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IE lab 8

Pre-Lab Exercise 1:

1. Simulate the circuit shown above. Note, the PMOS transistor needs to be 'mirrored vertically' so that the source is on the 'top'. You can change the orientation of a component by right clicking on it. Set the simulation to a DC voltage sweep for 0 < Vin < 5 V.

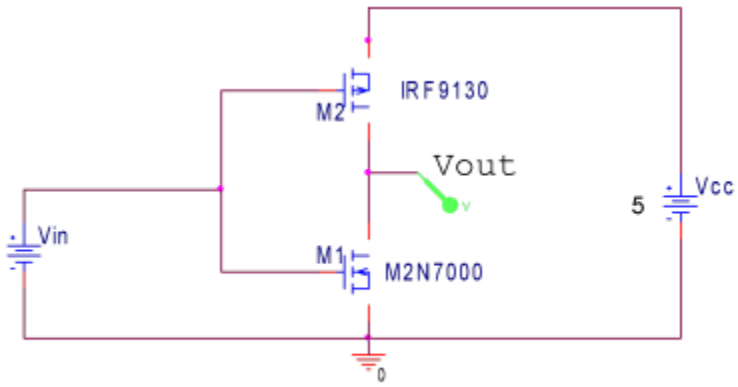

Figure 2: CMOS inverter (M1 = N-channel FET; M2 = P-channel FET)

Estimate the output high voltage, the output low voltage, the low noise margin and the high noise margin.

output high voltage is 5V (VCC)
output low voltage is 0V (GND)
low noise margin is 1.75V
high noise margin is 3.25V

2. Add an input side resistance and an output side capacitance. Set Vin to a pulse stream with a 50% duty cycle and a 2 μs period.

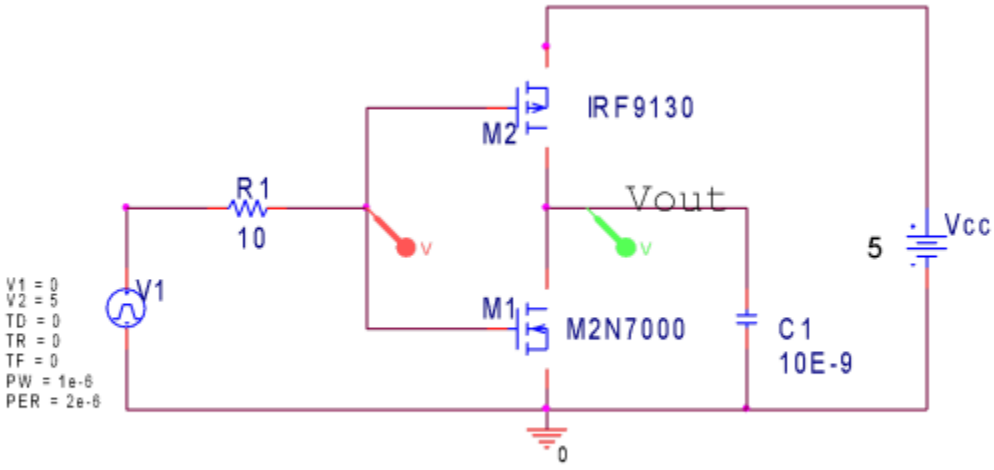

Figure 3: CMOS inverter (M1 = N-channel FET; M2 = P-channel FET)

Estimate the propagation delay as the output switches from LO to HI and from HI to LO.

150ns for both

Exercise 1:

1. Build the circuit above using the IRF9120 PMOS and 2N7000 NMOS transistors. Set the input signal to a 10 Hz sawtooth triangle wave, oscillating between 0 V and 5 V.
2. Use the x-y channel to plot the voltage transfer function, Vout versus Vin .
    a. Determine the LO and HI output voltages, VOut,Low and VOut,High .

LO = 0V
HI = .925V

    b. Estimate the high and low noise margins.

low noise margin = VinL-VoutL=1.4V-0.05V=1.35V
high noise margin = VoutH-VinH=0.7V-2V=1.3V

3. Add a 10 nF capacitor at the load (Vout) and change the input signal to a square wave. You will need to 'zoom in' to see the tPLH and tPHL . In order to do that, you need to set the horizontal axis to ~100 ns/div. The triggering must also be set correctly. Set the triggering source to the oscilloscope channel connected to the input and the triggering level to ~2 V. You can change the condition ("Cond.") to Rising and Falling, giving you the two different propagation delays.
   Estimate the propagation delays.

VOL (Output voltage – Low)
31.25mV
VOH (Output voltage – High)
775mV
NMLow (Noise margin – Low)
hard to get good values due to scope and probes
NMHigh (Noise margin – High)
hard to get good values
tPLH (Propagation delay – L-to-H)
60ns
tPHL (Propagation delay – H-to-L)
64ns