VLSI Design Monsoon 2023
Assignment 2

Deadline: 3rd November(Hard Deadline)

1. Make the following gates in the MAGIC Layout tool and compute the maximum delay in each case.
   a) NOT
   b) 5-input AND
   c) 4-input OR
   d) 2-input XOR

2. Make a ring oscillator circuit using 3 NOT gates and verify it's functioning in NGSPICE. Verify if it is functioning when extracted from the layout. Will the circuit function in the same way if it was just one inverter instead of three? Give the reasons for your answer.

3. Majority function is the one which gives **1** if the input has more 1s than 0s. Design 3-bit majority function on NGspice using a 4:1 Mux. What is the significance of this block, i.e., in which of the well-known building blocks, we can use this in it?
   Let the input be A2A1A0. Now perform temperature analysis for a range of 0^0 to 80^0 and observe the trend in delays of A2-Y, A1-Y, A0-Y where Y is the output of the circuit. Try this for the input sequence 111.

4. Using a four-bit adder, design a combinational circuit in NGspice that gives out the absolute value of a 4-bit number (negative numbers are used in 2's complement form). Absolute value of a number is defined as

$$|A| = A, \text{ if } A > 0,$$

$$= \text{-A, else.}$$

   Try designing the adder circuit in NGspice by calling subckts for implementing FA for ease in implementation.

5. Design and simulate the given CMOS 2-input NAND gate to estimate propagation delays using 180NM technology model parameters.
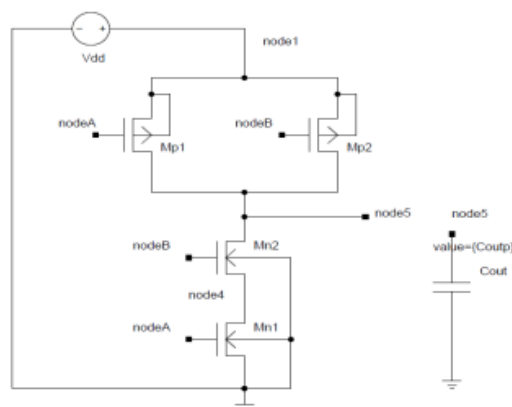
a) Show the impact of temperature variations (e.g., from 0°C to 80°C) on propagations delays in the given NAND gate. [Help: Generate random 500 (as an example) values of temperature within the targeted range (0°C to 80°C) and simulate/estimate propagation delays for all 500-temperature value and show the impact. Again, go for automated way.]

b) Vary the output capacitances by a scale of 2 from your current value and observe the trend in delay for 10 such capacitances. [use an automated script or you can do it manually]

Note:

While calculating propagation delays, use the capacitive load (in fF) in following fashion as per your roll numbers.

➤ If the last digit in your roll number is 1, 2, 3 and 4: Then CL = 1fF, 2fF, 3fF and 4fF respectively.

➤ If the last digit is 5, 7 and 9: Then divide by 2, therefore CL= 2.5fF, 3.5fF and 4.5fF.

➤ If the last digit is 6 and 8: Then use CL= 1.5fF and 1.75fF respectively.

➤ If the last digit is 0: Then use CL= 0.5fF.