Gabriel Emerson gte0002 Dynamic Design HW Due 3/17

1.)

NMOS	PMOS	Min size
$KP = 200 \frac{mA}{V^2}$	$KP = 80 \frac{mA}{V^2}$	$0.5mm$
$V_{TO} = 0.5V$	$V_{TO} = -0.5V$	$V_{DD} = 3.3V$

$$R_{on} = \frac{\tau_p}{1.2C} = \frac{1.5}{1.2(1pF)} = 1250\,\Omega$$

$$K_{nmos} = \frac{1}{R_{on}(V_{DD} - V_{TN})} = \frac{1}{1250(3.3-0.5)} = \boxed{286 \frac{mA}{V^2}}$$

$$\frac{K_{nmos}}{kP_{nmos}} \cdot L = W_{nmos} \Rightarrow \frac{286}{200}(0.5) = 0.715 = W_n$$

$$\frac{W}{L}_{nmos} = \frac{0.715mm}{0.5mm} = \boxed{\frac{1.43}{1}}$$

$$W_P = \frac{286}{80}(0.5) = 1.788 \qquad \frac{W}{L}_{pmos} = \frac{1.788}{0.5} = \boxed{\frac{3.576}{1}}$$

2.) $$R_{on} = \frac{0.5ns}{2.4(0.25pF)} = 833.33\,\Omega$$

$$K_{nmos} = K_{pmos} = \frac{1}{R_{on}(V_{DD} - V_{TN})} \Rightarrow \frac{1}{833.33(3.3-0.5)} = \boxed{429 \frac{mA}{V^2}}$$

$$W_n = \frac{429}{200} \cdot (0.35) = 0.751mm \qquad \frac{W}{L} = \frac{0.751}{0.35} = \boxed{\frac{2.146}{1}}$$

$$W_P = \frac{429}{80} \cdot (0.35) = 1.877mm$$

$$\frac{W}{L}_{pmos} = \frac{1.877}{0.35} = \boxed{\frac{5.363}{1}}$$

3.) $\frac{1}{5\tau_p} = 400\,MHz$ $\quad \tau_p = \frac{1}{400 \cdot 5} = 0.5ns$

$R_{on} = \frac{0.5}{2.4 - 0.25} = 833.33\Omega$ $\quad K_{nmos} = 429 \frac{mA}{V^2}$

$W_n = \frac{429}{200} \cdot (0.35) = 0.751$ $\quad \frac{W}{L} = \frac{0.751}{0.35} = \boxed{\frac{2.146}{1}}$

$W_p = \frac{429}{80} (0.35) = 1.877$ $\quad \frac{W}{L} = \frac{1.877}{0.35} = \boxed{\frac{5.363}{1}}$

4.) $T_r = 2 \cdot t_{PLH}$

a.) $T_{f1} = T_{r1} = 2 \cdot 2.7628 \times 10^{-10} = 5.5256 \times 10^{-10}$

$T_{f2} = T_{r2} = 2 \cdot 5.03244 \times 10^{-10} = 1.006 \times 10^{-9}$

$T_{f3} = T_{r3} = 2 \cdot 5.13971 \times 10^{-10} = 1.028 \times 10^{-9}$

$T_{f4} = T_{r4} = 2 \cdot 5.14464 \times 10^{-10} = 1.029 \times 10^{-9}$

$T_{f5} = T_{r5} = 2 \cdot 5.14512 \times 10^{-10} = 1.0290 \times 10^{-9}$

b.) $T_{PLH1} = 2.763 \times 10^{-10}$

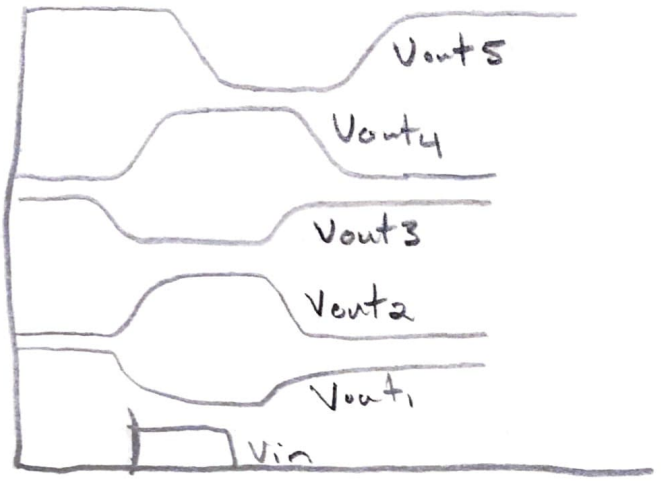
$T_{PLH2} = 5.032 \times 10^{-10}$

$T_{PLH3} = 5.1397 \times 10^{-10}$

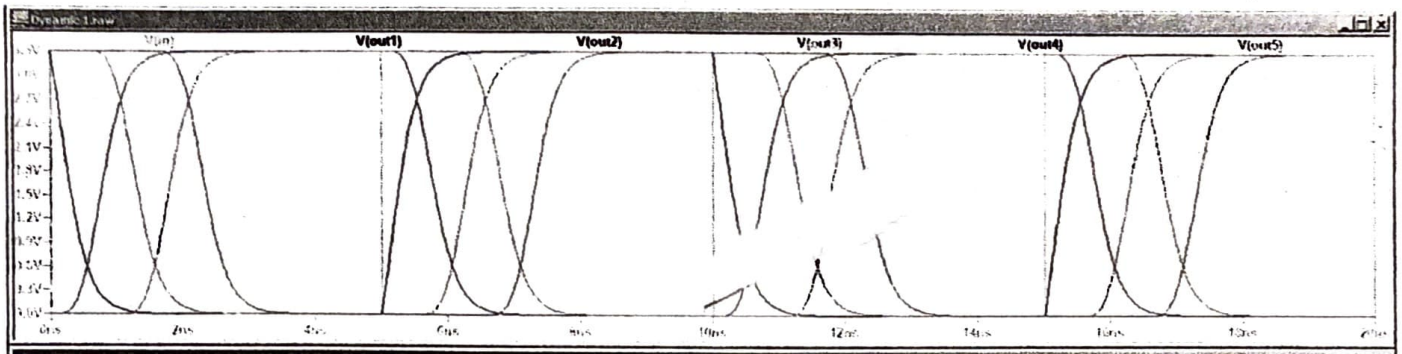
$T_{PLH4} = 5.1446 \times 10^{-10}$

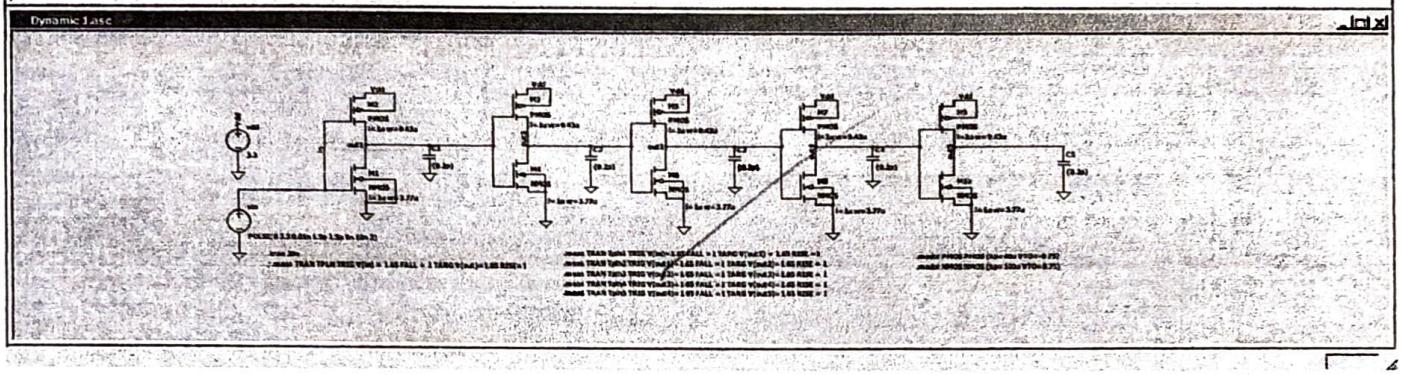
$T_{PLH5} = 5.1451 \times 10^{-10}$

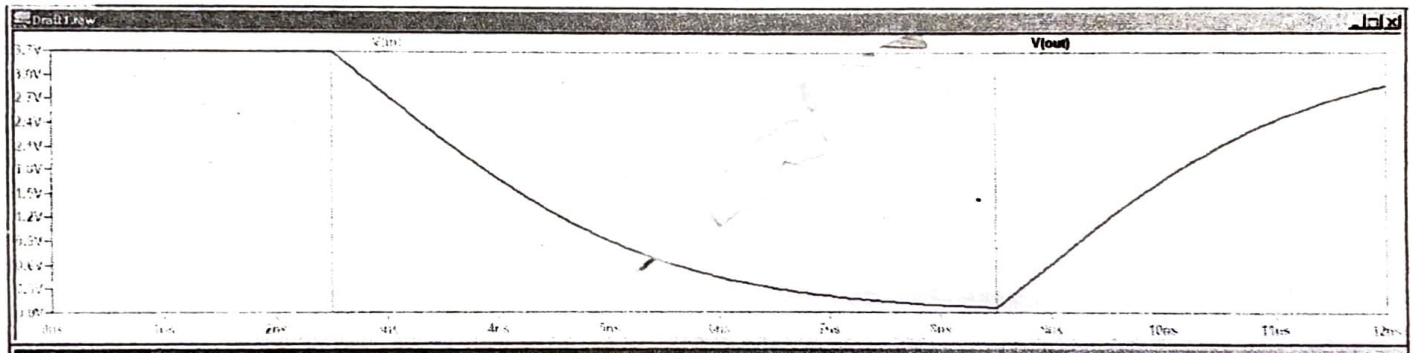
c.) They are offset by different delay times and the peak values are different. This is due to a lower amount of voltage reaching the last inverter.

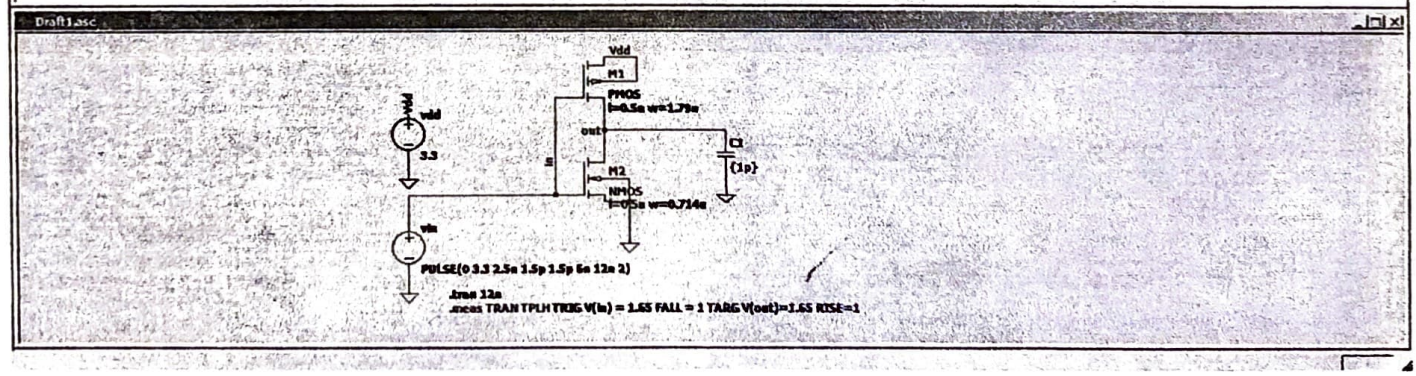


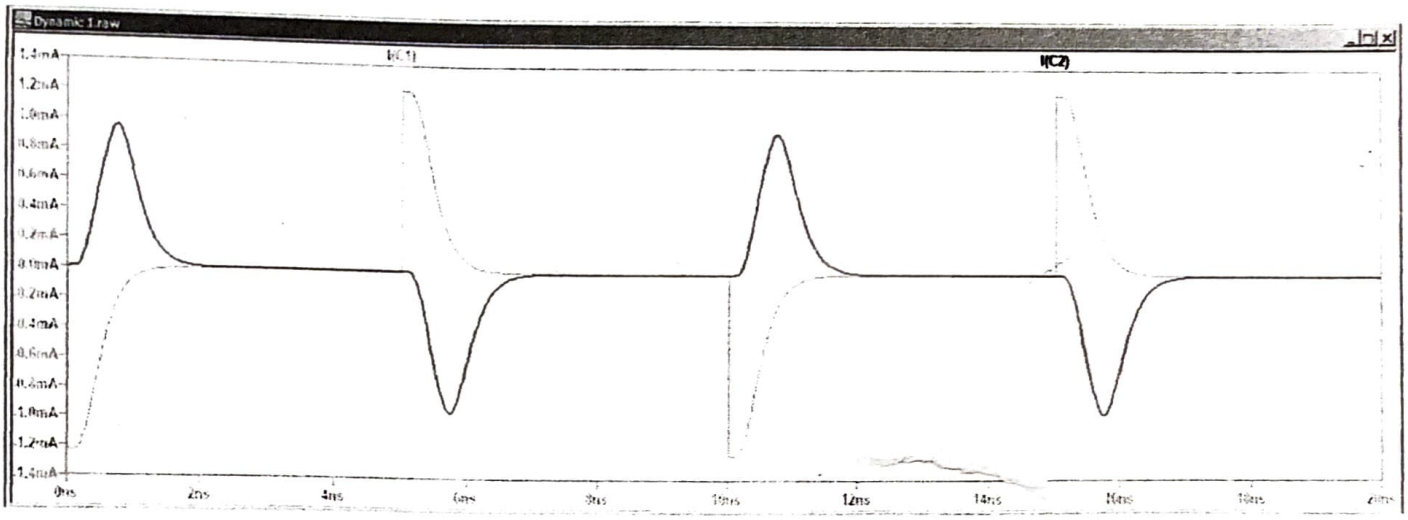
d.) The second stage has to wait for the first capaciter to begin discharging.


Dynamic1.raw
V(in)
V(out1)
V(out2)
V(out3)
V(out4)
V(out5)


Dynamic1.asc


Draft1.raw
V(out)


Draft1.asc
Vdd
M1
PMOS
l=0.5u w=1.79u
out
C1
{1p}
M2
NMOS
l=.05u w=0.714u
vdd
3.3
in
PULSE(0 3.3 2.5n 1.5p 1.5p 6n 12n 2)
.tran 12n
.meas TRAN TPLH TRIG V(in) = 1.65 FALL = 1 TARG V(out)=1.65 RISE=1



SPICE Error Log: G:\ELEC 2210\Homework\Dynamic\Dynamic 1.log

```
Instance "m5": Width narrower than recommended for a level 1 MOSFET.
Instance "m3": Length shorter than recommended for a level 1 MOSFET.
Instance "m3": Width narrower than recommended for a level 1 MOSFET.
Direct Newton iteration for .op point succeeded.

tplh1=2.7628e-010 FROM 5.01225e-009 TO 5.28853e-009
tplh2=5.03244e-010 FROM 2.8719e-010 TO 7.90435e-010
tplh3=5.13971e-010 FROM 5.79185e-009 TO 6.30582e-009
tplh4=5.14464e-010 FROM 1.30449e-009 TO 1.81896e-009
tplh5=5.14512e-010 FROM 6.82039e-009 TO 7.33491e-009


Date: Wed Mar 06 10:46:04 2019
Total elapsed time: 0.564 seconds.

tnom = 27
temp = 27
method = modified trap
totiter = 2339
traniter = 2299
tranpoints = 1149
accept = 1127
rejected = 22
matrix size = 9
fillins = 0
solver = Normal
Matrix Compiler1:      24 opcodes  1.4/[0.3]/0.4
Matrix Compiler2: off  [0.2]/0.4/0.2
```