National University of Computer and Emerging Sciences

Digital Logic Design
(EE1005)

Date: February 25th, 2025

Course Instructor(s)

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Sessional-I Exam

Total Time: 1 Hour
Total Marks: 30
Total Questions: 02

Semester: SP-2025
Campus: Karachi
Dept: School of Computing

Student Name _____ Roll No _____ Section _____ Student Signature _____

CLO # 1 Number systems and logic **Estimated Time=20mins**

Q1: Answer the following: **[10]**

(a) What is the largest binary number that can be expressed with 14 bits? [1]

$2^{14} - 1 = 16383$ ①

(b) Calculate the binary equivalent of ⅔ out to three places. [1]

0.666 × 2 = 1.33 → 1
0.333 × 2 = 0.66 → 0
0.666 × 2 = 1.33 → 1 ①

$(0.101)_2$

(c) Perform the 8-bit signed addition of (using 2's Complement) [2]

(i) [(+29) + (-49)] (ii) [(-29)+ (+49)]

+29	00011101	+29	00011101	-29	11100011
+49	00110001	-49	11001111	+49	00110001
-29	11100011	-20	11101100	+20	100010100
-49	11001111	+20	00010100		

① ②

(d) Find gray code for the following hexadecimal numbers: $(E5)_{16}$ [2]

E5
B 1110 0101 ①
G 1001 0111 ②

(e) Perform the following BCD addition and show the answer is correct. 1485 + 754 [2]

0001 0100 1000 0101
0000 0111 0101 0100
0001 1011 1101 1001
0110 0110
0010 0001 0001

1485
754
2239

(f) Express each decimal number in binary as an 8-bit sign-magnitude number, the 1's complement form and the 2's complement form. [2]
(i) +67 (ii) – 89

+67 = 01000011
1's Comp. = 01000011
2's Comp = 01000011

-89 = 11011001
+89 = 01011001
1's Comp = 10100110
2's Comp = 10100111

CLO # 2 Techniques to design logic circuits **Estimated Time=40mins**

Q2: Answer the following: **[20]**

(a) Design a combinational circuit with four inputs (**A, B, C,D**) and one output (**F**) such that: **F=1** when the number of **1's** in the input is **odd**. Develop the truth table(Input variables are **A,B,C,D** and output **F**) and write down the SOP and POS expressions for the logic circuit. [5]

A	B	C	D	X
0	0	0	0	0
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
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	1

(2)

$\Sigma(1,2,4,7,8,11,13,14)$

$X = \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}C\bar{D} + \bar{A}B\bar{C}\bar{D} + \bar{A}BCD + A\bar{B}\bar{C}\bar{D} + A\bar{B}CD + AB\bar{C}D + ABC\bar{D}$

(1.5)

$\Pi(0,3,5,6,9,10,12,15)$

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

(1.5)

(b) For the waveforms given in Fig-1 below, **A** and **B** are XORed to get an output F, then **C** and **D** are XNORed to get an output **G**. Finally **C**, **F** and **G** are ORed. Draw the net output waveform. [2]

1 1 1 0 1
1 1 1 1 0

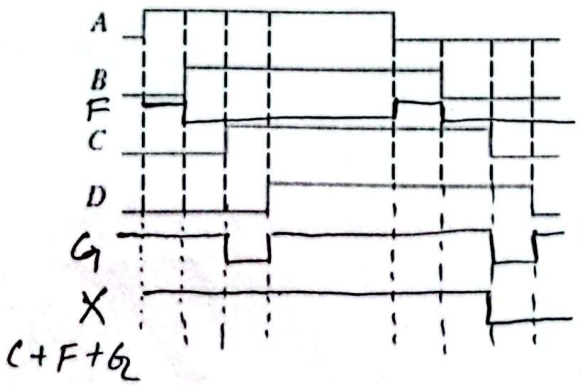


Fig-1

(0.5) (0.5) (1)

C+F+G

(c) Convert the following expressions into standard SOP Expressions: [3]

a) $A + A\bar{B} + ABC$

$A\bar{B}\bar{C} + AB\bar{C} + A\bar{B}C + AB\bar{C} + A\bar{B}C + A\bar{B}\bar{C} + ABC$

$\Rightarrow ABC + A\bar{B}\bar{C} + AB\bar{C} + A\bar{B}C$

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

$\bar{A}C + BC + A\bar{B}C$

$\bar{A}\bar{B}C + \bar{A}BC + ABC + A\bar{B}C + \bar{A}BC + ABC$

$\bar{A}\bar{B}C + \bar{A}BC + ABC$

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

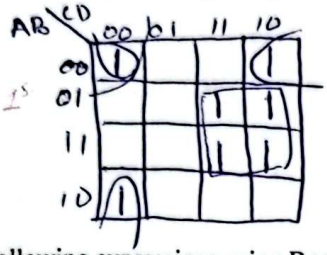
$A\bar{B}CD + A\bar{B}CD + AB\bar{C}D + AB\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} + AB\bar{C}\bar{D}$

$A\bar{B}CD + AB\bar{C}D + A\bar{B}\bar{C}\bar{D} + AB\bar{C}D + AB\bar{C}\bar{D}$

(d) Use a Karnaugh map to minimize the following standard SOP expression: [5]

$Y = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}C\bar{D} + \bar{A}BC\bar{D} + \bar{A}BCD + A\bar{B}\bar{C}\bar{D} + ABC\bar{D} + ABCD$

0000 0010 0110 0111 1000 1110 1111



(1) K-map
(1) Position of 1's
(1) Groupings

$X = BC + \bar{A}\bar{B}\bar{D} + \bar{B}\bar{C}\bar{D}$ (2)

(e) Simplify the following expressions using Boolean algebra and draw the circuits for simplified expressions. [5]

(i) $X = AB + \bar{A}B + AB\bar{C}$ (2.5)

$X = AB + \bar{A}B + AB\bar{C}$

$= AB[1 + \bar{C}] + \bar{A}B$

$= AB[1] + \bar{A}B$

$= B[A + \bar{A}]$

$= B[1]$

$X = B$ (1.5)

(ii) $X = \overline{\overline{(A + B\bar{C})} + D\overline{(E + \bar{F})}}$ (2.5)

$= \overline{\overline{(A + B\bar{C})}} \cdot \overline{D\overline{(E + \bar{F})}}$

$= (A + B\bar{C}) \cdot (\bar{D} + \overline{(E + \bar{F})})$

$= (A + B\bar{C}) \cdot (\bar{D} + E + \bar{F})$ (1.5)

(2) For Diagram

GOOD LUCK☺