Electrical Engineering
Indian Institute of Technology Hyd
CMOS VLSI Design

August 14, 2025

Deadline: 24 Aug 2025 | *Assignment # 1* | Maximum Marks: TBD

Instructions:
1. Use LT Spice and/or MATLAB for the simulations.

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1. Consider a RC circuit (R and C in series) with RC = 10μS given with an input of square waveform with 50% duty cycle (0 to 1 Volts) with TON (time interval for level high) varies from 1ns to 1 μs. Plot the output waveform across capacitor for different TON (simulate for TON = 1ns, 10ns, 100ns, and 1μs).

2. Consider A PMOS device (ideal) with following specifications: Nd varies from 10^{14} to 10^{20} atoms/cm3, Ni = 10^{10} atom/cm3, Oxide thickness: 10nm, Temperature: 300K, $\epsilon_0 = 8.85\times 10^{-14}$ F/cm, $\epsilon_{si} = 12\epsilon_0$, $\epsilon_{sio2} = 4\epsilon_0$, Applied voltage at Gate terminal = -2V,

   (a). Plot graphs for voltage drop across oxide layer and semiconductor to calculate the threshold voltage.

   (b). Draw the profile of electric field inside Si-bulk and SiO2.

   (c). Draw the graph between Gate voltage and drop across semiconductor. Show the shift of the curve with the variation of Gate oxide thickness from 1nm to 10 nm?

   (d). Repeat all for NMOS device with Gate voltage = 2 volts and consider Na instead of Nd.

3. For the Fig. 1, find the value of R_2 and C_2 to get the circuit response (output) free from delay or any transient behavior. R_1 = 100 kΩ and C_1= 10μF.

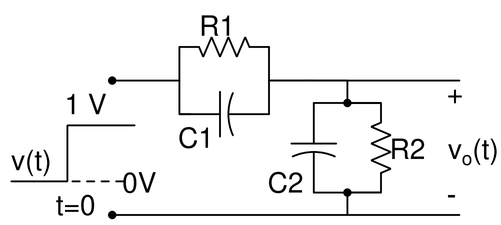

Figure 1:

4. Find out the threshold voltage for a MOS Device using following method:

   1. Keep Width/Length = 1.
   2. Body and source terminal shorted.
   3. Keep V_{DS} = 0.1V fixed and vary the value of V_{GS} till I_{DS} is not reaching to 100 nA .
   4. Now keep V_{DS} = 1V fixed and vary the value of V_{GS} till I_{DS} is not reaching to 100 nA
   5. The obtained value of V_{GS} can be considered as the threshold voltage of the device in each case of V_{DS}.

5. i Generate a square wavefrom (approximate) using sinusoildal waveforms with different frequencies. (start from 5 kHz)

   ii Pass this square wavefrom with an amplifier with a gain A(ω) and the following frequency response
   - (upto 10 kHz A(ω) = 5)
   - (From 10 kHz to 50 kHz A(ω) = 3)
   - (Above 50 kHz to 200 kHz A(ω) = 2)
   - (Above 200 kHz to 1 MHz A(ω) = 1)
   - (Above 1 MHz to 1.1 MHz A(ω) = 20)
   - (Above 1.1 MHz to 2 MHz A(ω) = 2)
   - (Above 2 MHz A(ω) = 0)

   iii Pass the square waveform generated in (1) with an ideal low-pass filter with cut-off frequenecy = 9 kHz. Get the output waveform.