ENEE 307 Laboratory#8 (Digital circuits)

This laboratory is to experiment with the basics of logic gates by CMOS.

A. Pre-laboratory work
   1. Study Section 11.1 Latches and Flip-flops.
   2. Draw the circuit diagram as shown in Fig. 11.5 --- CMOS implementation of a
clocked SR flip-flop. Put down the truth table. Explain each entry.
   3. Draw the circuit diagram of that shown in Fig. 10.12 for a two-input CMOS NOR
   logic gate. Put down its truth table.
   4. Draw the circuit diagram of that shown in Fig. 10.13or a two-input CMOS NAND
   logic gate. Put down its truth table.
   5. Use PSPICE to simulate the above three logic circuits.

B. What to do in the laboratory
   6. Construct the SR flip-flop by the HEF4007UB chip and measure its
   characteristics, including (1) the truth table; (2) delay from high to low; and (3)
delay from low to high. Use 5V as the supply voltage.
   7. Construct the NOR logic gate by the HEF4007UB chip and measure its
   characteristics, including (1) the truth table; (2) delay from high to low; and (3)
delay from low to high. Use 5V as the supply voltage.
   8. Construct the NAND by the HEF4007UB chip and measure its characteristics,
   including (1) the truth table; (2) delay from high to low; and (3) delay from low to
   high. Use 5V as the supply voltage.
   9. Use a light emitting diode (LED) with a resistor as the “logic status sensor.” First,
   add dc voltage (V=0) to the LED. Gradually increase the voltage setting, until the
   LED is lit up. What is the voltage that is necessary to lit up the LED? From this
   voltage, estimate how much resistance you should have in series, in order to use
   the LED to sense 5V. The LED and this Resistance in series (as a unit) is then
   wired at the circuit node to provide a visual verification of the digitized output
   voltage.

C. Post-laboratory report questions, in addition to your report on data and your additional
observation
   1. What is the measured high frequency limit of your logic circuits? Discuss the
   possible physical origin and estimate the order of magnitude of the delay from
   these origins.
   2. What the LED is made of? More specifically, what was the color of the LED that
   you used? What type of semiconductor one can use to generate that color? Search
   online and put down your best answer in a few sentences. Explain your answer.
   For example, explain why the red LED is made of that specific semiconductor.