**National University of Computer & Emerging Sciences, Karachi.**
**Spring-2019 CS-Department**
**MidTerm-1 Exam [KEY]**
**February 26th, 2019. 9:00 am – 10:00 am**

| | |
|---|---|
| **Course Code: EE227** | **Course Name: Digital Logic Design** |
| **Instructors: Jawed Qureshi, Khalid Soomro, Rabia Tabassum, Behraj Khan, Shahbaz Siddiqui** | |
| **Student Roll No:** | **Section:** |

**Time Allowed**: 60 minutes. **Max Marks/Points: 15/45**

**Question-1 (6-Points)**

**i).** The decimal number –37 as an 8-bit binary number in sign-magnitude is: $10100101_2$.

**ii).** The decimal equivalent of hex number $1A53_{16}$ is: $6739_{10}$.

**iii).** The Hex equivalent of Octal $734_8$ is: $1\ D\ C_{16}$.

**iv).** The 2's complement of the number $1101101_2$ is: $0010011_2$

**v).** How many two-input (AND) and (OR) gates are required to realize: Y=CD+EF+G: 2, 1

**vi).** Express - 415 decimal numbers in sign–magnitude number: $1110011111_2$.

**Question-2 (12-Points)**

**i).** Convert the sequence from $60_{10}$ to $63_{10}$ to Gray code. **(4)**

60 = 111100
Gray = 100010

61 = 111101
Gray = 100011

62 = 111110
Gray = 100001

63 = 111111
Gray = 100000

**ii).** Convert the following into BCD code and add: 295 + 157 **(4)**

| | | |
|---|---|---|
| 0010 | 1001 | 0101 |
| 0001 | 0101 | 0111 |
| 0011 | 1110 | 1100 |
| | 0110 | 0110 |
| 0100 | 0101 | 0010 |

**iii).** Determine the value of the following *single-precision floating-point* binary number. **(4)**

1 10000010 01101101110001000000000 = Number= $(-1)^s(1+F)\ (2^{E-127})$

$10000010_2 = 130_{10} = (130 - 127 = 3_{10}) = (-1)^1\ (1.0110110001)\ (2^3) = -1011_2 = -11_{10}$

**Question-3 (7-Points)**

**i).** Using Boolean algebra techniques, simplify the following expressions: **(3)**

$[A\overline{B}(C + BD) + \overline{A}\,\overline{B}]C$ $\overline{B}C$

**Solution**

**Step 1:** Apply the distributive law to the terms within the brackets.

$$(A\overline{B}C + A\overline{B}BD + \overline{A}\,\overline{B})C$$

**Step 2:** Apply rule 8 ($\overline{B}B = 0$) to the second term within the parentheses.

$$(A\overline{B}C + A \cdot 0 \cdot D + \overline{A}\,\overline{B})C$$

**Step 3:** Apply rule 3 ($A \cdot 0 \cdot D = 0$) to the second term within the parentheses.

$$(A\overline{B}C + 0 + \overline{A}\,\overline{B})C$$

**Step 4:** Apply rule 1 (drop the 0) within the parentheses.

$$(A\overline{B}C + \overline{A}\,\overline{B})C$$

**Step 5:** Apply the distributive law.

$$A\overline{B}CC + \overline{A}\,\overline{B}C$$

**Step 6:** Apply rule 7 ($CC = C$) to the first term.

$$A\overline{B}C + \overline{A}\,\overline{B}C$$

**Step 7:** Factor out $\overline{B}C$.

$$\overline{B}C(A + \overline{A})$$

**Step 8:** Apply rule 6 ($A + \overline{A} = 1$).

$$\overline{B}C \cdot 1$$

**Step 9:** Apply rule 4 (drop the 1).

$$\overline{B}C$$

**ii).** From the truth table in Table 3-1, determine the standard SOP expression and the equivalent standard POS expression. **(4)**

| Inputs | | | Output |
|---|---|---|---|
| *A* | *B* | *C* | *X* |
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 |

(Table 3-1)

SOP: X=A'BC + AB'C' + ABC' + ABC

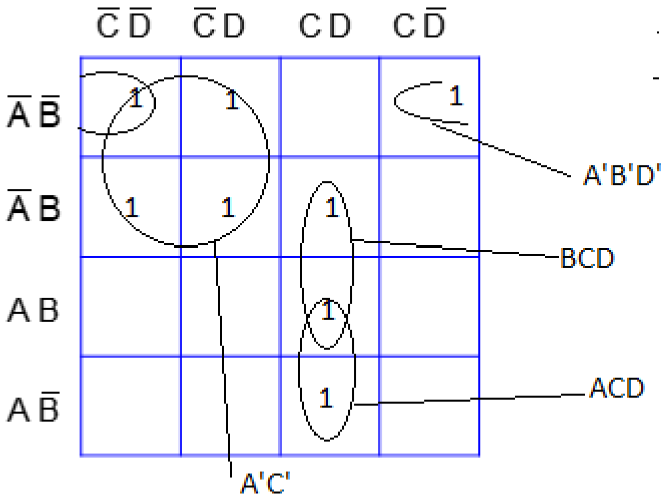
POS: X=(A+B+C) (A+B+C') (A+B'+C) (A'+B+C')

## Question-4 (10-Points)

**a).** Use a Karnaugh map to simplify each Boolean function **(5)**

$$F(A, B, C, D) = \Sigma(0, 1, 2\ 4, 5, 7, 11, 15)$$

Solution:

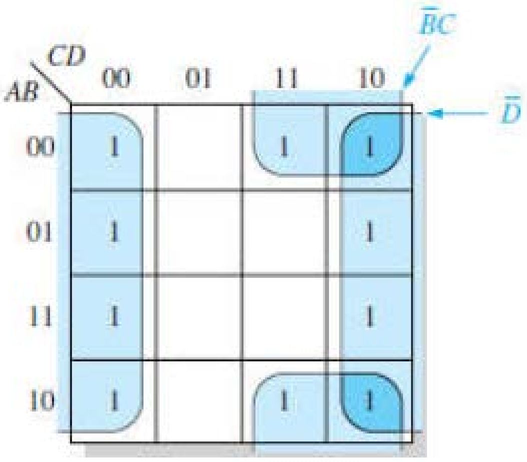



X = A'B'D' + BCD + ACD + A'C'

**b).** convert into standard SOP form, apply DeMorgan's theorem where applicable: **(5)**

$$\overline{BCD} + \overline{A}B\overline{CD} + AB\overline{CD} + \overline{A}BCD + A\overline{B}CD + \overline{AB}C\overline{D} + \overline{A}BC\overline{D} + ABC\overline{D} + A\overline{B}C\overline{D}$$

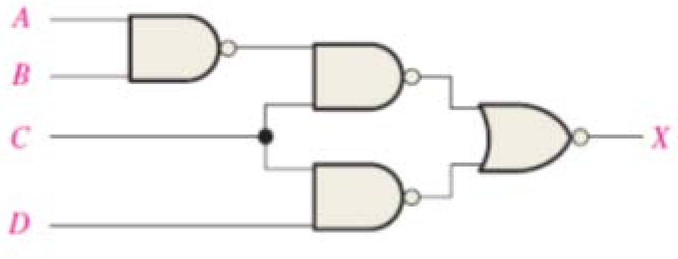
The first term $\overline{B\ C\ D}$ must be expanded into AB'C'D' and A'B'C'D' to get the standard SOP expression, which is then mapped; the cells are grouped as shown in figure below:




X = D' + B'C

**Question-5 (10 points)**

**a).** Write the output expression for the circuit given in Fig-5(b). Develop a truth table and simplify the resultant expression by applying DeMorgan's theorem. **(8)**

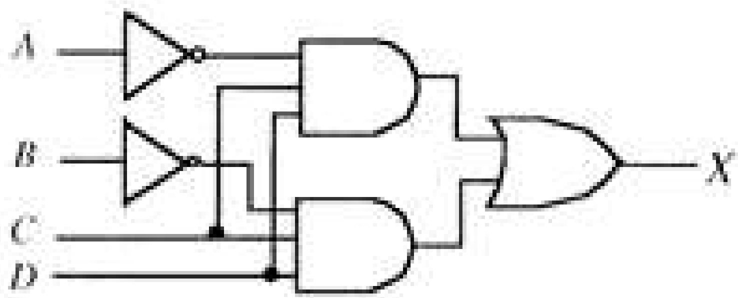



$$X = \overline{\overline{\overline{AB}C} + \overline{CD}} = (\overline{AB}C)(CD) = (\overline{A} + \overline{B})\,CCD$$

$$X = \overline{A}CD + \overline{B}CD$$

$X = \overline{\overline{\overline{AB}C} + \overline{CD}}$

| A | B | C | D | X |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 0 |



**b).** The NAND and the negative-OR symbols represent equivalent operations, but they are functionally different. For the NOR symbol, look for at least one HIGH on the inputs to give a LOW on the output. For the negative-AND, look for two LOWs on the inputs to give a HIGH output. Using these two functional points of view, show that both gates in Figure-5(b) will produce the same output for the given inputs. **(2)**

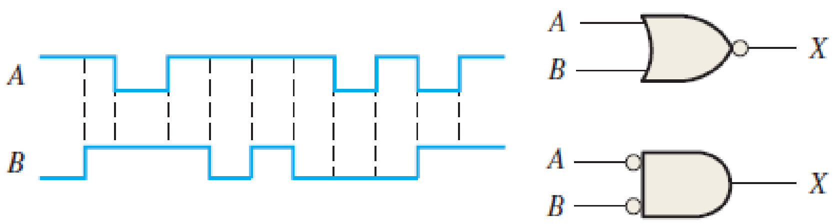
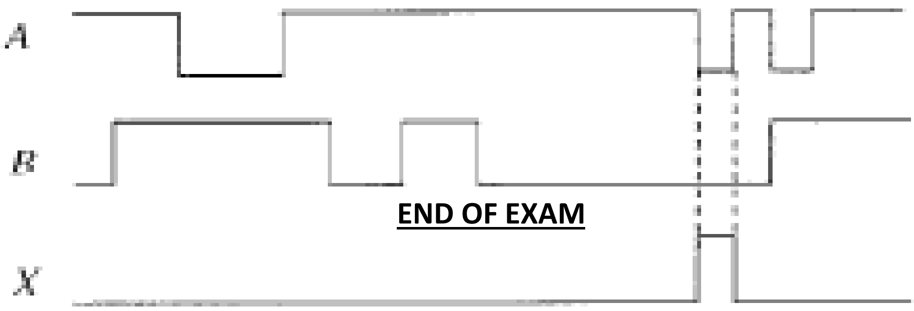



**Fig-5(b)**

## Solution:




**<u>END OF EXAM</u>**

| $A$ | $B$ | $\overline{A}$ | $\overline{B}$ | $\overline{A+B}$ | $\overline{A}\,\overline{B}$ |
|---|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 1 | 1 |
| 0 | 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 |