Assignment-Midterm
Digital Logic & Circuits

Basic Logic Gate (2 Points)

1. **Write down** the **truth table, logic, logic expression** and **draw the logic symbol** for each of the following gates with 3 inputs.

a. NOT (1 input)	**b. OR**	**c. AND**	**d. NAND**
e. NOR	**f. XOR**	**g. XNOR**	

Logic Simplification with Boolean algebra: (1 Points)

2. Using **Boolean algebra** and **De Morgan's Rule where applicable**, **simplify** the following expressions
   a. $A\bar{B} + A(\overline{B+C}) + B(\overline{B+C})$
   b. $\overline{AB + A\bar{C}} + \bar{A}\bar{B}C$

Building Combinational Logic Circuit and Universal Gates: (2 Points)

3. For the following output expressions, **design the combinational logic circuits with basic logic gates** (**use Boolean algebra to reduce the expressions where possible**).
   a. For the designed logic circuits, **redraw** each of them with only **Universal NAND gates only**.
      i. $ABC+A\bar{B}\bar{C}+\overline{A\bar{C}}$
   b. For the designed logic circuits, **redraw** each of them with only **Universal NOR gates only**.
      i. $A\bar{B}C+A\bar{B}\bar{C}+\overline{A\bar{C}}$

Types of Boolean Expressions (2 Points)

4. **Convert** the following to **Standard SOP expressions**:
   a. $\bar{A}BC + A\bar{D} + \overline{B\bar{C}}D$
5. **Convert** the following to **Standard POS expressions**:
   a. *A+B(AC+(B+$\bar{C}$)D*
6. **Develop** a **truth table** from **each of the following expressions**. (**Hint**: Convert them to their standard forms before you create any truth table)
   a. $\bar{A}B + AB\bar{C} + \overline{A\bar{C}} + A\bar{B}C$

Karnaugh Map (3 Points)

7. **Use K-map** to find the **minimum SOP and POS expression** from the following expressions **and draw the logic gate diagrams**.
   a. AC($\bar{B} + C$)
   b. A+B$\bar{C} + CD$
   c. A(B+$\bar{C}$)($\bar{A} + C$)(A+$\bar{B} + C$)($\bar{A} + B + \bar{C}$)

Don't Care Condition: (6 Points)

8. The following is a **truth-table** of a **combinational logic circuit**. With **inputs A, B, C, D** and **output F**.

Fill-up a K-MAP out of the truth-table.

A	B	C	D	F
0	0	0	0	**1**
0	0	0	1	**0**
0	0	1	0	**X**
0	0	1	1	**X**
0	1	0	0	**X**
0	1	0	1	**1**
0	1	1	0	**1**
0	1	1	1	**0**
1	0	0	0	**1**
1	0	0	1	**X**
1	0	1	0	**X**
1	0	1	1	**1**
1	1	0	0	**1**
1	1	0	1	**X**
1	1	1	0	**0**
1	1	1	1	**1**

a. **Derive** the **simplified expression using K-map** (**without using don't care values**).
b. **Derive** the **simplified expression using K-map** (**using don't care values**).
c. **Using your results** in parts **a** and **b**, **explain the importance** of **using don't care terms**.

9. **Consider the given expression**:

F (A,B,C,D) = ∑ (3,7,8,12,15)
d (A,B,C,D) = (1,5,9,10,11)
where **d(A,B,C,D)** represents the don't care conditions.
Fill-up a K-MAP with the above data.

1. **Derive** the **simplified SOP expression** using **K-map** (**without using don't care values**).
2. **Derive** the **simplified expression** using **K-map** (**using don't care values**).
3. Using your results in parts 1 and 2, **explain the importance of using don't care terms**

Adder-Subtractor: (4 Points)

10. **Derive** the **truth-table** and corresponding **output expressions** of **Sum (S)** and **Carry (C_{out})** of a **Half-Adder** having **inputs A** and **B. For the derived expression, design the combinational logic circuit** using **basic logic gates**.
    a. Use the above logic circuit to redesign the **Half-Adder** using only NAND gates.
11. **Derive** the **truth-table** and corresponding **output expressions** of **Difference (D)** and **Borrow (B)** of a **Half-Subtractor** having **inputs A** and **B. For the derived expression, design the combinational logic circuit** using **basic logic gates**.
    a. Use the above logic circuit to redesign the **Half-Subtractor** using only NOR gates.

Magnitude Comparators: (2 Points)

12. Design a **1-bit Magnitude Comparator**. State **how many input** and **output terminals** your device will have with **proper markings in a block diagram**. **For your design show** the **truth table, derive SOP output expressions** and **draw combinational logic diagram**.

Complex Digital System Design: (8 Points)

13. You are hired to design a system that can be used in a safety push button lock device. There will be three buttons for example A, B and C. If odd number of inputs are pressed, the lock mechanism opens. In any other case the lock mechanism remains closed. If any of two buttons is pressed simultaneously, an alarm sounds. Let's say X is the lock mechanism and Y is the alarm that makes the sound,
    i) construct a truth-table for the system and
    ii) find the minimized output expression using Boolean algebra or k-map
    iii) draw the logic diagram for the system.
14. In a departmental store hired you to design a cash register, operated by four personnel- the store manager (A), the assistant manager (B), the cashier (C) and the chief accountant (D). At least two of these personnel must be present, along with the cashier, for the register to unlock. Design a logic system that can perform this operation. For your design, show the truth-table, write the simplified output expression and a draw logic diagram.
    i. construct a truth-table for the system and
    ii. find the minimized output expression using Boolean algebra or k-map
    iii. draw the logic diagram for the system

Instructions:

1. You must complete the assignment, solely by yourself, with ethics and self-belief. Plagiarism, copying from your peers/ or any other source will cause you to loose all the marks.
2. Answers must be handwritten, clear to read and properly numbered, and every page must have your name and I.D on top right corner of your page.
3. You must use CAMSCANNER tool to take picture, convert it to pdf and then upload. Please do not upload individual pictures. It should be a complete pdf.
4. Deadline for submission of Assignment is on 3rd July **2021** **(**, **2:00 P.M**, in MS TEAMS. A a portal has been opened already.
5. Failure to follow the instructions mentioned above, will cause you to lose marks.