DLD Homework 2

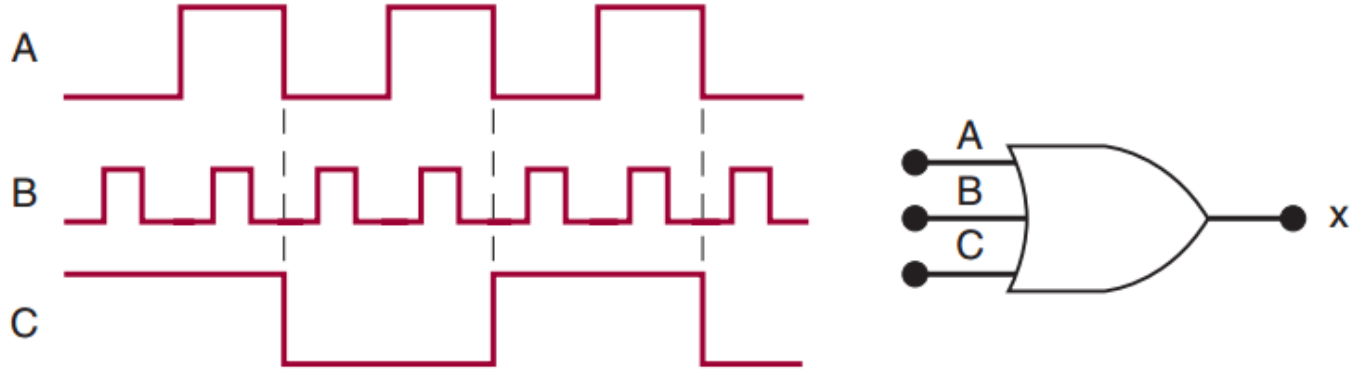
Term II – 2023-2024

Student 1's Name: _____ Student 1's code_____

Student 2's Name: _____ Student 2's code_____

Please attach this page to the front of your work. Show your work for each problem.

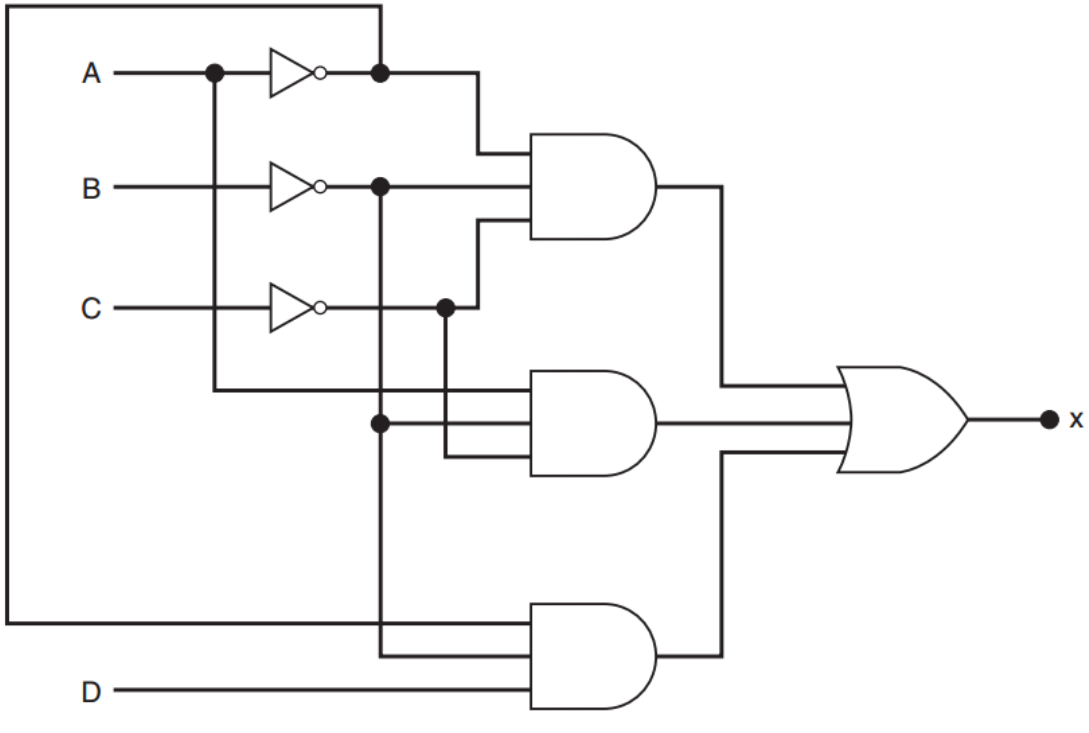
1. Draw the output waveform for the OR gate



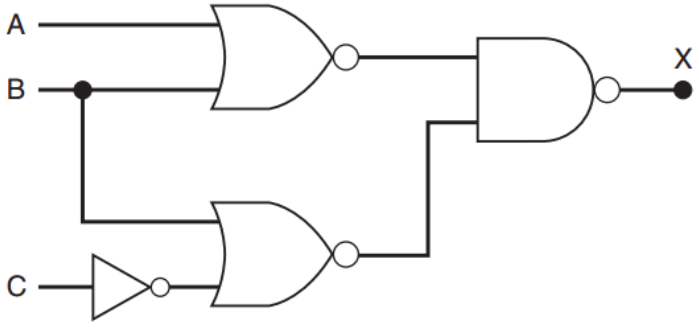
Change the OR gate to a NAND gate. Draw the output waveform.

2. Write the Boolean expression for output x in the following figure. Determine the value of x for all possible input conditions, and list the values in a truth table.

a.



b.



3. For each of the following expressions, construct the corresponding logic circuit, using AND and OR gates and INVERTERs
   a. $x = \overline{AB(C + D)}$
   b. $y = (\overline{M + N} + \overline{P}Q)$
   c. $z = \overline{A + B + \overline{C}D\overline{E}} + \overline{B}C\overline{D}$

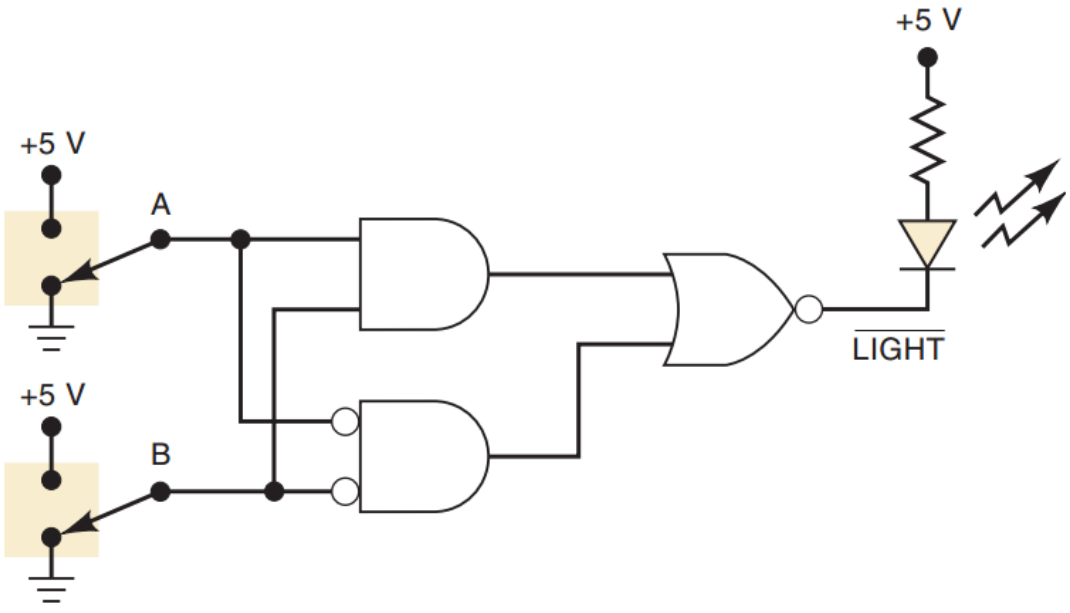
4. Simplify the following expression using Boolean theorems
   a. The output of Figure 2b
   b. $y = (M + N)(\overline{M} + P)(\overline{N} + \overline{P})$
   c. $z = \overline{A}B\overline{C} + AB\overline{C} + B\overline{C}D$

5. Implement y = ABCD using only **two-input NAND gates**.

6. Convert the circuit of Figure 2a to one using **only NOR gates**. Then write the output expression for the new circuit, simplify it using DeMorgan's theorems, and compare it with the expression for the original circuit

7. The circuit of Figure 2b is supposed to be a simple digital combination lock whose output will generate an active-LOW signal for only one combination of inputs.
   a. Modify the circuit diagram so that it represents more effectively the circuit operation.
   b. Use the new circuit diagram to determine the input combination that will activate the output.

8. The following figure shows an application of logic gates that simulates a two-way switch like the ones used in our homes to turn a light on or off from two different switches. Here the light is an LED that will be ON (conducting) when the NOR gate output is LOW. Note that this output is labeled $\overline{LIGHT}$ to indicate that it is active-LOW. Determine the input conditions needed to turn on the LED. Then verify that the circuit operates as a two-way switch using switches A and B.



9. Simplify the following expression using Boolean algebra
   a. $x = \overline{A}\,\overline{B}\,\overline{C} + \overline{A}\,B\,C + A\,B\,C + A\,\overline{B}\,\overline{C} + A\,\overline{B}\,C$
   b. $y = \left(\overline{C + D}\right) + \overline{A}\,C\,\overline{D} + A\,\overline{B}\,\overline{C} + \overline{A}\,\overline{B}\,C\,D + A\,C\,\overline{D}$
   c. $z = (B + \overline{C})(\overline{B} + C) + \overline{\overline{A} + B + \overline{C}}$

10. Design the logic circuit corresponding to the truth table and then implement the circuit using all NAND gates.

A	B	C	x
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1