Digital Logic Design
(EE1005)

Date: February 25th, 2025

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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]

largest binary 14 bits

$(16383)_{10}$

(b) Calculate the binary equivalent of $\frac{2}{3}$ out to three places. [1]

$0.666 \times 2 = 1.33 \quad 1$
$0.333 \times 2 = 0.66 \quad 0$
$0.666 \times 2 = 1.33 \quad 1$

$(0.101)_2$

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

(I) [(29)+(-49)] (II) [(-29)+(+49)]

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

(1)

-29	11100011	
+49	00110001	(2)
+20	100010100	

(d) Find gray code for the following hexadecimal numbers: $(B5)_{16}$ $(E5)_{16}$ [2]

E5 (1)

B 1110 0101 (2)

5 1001 0111

(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 0011

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

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

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

(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]

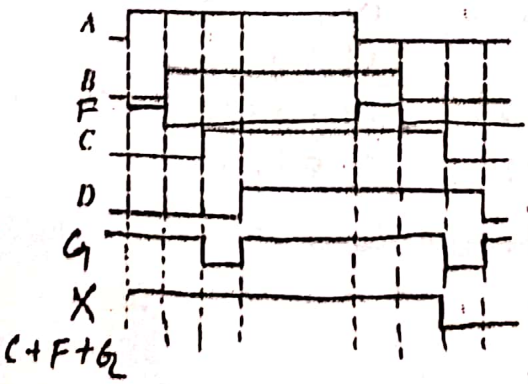


Fig-1

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

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

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

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

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

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

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

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

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

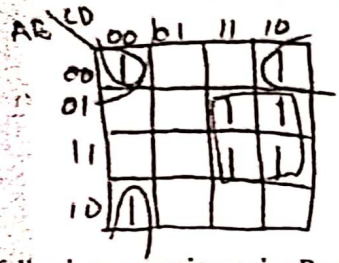
$A\bar{B}CD + A\bar{B}CD + AB\bar{C}D + AB\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} + AB\bar{C}D$

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

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

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

$0000 \quad 0010 \quad 0110 \quad 0111 \quad 1000 \quad 1110 \quad 1111$



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

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

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

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

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

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

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

$= B[1]$

$X = B$

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

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

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

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

GOOD LUCK☺