

Haroutun Haroutunian  
Professor Berhe  
ECE 443L  
8 February 2022

## Lab 1: Familiar with CMOS Transistors

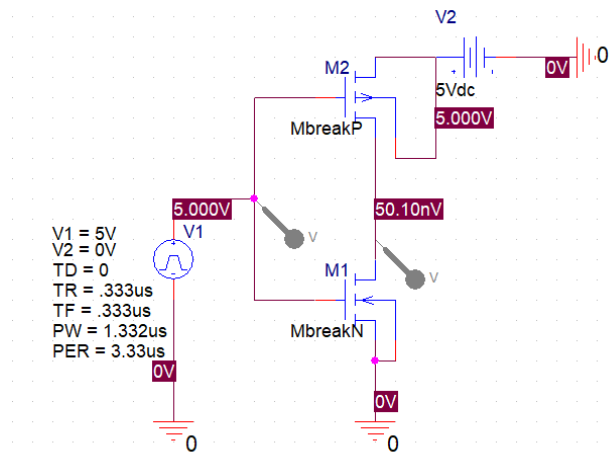


Figure 1.1: Case 2 CMOS Inverter circuit with square wave input of 5V @  $f = 300 \text{ kHz}$

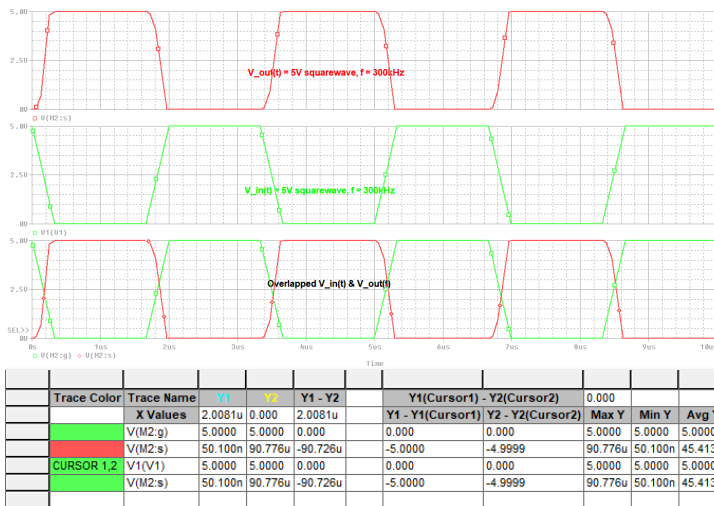


Figure 1.2: I/O waveforms of CMOS inverter with input of 5V @  $f = 300 \text{ kHz}$

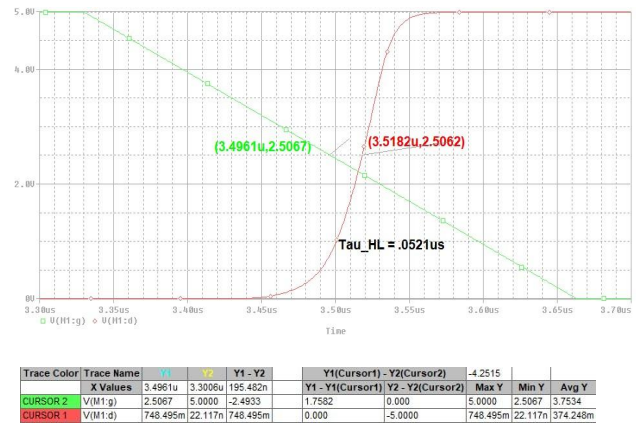


Figure 1.3: ZOOMED I/O waveforms of CMOS inverter of propagation delay High-to-Low @  $f = 300 \text{ kHz}$

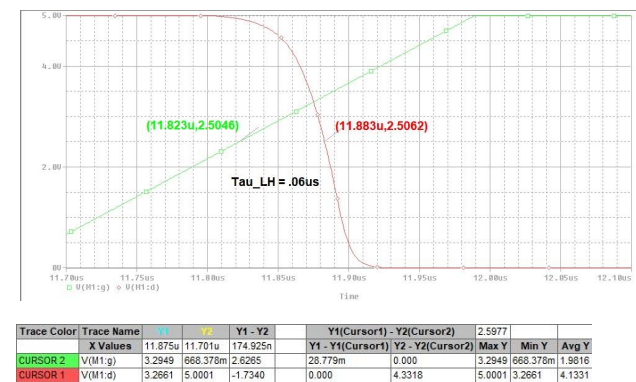


Figure 1.4: ZOOMED I/O waveforms of CMOS inverter of propagation delay Low-to-High @  $f = 300 \text{ kHz}$

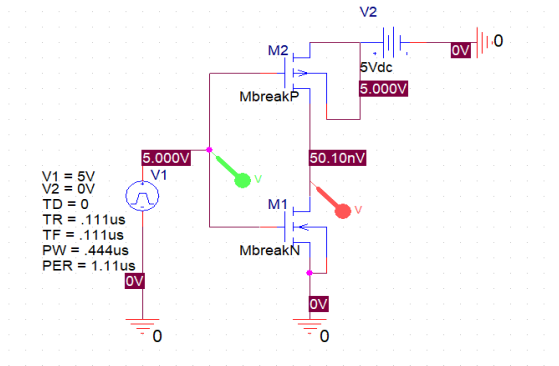
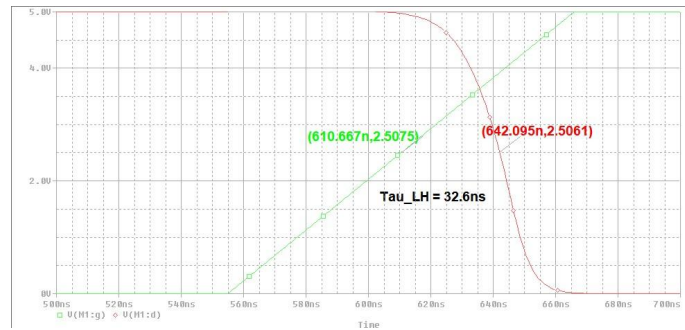
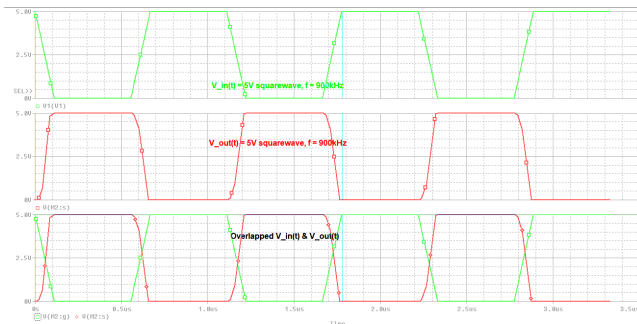


Figure 1.5: CMOS Inverter circuit with square wave input of 5V @  $f = 900 \text{ kHz}$



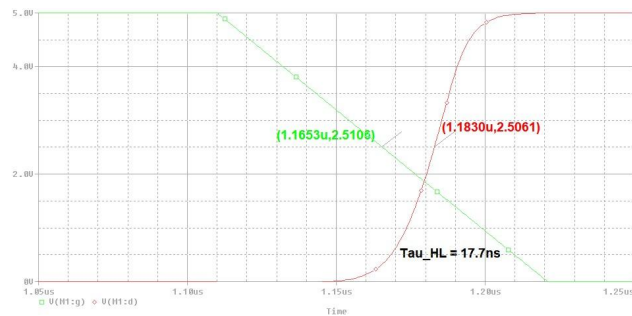
Trace Color	Trace Name	Y1	Y2	Y1 - Y2	Y1(Cursor1) - Y2(Cursor2)		2.5061		
	X Values	642.095n	500.521n	141.574n	Y1 - Y1(Cursor1)	Y2 - Y2(Cursor2)	Max Y	Min Y	Avg Y
CURSOR 2	V(M1:g)	3.9189	0.0000	3.9189	1.4128	0.0000	3.9189	0.0000	1.9595
CURSOR 1	V(M1:d)	2.5061	5.0000	-2.4939	0.0000	5.0000	5.0000	2.5061	3.7531

Figure 1.8: ZOOMED I/O waveforms of CMOS inverter of propagation delay Low-to-High @  $f = 900 \text{ kHz}$



Trace Color	Trace Name	Y1	Y2	Y1 - Y2	Y1(Cursor1) - Y2(Cursor2)	0.000			
	X Values	1.7784u	0.000	1.7784u	Y1 - Y1(Cursor1)	Y2 - Y2(Cursor2)	Max Y	Min Y	Avg Y
CURSOR 1,2	V(M2:g)	5.0000	5.0000	0.0000	0.0000	0.000	5.0000	5.0000	5.0000
	V(M2:s)	50.100n	90.595u	-90.544u	-5.0000	-4.9999	90.595u	50.100n	45.322u
	V(M2:s)	50.100n	90.595u	-90.544u	-5.0000	-4.9999	90.595u	50.100n	45.322u
	V1(V1)	5.0000	5.0000	0.000	0.000	0.000	5.0000	5.0000	5.0000

Figure 1.6: I/O waveforms of CMOS inverter with input of 5V @  $f = 900 \text{ kHz}$



Trace Color	Trace Name	Y1	Y2	Y1 - Y2	Y1(Cursor1) - Y2(Cursor2)		-2.4939		
	X Values	1.1830u	1.0505u	132.505n	Y1 - Y1(Cursor1)	Y2 - Y2(Cursor2)	Max Y	Min Y	Avg Y
CURSOR 2	V(M1:g)	1.7133	5.0000	-3.2867	-792.836m	0.000	5.0000	1.7133	3.3567
CURSOR 1	V(M1:d)	2.5061	21.992n	2.5061	0.000	-5.0000	2.5061	21.992n	1.2531

Figure 1.7: ZOOMED I/O waveforms of CMOS inverter of propagation delay Low-to-High @  $f = 900 \text{ kHz}$

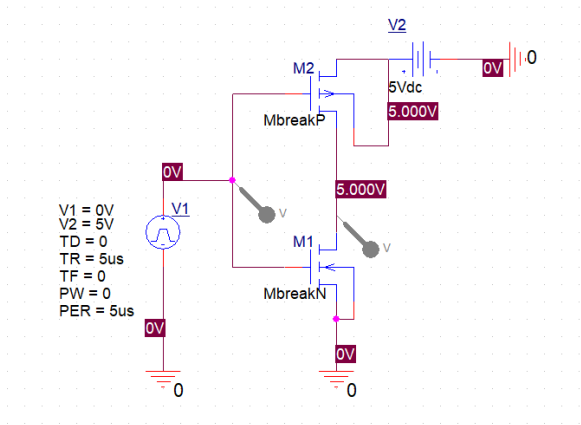


Figure 1.9: CMOS Inverter circuit with ramp wave input of 5V @  $f = 200$  kHz

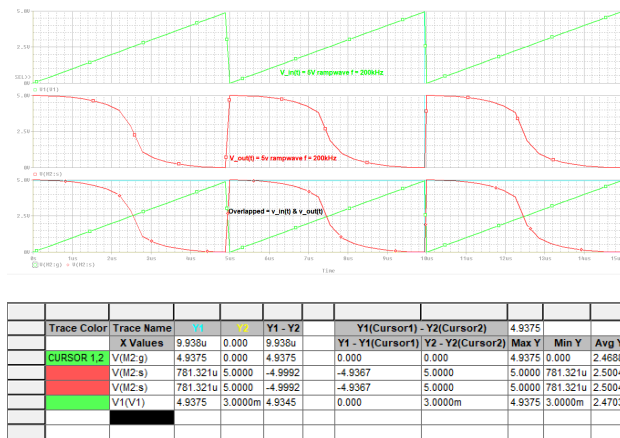


Figure 1.10: I/O waveforms of CMOS inverter with input of 5V @  $f = 200$  kHz

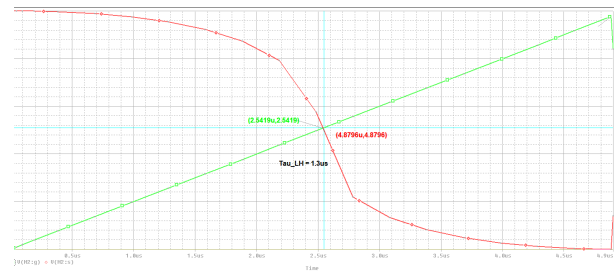


Figure 1.11: ZOOMED I/O waveforms of CMOS inverter of propagation delay Low-to-High @  $f = 200$  kHz

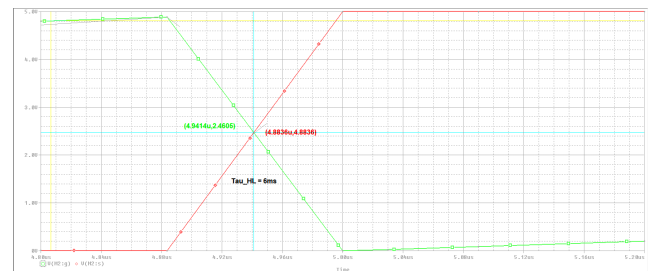


Figure 1.12: ZOOMED I/O waveforms of CMOS inverter of propagation delay High-to-Low @  $f = 200$  kHz