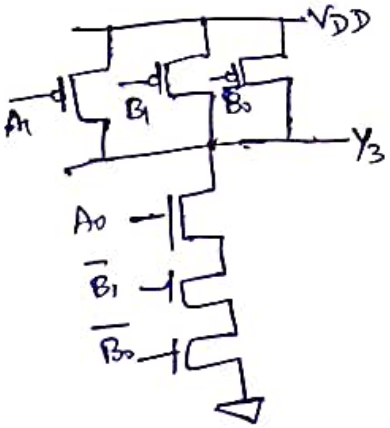


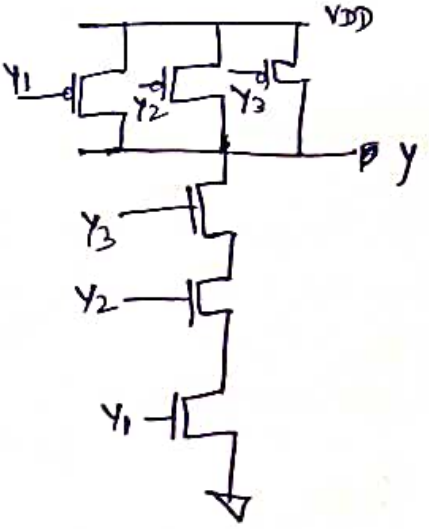












Area $= (19\lambda)(64)\lambda^2$

$= 288(64)\lambda^2$

$= 14592\lambda^2$