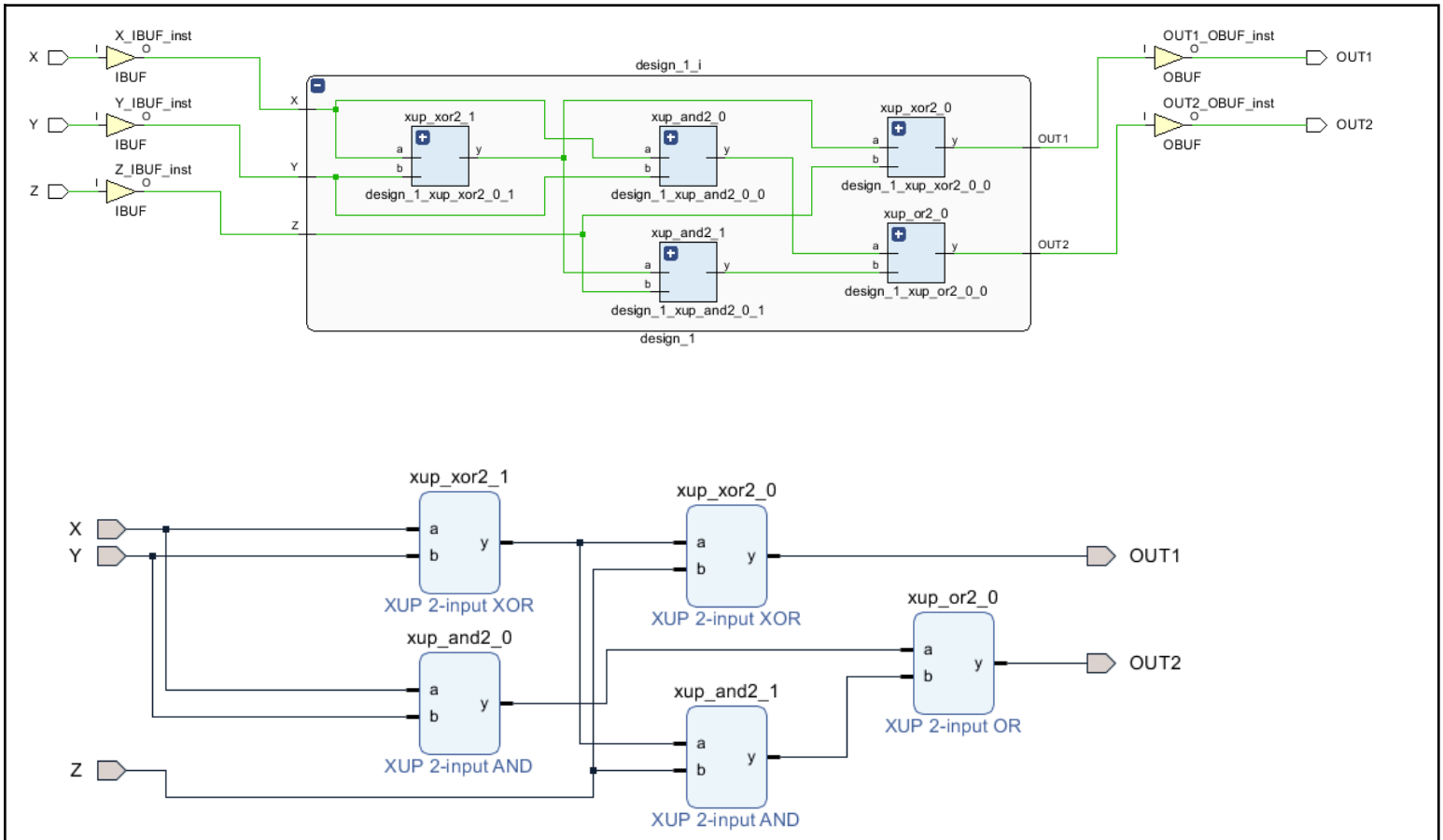
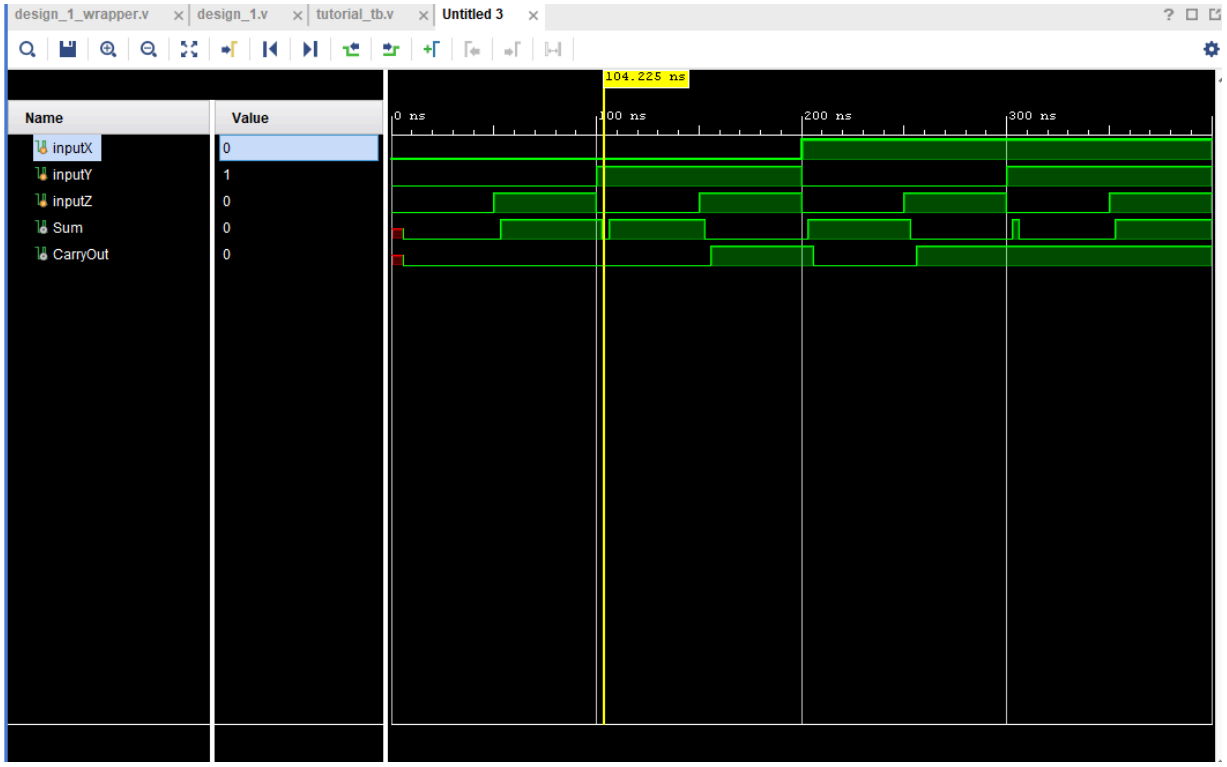
Name: Danyal Falsafi
Section: 02
X500: falsa003

Lab 1a:



Include your Vivado block diagram - Hierarchical View



Capture a screenshot of the simulation results.(Waveform)

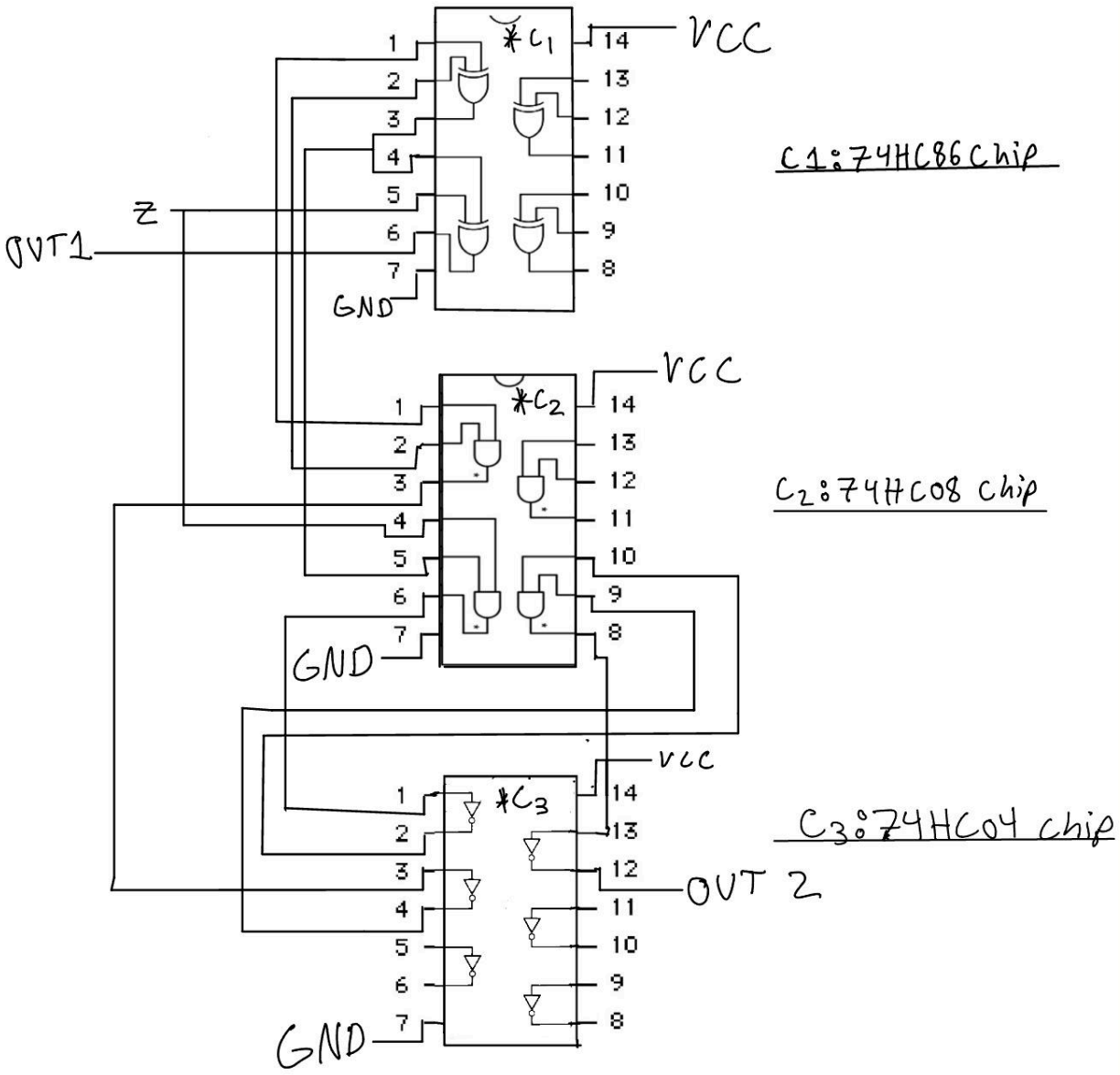
```
`timescale 1ns / 1ps
//////////////////////////////////////////////////////////////////
// Module Name: tutorial_tb
//////////////////////////////////////////////////////////////////

module tutorial_tb(
);
reg inputX, inputY, inputZ;
wire Sum;
wire CarryOut;
design_1_wrapper Instance_1_of_Adder(
    .X(inputX),
    .Y(inputY),
    .Z(inputZ),
    .OUT1(Sum),
    .OUT2(CarryOut));
initial
begin
    inputX = 0; inputY = 0; inputZ = 0;
    #50
    inputX = 0; inputY = 0; inputZ = 1;
    #50
    inputX = 0; inputY = 1; inputZ = 0;
    #50
    inputX = 0; inputY = 1; inputZ = 1;
    #50
    inputX = 1; inputY = 0; inputZ = 0;
    #50
    inputX = 1; inputY = 0; inputZ = 1;
    #50
    inputX = 1; inputY = 1; inputZ = 0;
    #50
    inputX = 1; inputY = 1; inputZ = 1;
    end
endmodule
```

Include a copy of your testbench file text. (Delete all unnecessary lines)

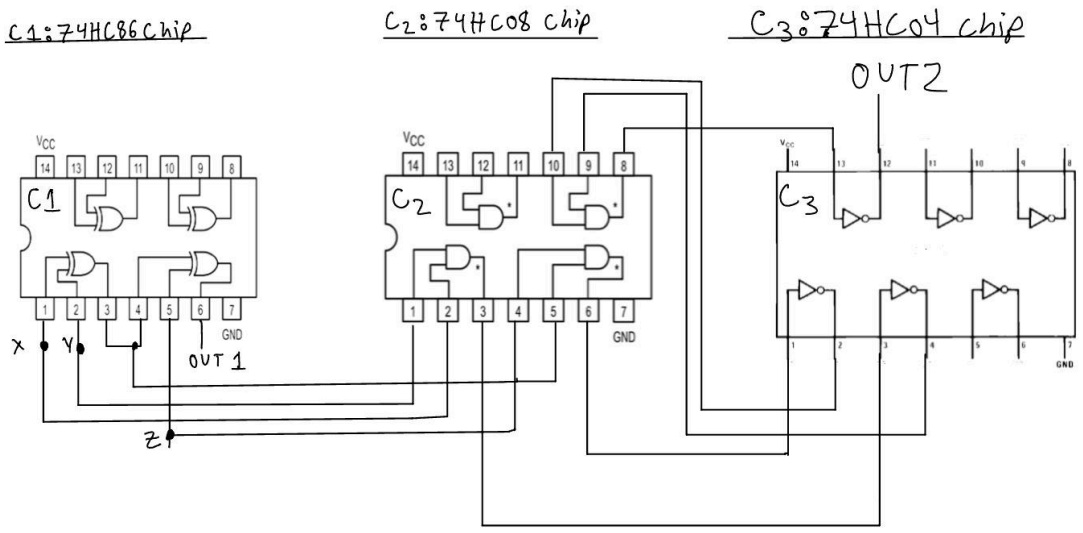
X	Y	Z	SUM	CARRYOUT
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Include a typed copy of the truth table that you filled out above.

Lab 1b:



Include a copy of your Logic Diagram from pre-lab.

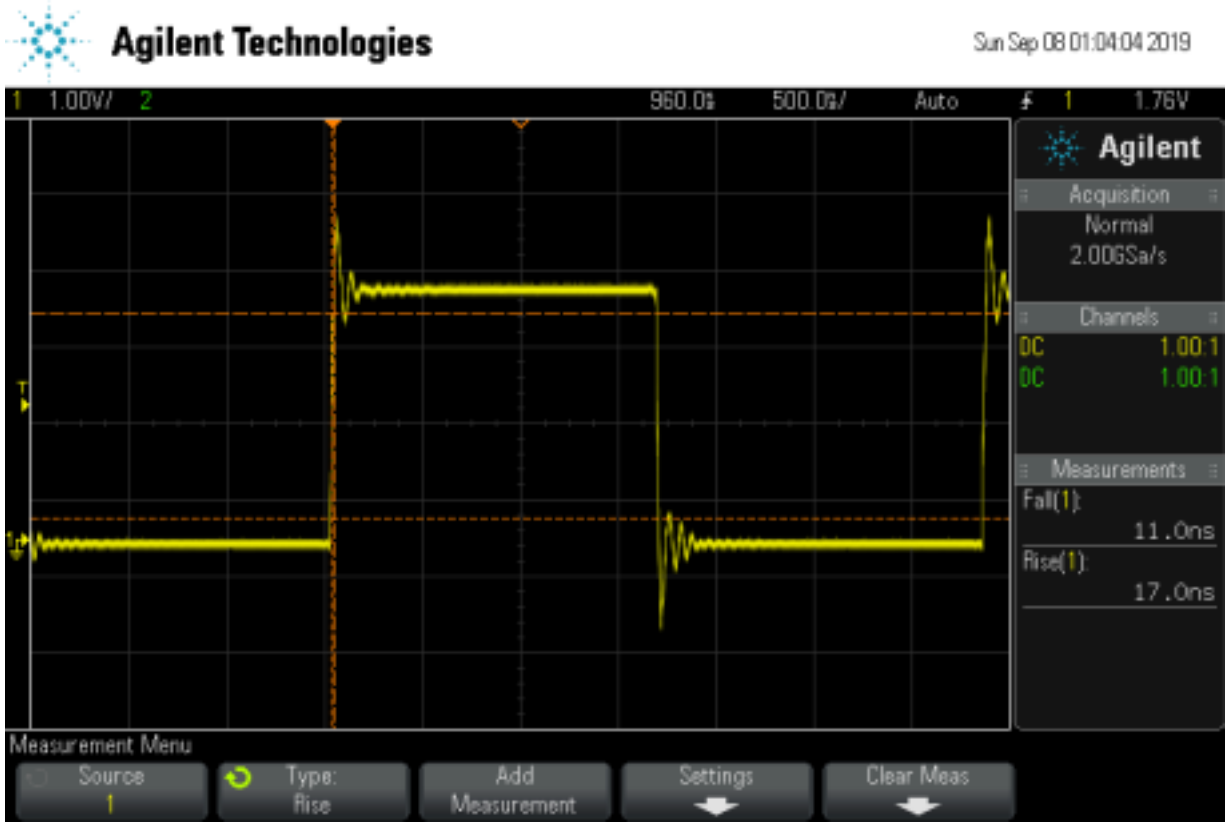


Include a copy of your Chip Layout Diagram from pre-lab.

X	Y	Z	SUM	CARRYOUT
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Include a typed copy of the truth table that you filled out above.

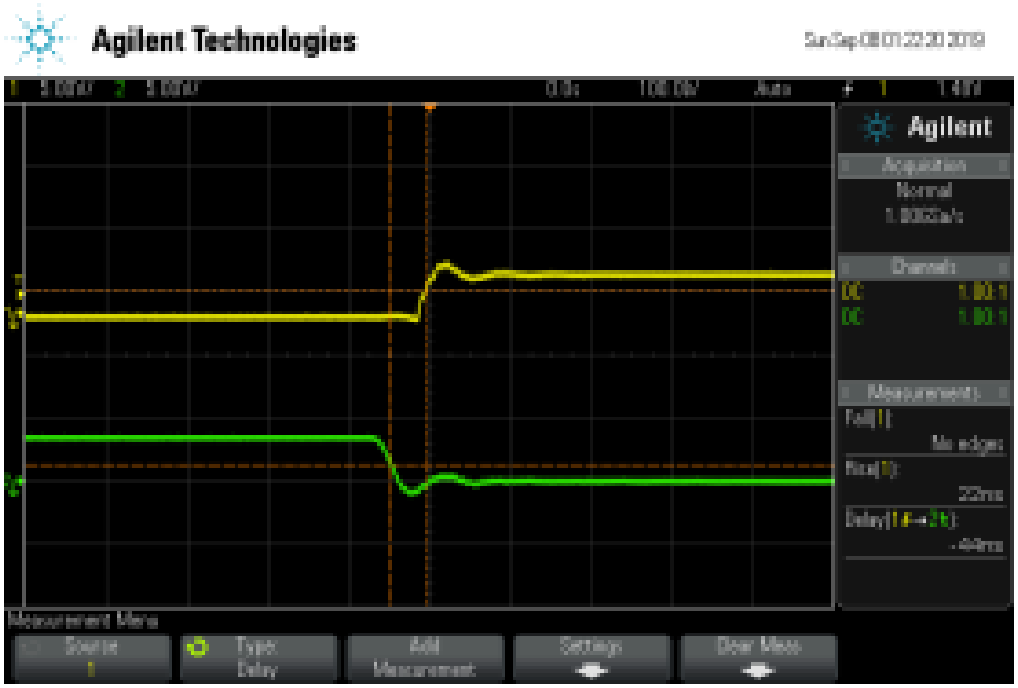
Lab 1c:



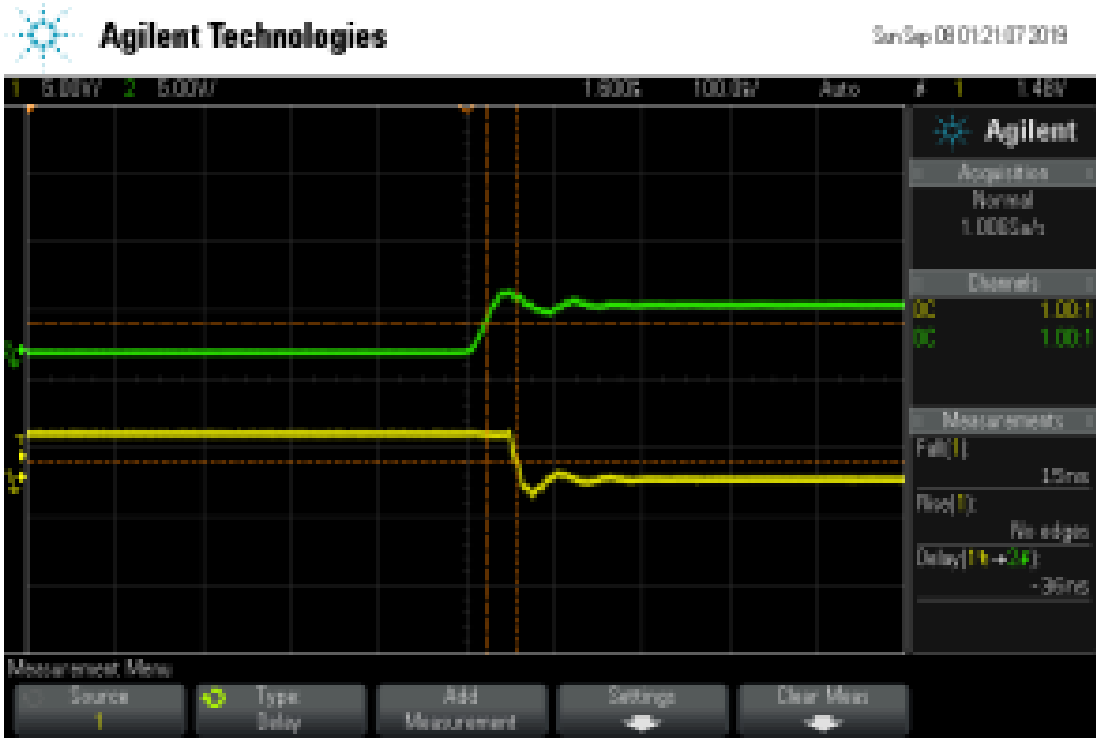
Include a copy the Waveform showing Rise Time and Fall Time Measurements captured.

Note: Green line = input signal, Yellow line = output signal.
The below images show the propagation delay of the input as it travels through 3 NAND gates which are arranged to behave as an inverter.

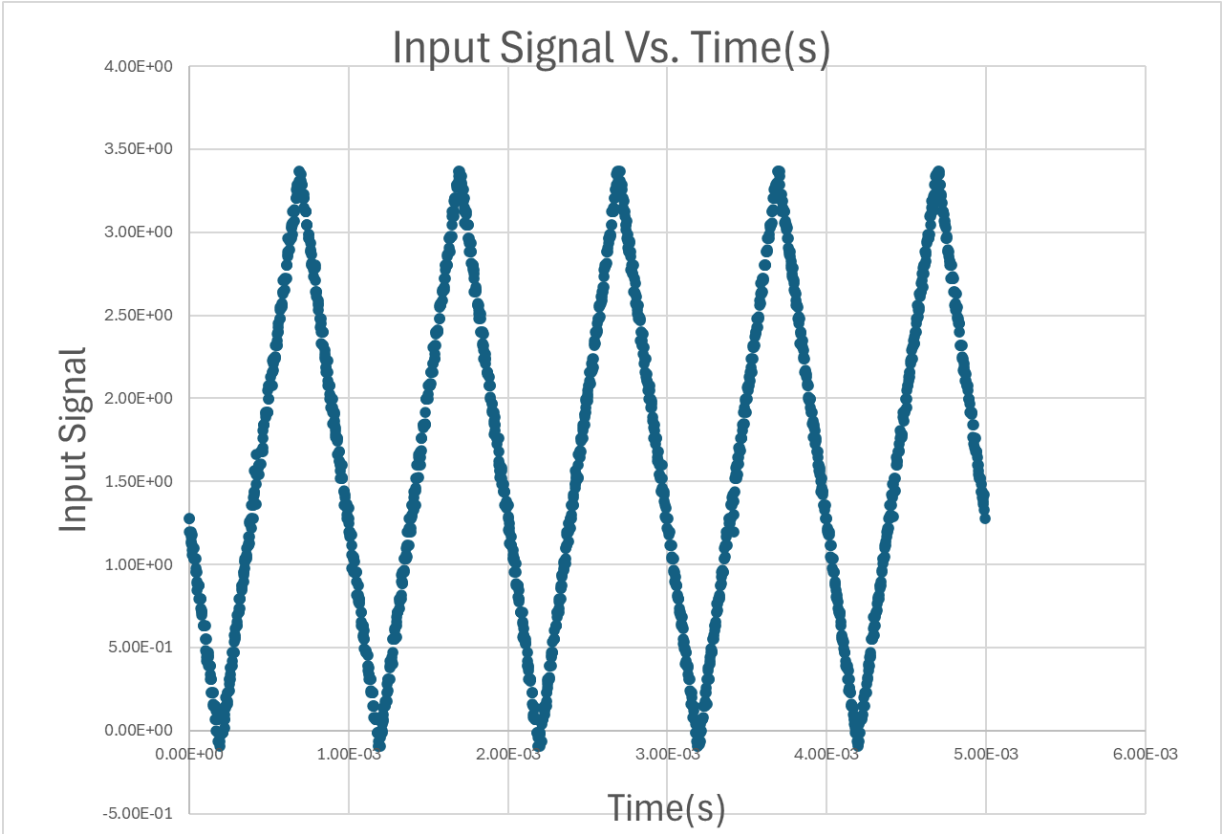
Falling input and rising output delay:



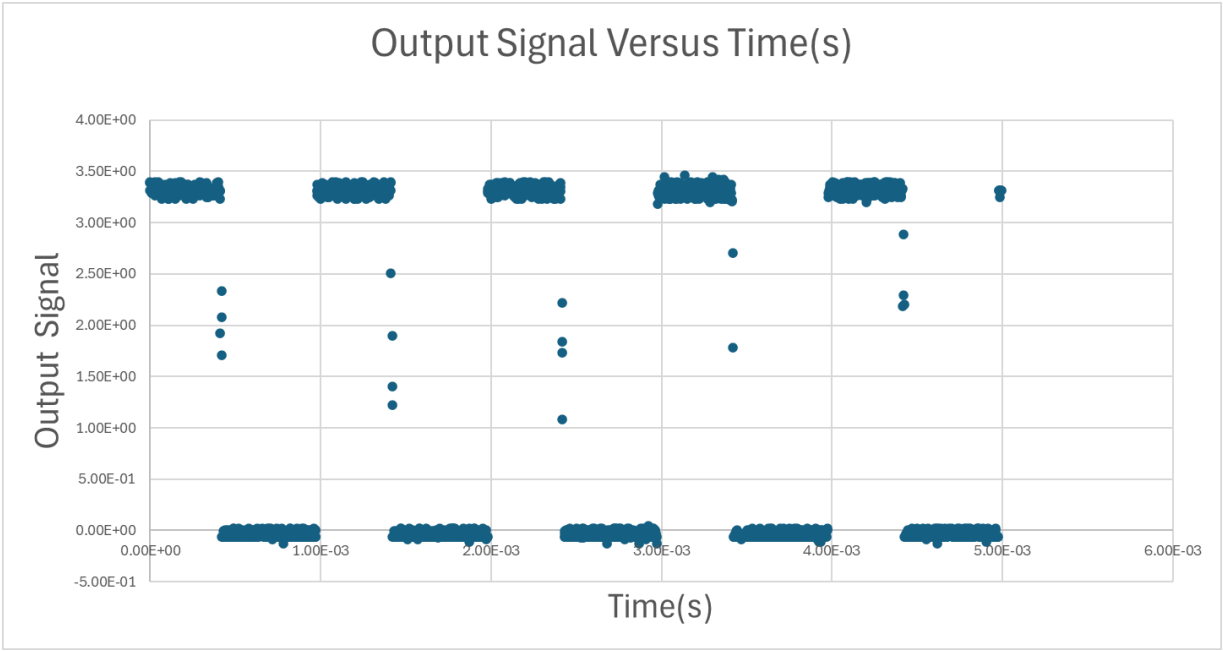
Rising input and falling output delay:



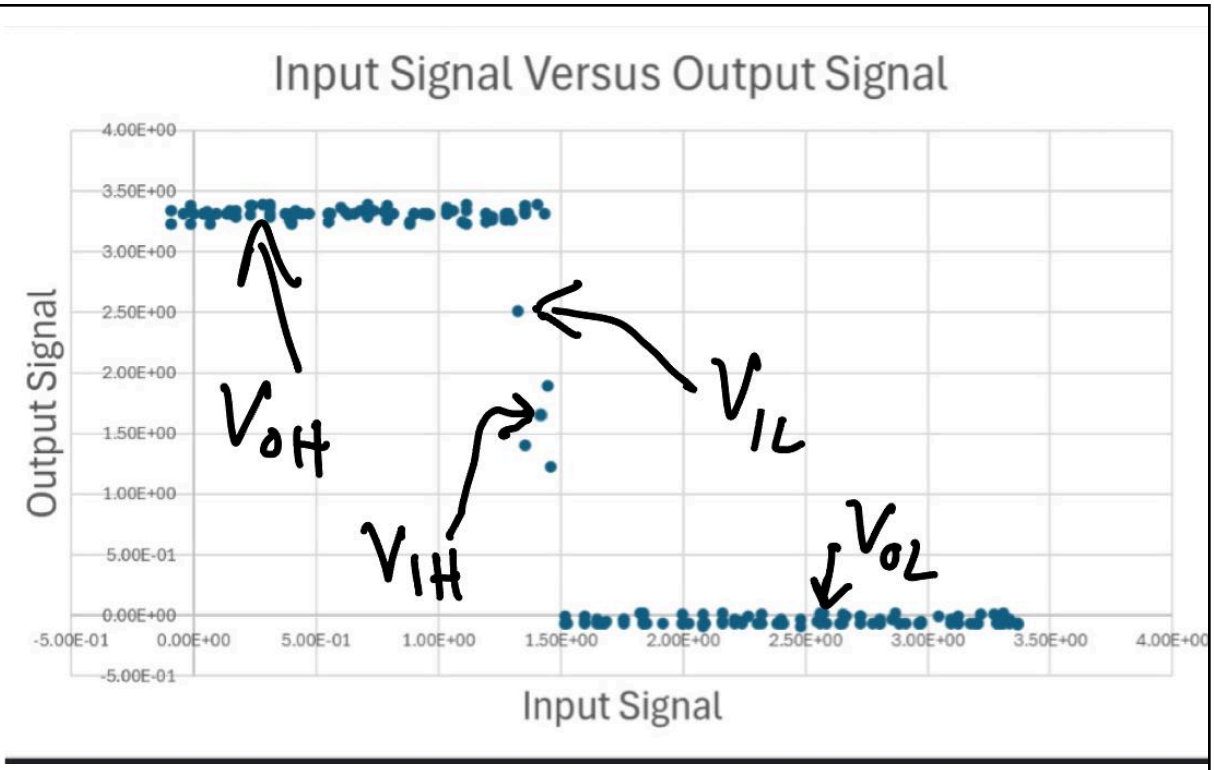
Include a copy of your waveform showing the Propagation Delay Measurements captured. Zoom in to show the associated (rising/falling) edges and cursors.



Include a plot of your **input vs time** data for the CMOS waveform from question 4 in lab 1c.



Include a plot of your **output vs time** data for the CMOS waveform from question 4 in lab 1c.



Include a plot of your **output vs input** data for the CMOS waveform from question 4 in lab 1c.

Make sure you Locate the V_{IH}, V_{IL}, V_{OH} and V_{OL} on this graph. [Located above]

* Note that the Output vs. Input graph above is that of an inverter:
- When the input signal is read as HIGH, the output will be read to be LOW.
- When the input signal is read as LOW, the output will be read to be HIGH.

Measurements of above graph:

- **V_{IH} = 1.517 V** [Minimum voltage input that will be recognized as a HIGH input for the output signal to be considered LOW, which is anything downwards of approximately 0.4V.]

- **V_{OH} = 3.303 V** [Minimum voltage that could occur on the output of a gate to achieve a HIGH voltage output signal]

- **V_{IL} = 1.326 V** [Maximum input voltage that will be interpreted as a LOW input–i.e. the output is still considered HIGH, which is anything upwards of approximately 2.4V.]

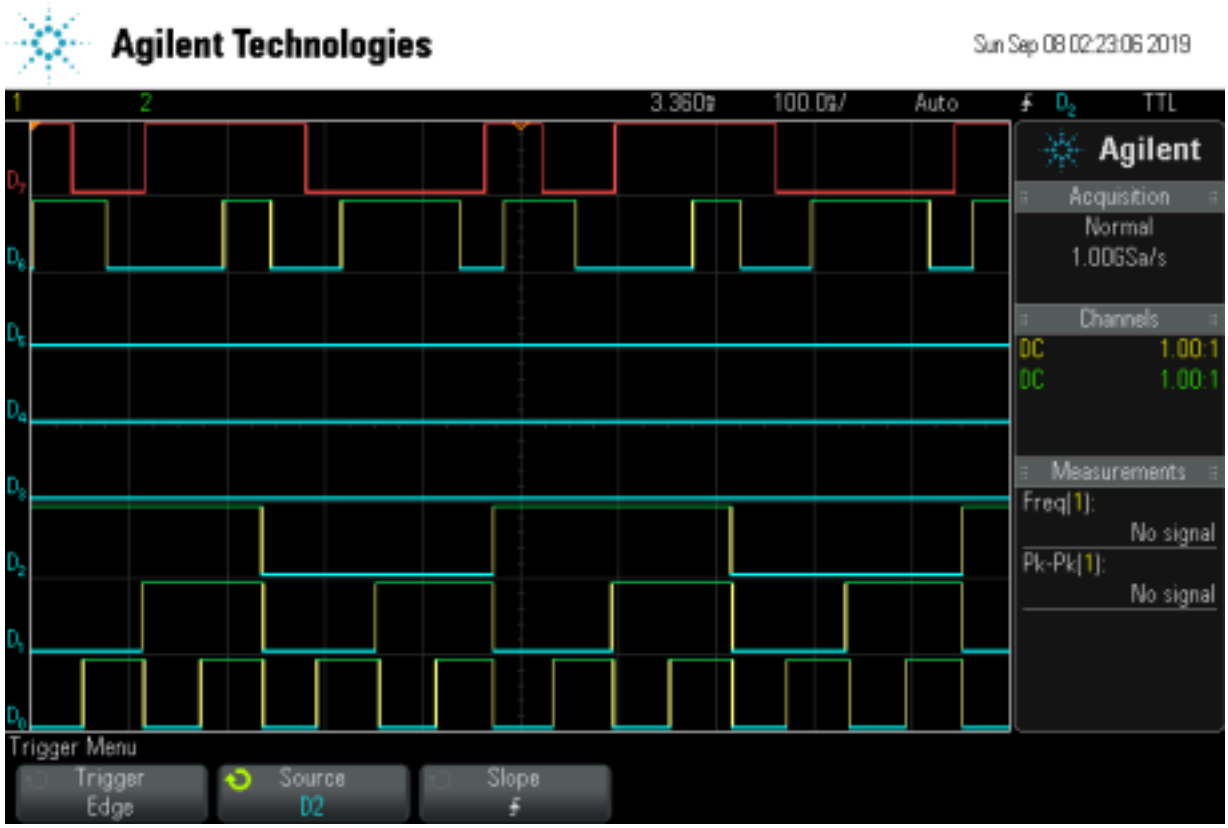
- **V_{OL} = 0.007 V** [Maximum voltage that could occur on the output of a gate for achieving a LOW output signal]

Calculate the NM_H and NM_L using these values.

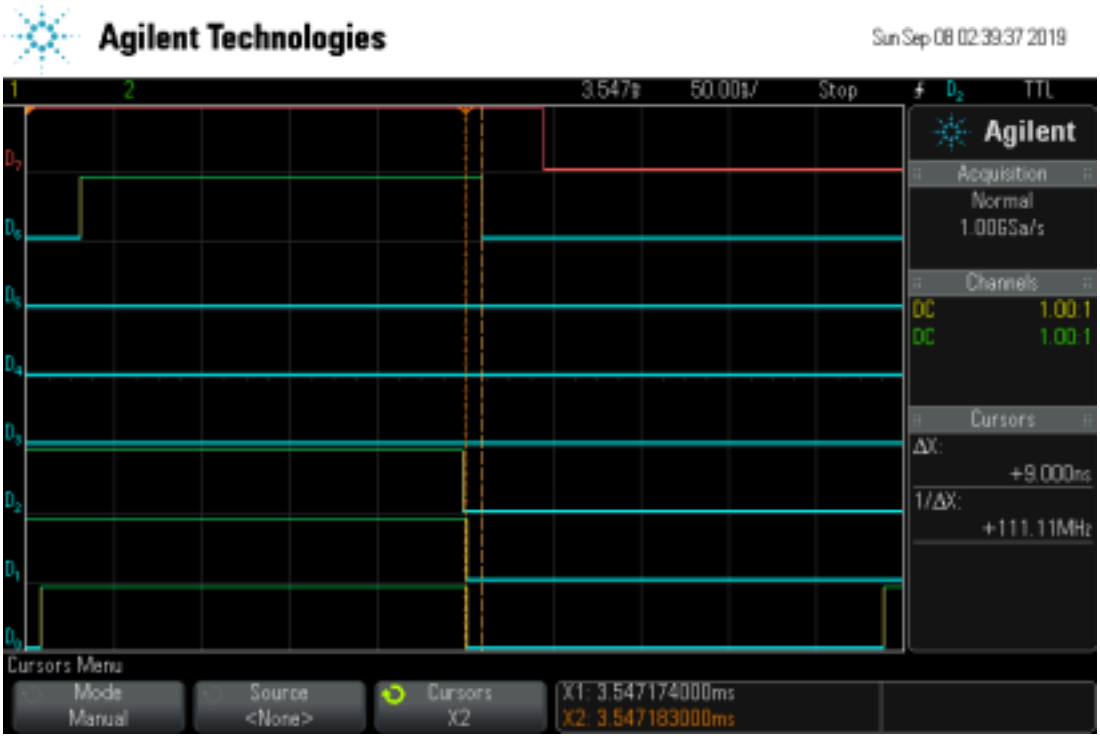
$NM_H = V_{OH} - V_{IH} = (3.303\ V) - (1.517\ V) = 1.786\ V$

$NM_L = V_{IL} - V_{OL} = (1.326\ V) - (0.007\ V) = 1.319\ V$

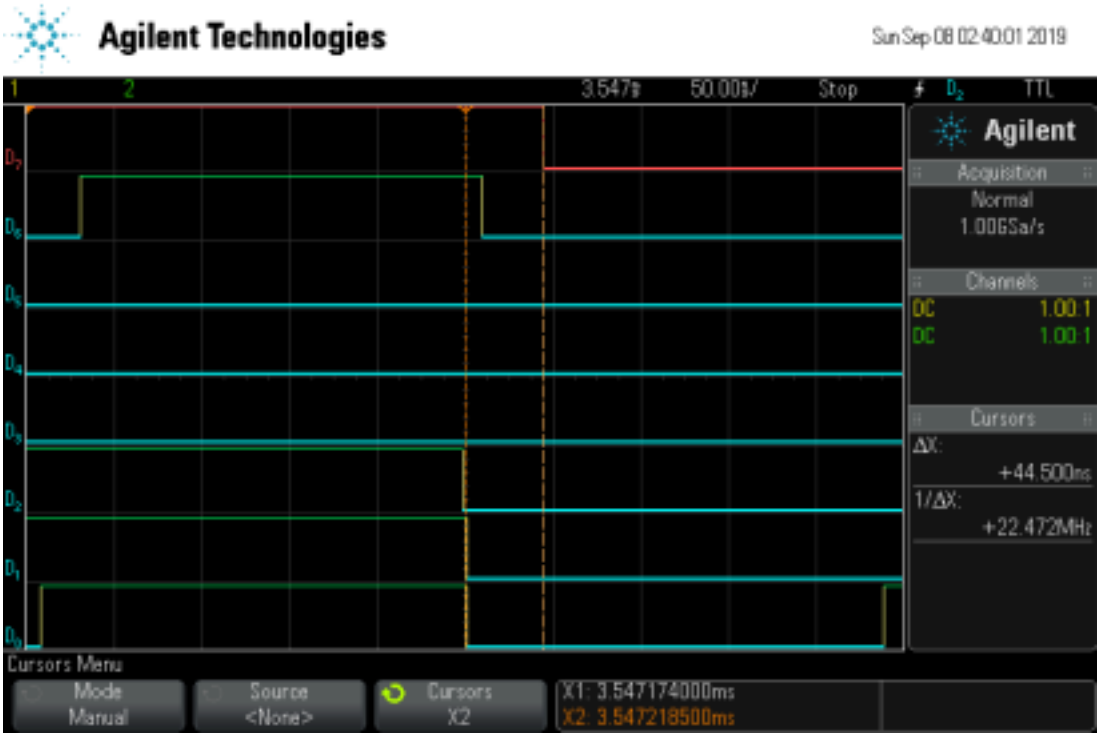
Noise margin = $\min(NM_L, NM_H) = 1.319\ V$



Include a copy of your waveform for all 8 input combinations from question 5 in lab 1c.

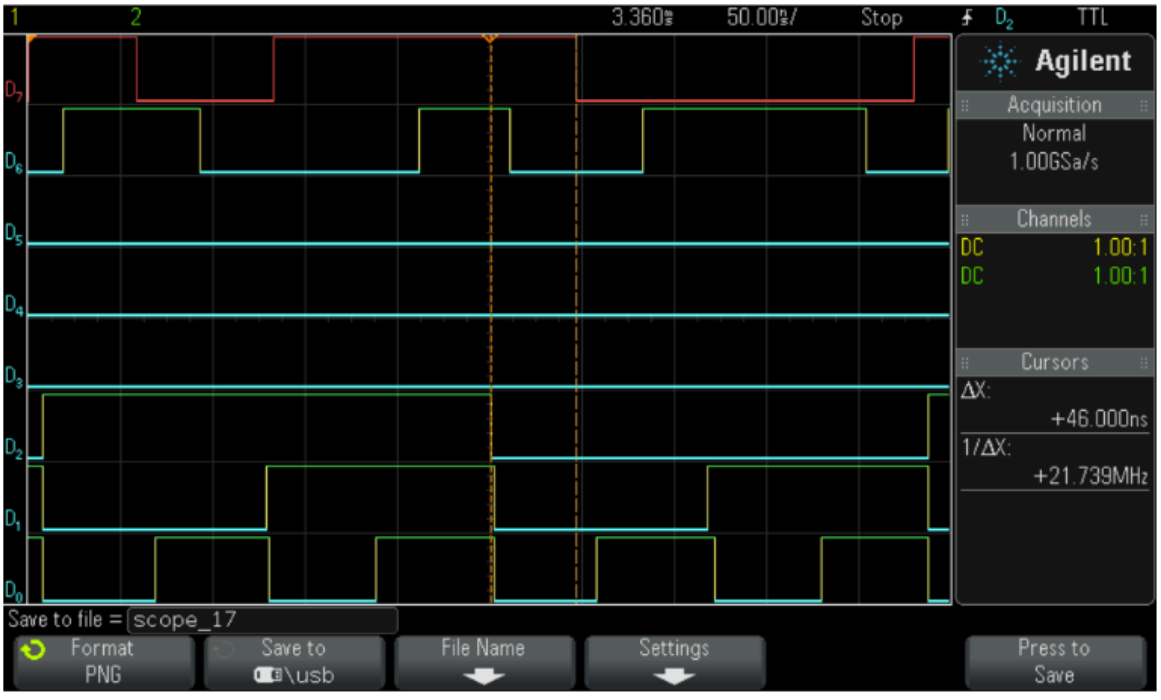


Propagation delay of OUTPUT2 given an input frequency of 2^22 Hz:



Propagation delay of OUTPUT1 given an input frequency of 2^24 Hz:

Propagation delay of OUTPUT2 given an input frequency of 2^24 Hz:



Include a copy of your propagation delay measurement from question 5 in lab 1c.

"You have to place cursors manually for the digital signals and see the delta(x) for the Propagation Delay"