National University of Computer and Emerging Sciences

FAST School of Computing **Spring-2023** **Islamabad Campus**

EE-1005: Digital Logic Design

Serial No:

Sessional Exam-I

Total Time: 1 Hour

Total Marks: 55

Tuesday, 28th February, 2023

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Signature of Invigilator

Course Instructors

Dr. Mehwish Hassan, Dr. Niaz Ahmed, Shehzad Ahmed, Dr. Muhammad Awais, Nirmal Tariq

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Student Name	Roll No.	Course Section	Student Signature

DO NOT OPEN THE QUESTION BOOK OR START UNTIL INSTRUCTED.

Instructions:

1. Attempt on question paper. Attempt all of them. Read the question carefully, understand the question, and then attempt it.
2. No additional sheet will be provided for rough work. Use the back of the last page for rough work.
3. If you need more space write on the back side of the paper and clearly mark question and part number etc.
4. After asked to commence the exam, please verify that you have **Nine (9)** different printed pages including this title page. There are a total of **Four (4)** questions.
5. Calculator sharing is strictly prohibited.
6. Use permanent ink pens only. Any part done using soft pencil will not be marked and cannot be claimed for rechecking.

	Q-1	Q-2	Q-3	Q-4	Total
Marks Obtained					
Total Marks	**15**	**20**	**10**	**10**	**55**

Question 1 [15 Marks]

1. Convert $(A0A)_{16}$ to octal representation. [2]

Solution:

$$A0A_{16} = 1010\ 0000\ 1010_2 = 101\ 000\ 001\ 010_2 = 5012_8$$

2. Convert $(A0A)_{16}$ to decimal representation. [2]

Solution:

$$A0A_{16} = 10 \rightarrow 16^2 + 0 \rightarrow 16^1 + 10 \rightarrow 16^0 = 2560 + 0 + 10 = 2570_{10}$$

3. In a 8-bit two's-complement system, what decimal number does the bit pattern 10000111 represent? [3]

Solution:

The number is negative. Its magnitude can be found with two's-complement negation . .

invert bits of number: 0111 1000
add 1: 0111 1001

The magnitude is $2^6 + 2^5 + 2^4 + 2^3 + 2^0 = 64 + 32 + 16 + 8 + 1 = 121_{10}$.

The bit pattern represents the number -121_{10}.

4. One of the following bit patterns is valid BCD (binary-coded decimal), but the other one is not: 100110110100, 100100111000. Which one is not valid? For credit to be given, you must give a correct reason. [1]

Solution:

100110110100 is an invalid code because 4 bit combination 1011 doesn't exist in BCD code.

5. What number does the valid bit pattern from part (4) represent? Give your answer in base ten. [1]

Solution: $(938)_{10}$

6. The ten-bit Gray code for 353_{10} is 0111010001. Explain briefly but precisely why it cannot possibly be true that 0111010100 is the ten-bit Gray code for 354_{10}. Or calculate gray code for 354_{10}. [1]

Solution:

$(354)_{10}$ = 0111010011

7. Add BCD numbers 256_{10} and 464_{10}. [2]

Solution:

```
0010  0101  0110
0100  0110  0100
--------------------
0111   1100  1010
       0110  0110
----------------------
0111   0010   0000
```

Find Subtraction of $(402)_8$ and $(314)_8$ using 7's complement method. [3]

Solution:

Here A = 402, B = 314.
Find A - B = ? using 7's complement
First find 7's complement of B = 314
Note : 7's complement of a number is obtained by subtracting all bits from 777.
7's complement of 314 is

```
    7  7  7
-   3  1  4
-------------
    4  6  3
```

Now Add this 7's complement of B to A

```
1
    4  0  2
+   4  6  3
-------------
1   0  6  5
```

Question 2 [20 Marks]

1. Write the Canonical / Standard Sum Of Products expression for the given function. [3]

$$\boldsymbol{F(A,B,C,D) = \prod(0,3,4,5,9,11,14)}$$

Solution:

For SOP form the function can be written as:

$$F(A,B,C,D) = \sum(1,2,6,7,8,10,12,13,15)$$

The canonical representation is

$$F = A'B'C'D + A'B'CD' + A'BCD' + A'BCD + AB'C'D' + AB'CD' + ABC'D' + ABC'D + ABCD$$

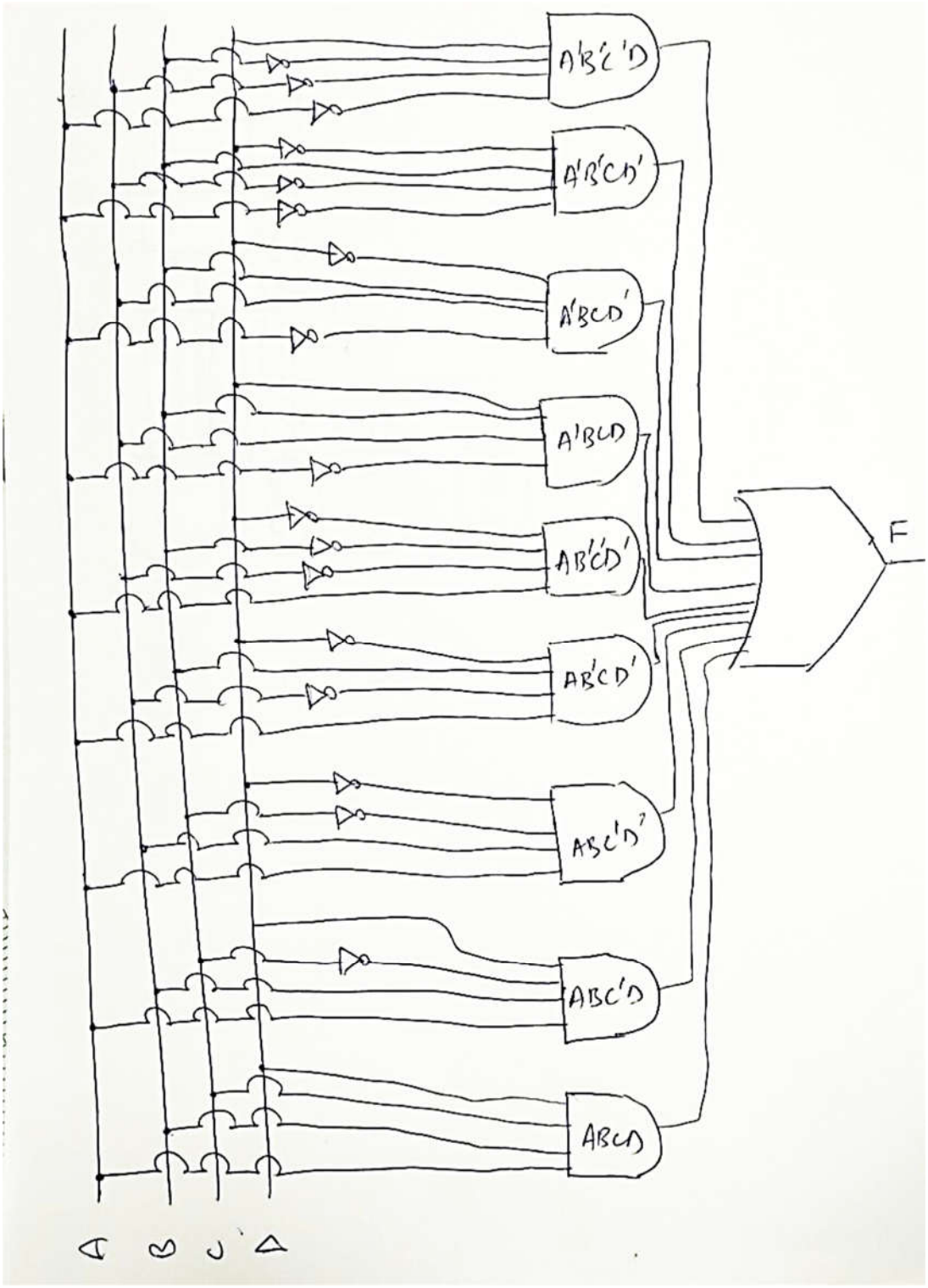
2. Write the Truth Table for the Function given in part (1). [3]

Truth Table can be directly written from the minterms or maxterms as given in the function expression.

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

3. Draw the circuit diagram from the Canonical SOP form written in part (1). [10]

Solution:



Question 3 [10 Marks]

1. **Write the Canonical Sum of Products expression for the given function and reduce it using Boolean Algebra.** **[5]**

$$F(A,B,C) = \sum(0,1,3,4,5,7)$$

Solution:

The canonical expression is

$$F = A'B'C' + A'B'C + A'BC + AB'C' + AB'C + ABC$$

Reduction Steps are:

$$F = A'B'(C' + C) + BC(A' + A) + AB'(C' + C)$$

$$F = A'B' + BC + AB'$$

$$F = B'(A' + A) + BC$$

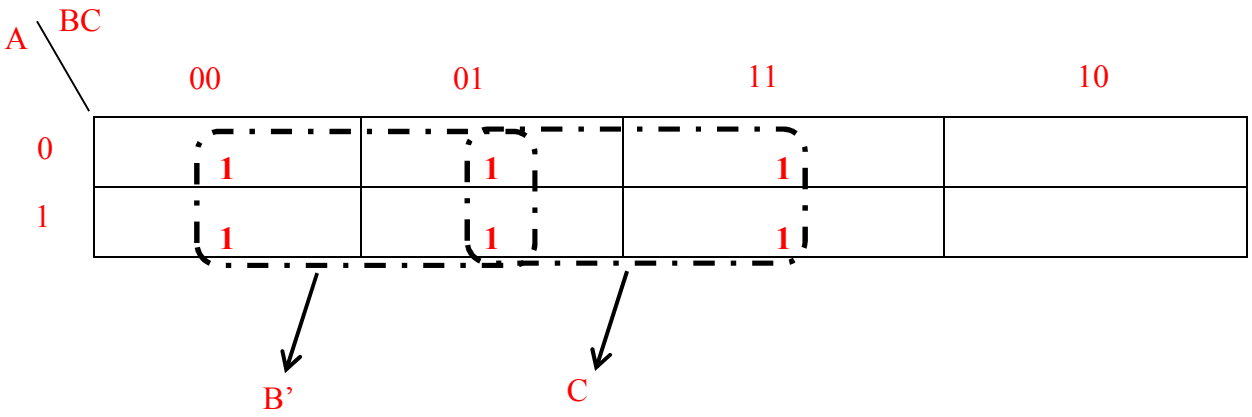
$$F = B' + BC$$

$$F = B' + C$$

2. **Reduce the expression using Karnaugh Map.** **[5]**

$$F(A,B,C) = \sum(0,1,3,4,5,7)$$

Solution:



$$F(A,B,C) = B' + C$$

Question 4 [10 Marks]

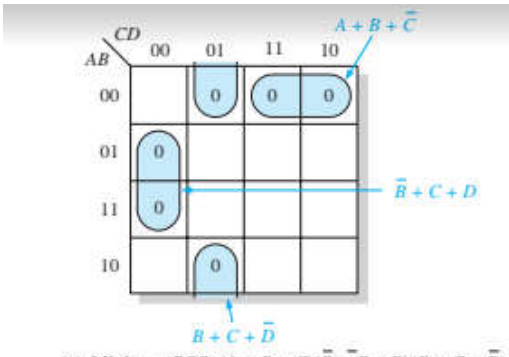
1. Use a Karnaugh map to minimize the following function into minimal SOP expression:

$$(\bar{A}+\bar{B}+C+D)(A+\bar{B}+C+D)(A+B+C+\bar{D})(A+B+\bar{C}+\bar{D})(\bar{A}+B+C+\bar{D})\ (A+B+\bar{C}+D)$$

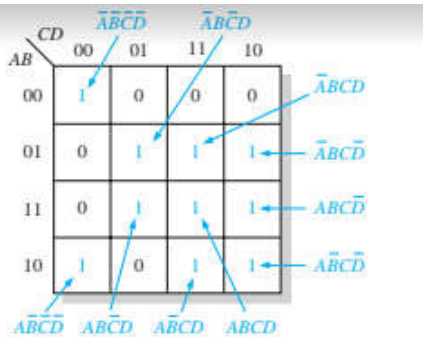
Solution:

Using a Karnaugh map, convert the following standard POS expression into a minimum POS expression, a standard SOP expression, and a minimum SOP expression.

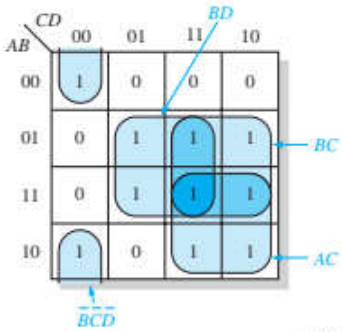
$$(\bar{A}+\bar{B}+C+D)(A+\bar{B}+C+D)(A+B+C+\bar{D})(A+B+\bar{C}+\bar{D})(\bar{A}+B+C+\bar{D})(A+B+\bar{C}+D)$$



(a) Minimum POS: $(A+B+C)(\bar{B}+\bar{C}+D)(B+C+\bar{D})$



(b) Standard SOP:
$\bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}CD + \bar{A}B\bar{C}D + \bar{A}BC\bar{D} + AB\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} +$
$A\bar{B}C\bar{D} + AB\bar{C}D + A\bar{B}CD + ABCD$



(c) Minimum SOP: $AC + BC + BD + \bar{B}\bar{C}\bar{D}$