Question Paper

Exam Date & Time: 25-Sep-2024 (10:45 AM - 12:15 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

Department of Information and Communication Technology
Mid Term Examination

DIGITAL SYSTEMS AND COMPUTER ORGANIZATION [ICT 2123]

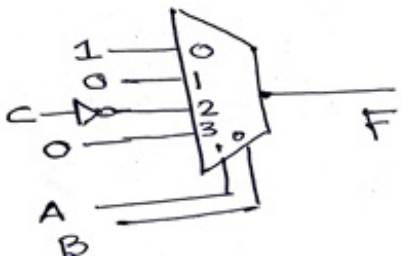
Marks: 30 **Duration: 90 mins.**

A

Answer all the questions. Section Duration: 20 mins

Select the correct answer for the following questions

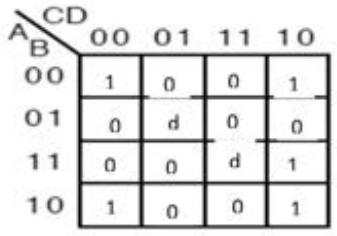
1) The following circuit realizes the function F(A,B,C) = _____ . (0.5)



m0+m2+m7 M0.M2.M7 m1+m2+m6+m7 m0+m1+m4

Correct option is: 4

2) The number of product terms in the minimized sum-of-product expression obtained through the following K-map is (where "d" denotes don't care states). (0.5)



2 3 4 5

Correct option is: 1

3) Which of the following statement is FALSE ? (0.5)

Excess-3 is non-weighted code	Gray code is unit distance code	2 4 2 1 is a weighted code	8 4 2 1 is self complimenting BCD code

Correct option is: 4

4) Convert binary number into Gray code: 100101. (0.5)

101101 | 001110 | 110111 | 111001

Correct option is: 3

5) A Binary multiplier is designed to multiply two numbers: $(B)_{16}$ and $(101)_2$. What is the minimum required number of 4-bit adders to perform the multiplication? (0.5)

3 | 2 | 4 | 1

Correct option is: 2

6) 8 bit Carry look ahead adder is _____ times faster than 8 bit ripple carry adder. (0.5)

8 | 3 | 6 | 10

Correct option is: 1

7) A BCD digit is represented in excess - 3 as 7 (in hexadecimal). What is the excess 3 representation of 9's complement for this BCD digit? (0.5)

2 | 8 | 5 | A

Correct option is: 2

8) The minimum number of Half adders used to realise Full adder if it is realised using only half adders, are: (0.5)

2 | 3 | 4 | 5

Correct option is: 2

9) The number of output lines for a decimal to BCD encoder are (0.5)

9 | 10 | 4 | 15

Correct option is: 3

10) the output (A>B) of a 2-bit comparator is logic 1 for _____ number of combinations. (0.5)

6 | 4 | 7 | 5

Correct option is: 1

B

Answer all the questions.

Answer all the questions.Any missing data can be assumed suitably with proper reasoning.

11) Design a full subtractor using minimum number of 4:1 and 2:1 multiplexers. Using this as a block and with minimum 2:1 multiplexers, design a 4-bit magnitude comparator. (4)

12) If the functions W, X, Y, and Z are as follows (3)

$W = R + \overline{P}\,Q + \overline{R}\,S$

$X = P\,Q\,\overline{R}\,\overline{S} + \overline{P}\,\overline{Q}\,\overline{R}\,\overline{S} + P\,\overline{Q}\,\overline{R}\,\overline{S}$

$Y = R\,S + \overline{P\,R + P\,\overline{Q} + \overline{P}\,\overline{Q}}$

$Z = R + S + \overline{P\,Q + \overline{P}\,\overline{Q}\,\overline{R} + P\,\overline{Q}\,\overline{S}}$

Then, apply the K-map method and show that W = Z.

13) Design a code converter using NOR gates only to convert a decimal digit represented in 8 4 2 1 code to a decimal digit represented in 8 4 -2 -1 code. (3)

14) Design a 4-bit by 4-bit binary multiplier using 7483 ICs and minimum external gates, detailing partial product generation, carry propagation, and logic gate usage. (3)

15) Design a 4-bit decimal adder using 7483 ICs and external NAND gates. (3)

16) Design the following combinational circuit using 74138 ICs and minimum external gates. (3)

$$F(A,B,C,D) = \sum_m(1,3,6,7,9,14)$$

17) Design a combinational circuit using 7485 IC, 7483 IC and minimum external gates to perform the following: (2)

If A>B, F= A-B

Else F=A+B

Where A and B are two 4 - bit binary numbers.

18) Design a 4 to 2 priority encoder, using basic gates. (2)

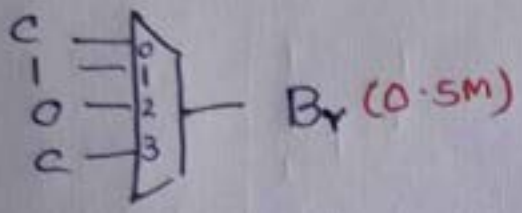
19) Design a 1-bit magnitude comparator with cascading inputs. (2)

-----End-----

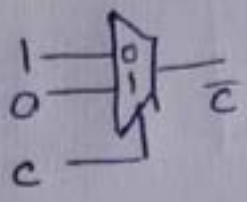
Q1.

Full Subtractor

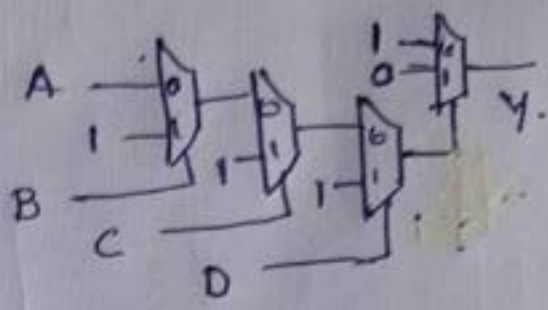
Truth table - 0.5



B_r (0.5M)

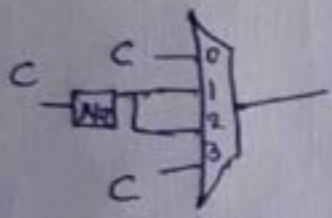


NOT



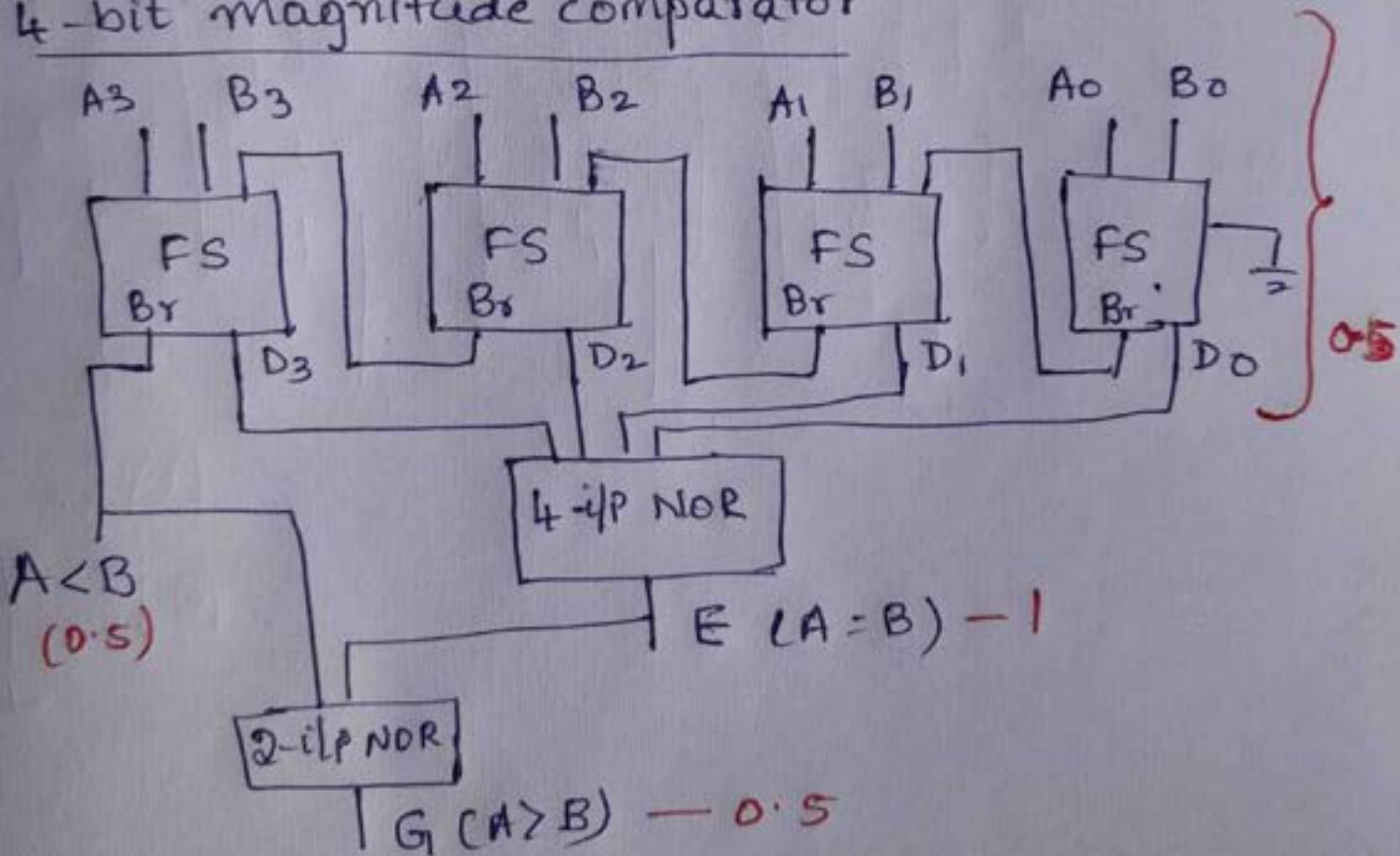
$Y = \overline{A+B+C+D}$

NOR



D (0.5)M.

4-bit magnitude comparator



Q. Show $W = Z$

Sol.

$$W = R + \bar{P}Q + \bar{R}S$$

PQ \ RS	00	01	11	10
00		1	1	1
01	1	1	1	1
11		1	1	1
10		1	1	1

1 mark

$$Z = R + S + \overline{PQ + \bar{P}\bar{Q}R + P\bar{Q}\bar{S}}$$

Simplification of Z → 1 mark

$$= R + S + \overline{PQ} \cdot \overline{\bar{P}\bar{Q}R} \cdot \overline{P\bar{Q}\bar{S}}$$

$$= R + S + (\bar{P} + \bar{Q})(P + Q + R)(\bar{P} + Q + S)$$

$$= R + S + (\bar{P} + \bar{Q})(\bar{P} + Q + S)(P + Q + R)$$

$(\bar{Q}+S) = X$

$(\bar{P}+\bar{Q})(\bar{P}+X)$

$\bar{P} + \bar{Q}X$

$\bar{P} + \bar{Q}(\bar{Q}+S)$

$$= R + S + (\bar{P} + \bar{Q}\bar{P} + \bar{P}Q + \bar{P}S + \bar{Q}\bar{P} + \bar{Q}Q + \bar{Q}S)(P + Q + R)$$

$$= R + S + (\bar{P} + \bar{Q}(Q + S))(P + Q + R)$$

$$= R + S + (\bar{P} + \bar{Q}S)(P + Q + R)$$

$= R+S+\bar{P}Q+\bar{P}R+\bar{Q}PS+\bar{Q}RS$

PQ \ RS	00	01	11	10
00		1	1	1
01	1	1	1	1
11		1	1	1
10		1	1	1

2 K-map
1 mark

RS \ PQ	00	01	11	10
00		1		
01	1	1	1	1
11	1	1	1	1
10	1	1	1	1

$(\bar{A}+B)(\bar{A}+C) = (\bar{A}\cdot\bar{A}) + (\bar{A}\cdot C) + (\bar{A}\cdot B) + B\cdot$

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

$= \bar{A}$

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

$= \bar{A}(1+C) + \bar{A}B + BC$

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

$= \bar{A}(1+B) + BC$

$= \bar{A} + BC$

If they ask the K-map

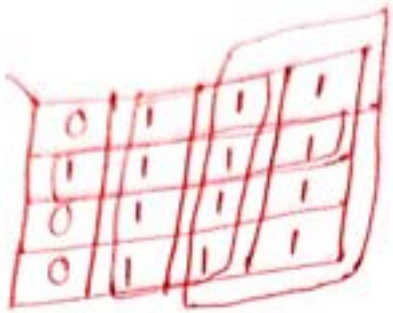
Give 1.5 mark

To attendance 0.5

$\bar{P}+QR+\bar{Q}(S+(\bar{P}P+\bar{Q}QR))$

$\bar{P}\bar{Q}($

	P	Q	R	S	Z
0	0	0	0	0	0
1	0	0	0	1	1
2	0	0	1	0	1
3	0	0	1	1	1
4	0	1	0	0	1
5	0	1	0	1	1
6	0	1	1	0	1
7	0	1	1	1	1
8	1	0	0	0	0
9	1	0	0	1	1
10	1	0	1	0	1
11	1	0	1	1	1
12	1	1	0	0	0
13	1	1	0	1	1
14	1	1	1	0	1
15	1	1	1	1	1



$Z = R + S + \bar{P}Q$

$W = R + \bar{P}Q + \bar{R}S$

$= R + \bar{R}S + \bar{P}Q$

$= \underline{\underline{R + S + \bar{P}Q}}$

$Z = R + S + \overline{\bar{P}Q + \bar{P}\bar{Q}R + P\bar{Q}\bar{S}}$

$\overline{\bar{P}Q + \bar{P}\bar{Q}R + P\bar{Q}\bar{S}} = \overline{\bar{P}Q} \cdot \overline{\bar{P}\bar{Q}R} \cdot \overline{P\bar{Q}\bar{S}}$

$= \overline{\bar{P}Q}\,(P+Q+R)\,(\bar{P}+Q+S)$

$= (\bar{P}+\bar{Q})(P+Q+R)(\bar{P}+Q+S)$

$= (\bar{P}Q + \bar{P}R + P\bar{Q} + \bar{Q}R)(\bar{P}+Q+S)$

$= \bar{P}Q + \bar{P}Q + \bar{P}QS + \bar{P}R + \bar{P}RQ + \bar{P}RS + P\bar{Q}S + \bar{Q}\bar{P}R + \bar{Q}RS$

$= \bar{P}Q(1+S) + \bar{P}R(1+Q) + \bar{P}RS + P\bar{Q}S + \bar{P}\bar{Q}S + \bar{Q}RS$

$1+0=1$
$0+1=1$

$= \bar{P}Q + \bar{P}R + \bar{P}RS + \bar{Q}S$

$= \bar{P}Q + \bar{P}R + \bar{Q}S.$ + (R + S) ...eqn.

$Z = \bar{P}Q + \bar{P}R + \bar{Q}S + R + S$

$= \bar{P}Q + R + S$

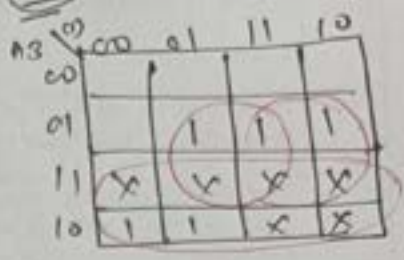
$W = R + \bar{P}Q + \bar{R}S$
$= R + \bar{R}S + \bar{P}Q$
$= R + S + \bar{P}Q$

Q.13 scheme (1 marks)

	8	4	2	1	8	4	−2	−1
	A	B	C	D	B_3	B_2	B_1	B_0
0	0	0	0	0	0	0	0	0
1	0	0	0	1	0	1	1	1
2	0	0	1	0	0	1	1	0
3	0	0	1	1	0	1	0	1
4	0	1	0	0	0	1	0	0
5	0	1	0	1	1	0	1	1
6	0	1	1	0	1	0	1	0
7	0	1	1	1	1	0	0	1
8	1	0	0	0	1	0	0	0
9	1	0	0	1	1	1	1	1
10	1	0	1	0	x	x	x	x
11	1	0	1	1	x	x	x	x
12	1	1	0	0	x	x	x	x
13	1	1	0	1	x	x	x	x
14	1	1	1	0	x	x	x	x
15	1	1	1	1	x	x	x	x

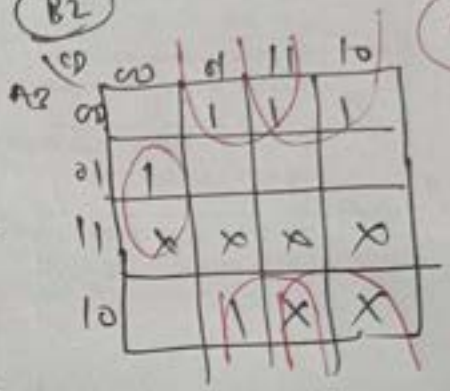
(0.5m)

B_3



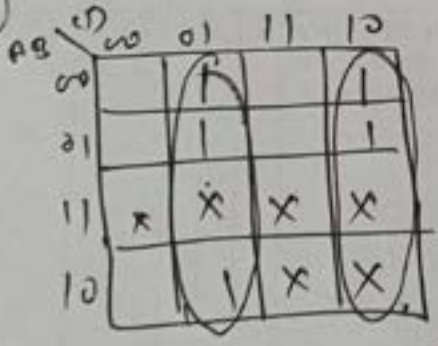
$B_3 = A + BD + BC$

B_2 (0.5m)



$B_2 = B\bar{C}\bar{D} + \bar{B}D + \bar{B}C$

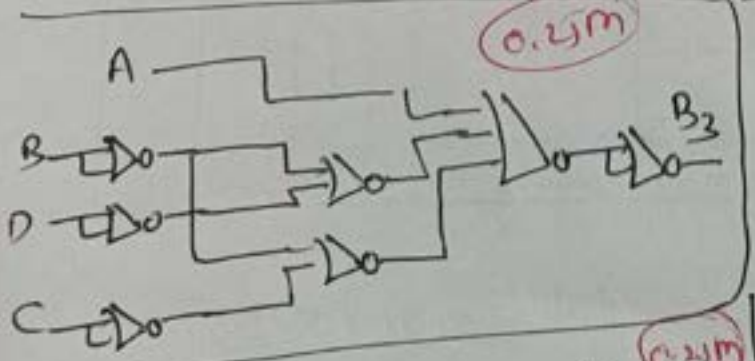
B_1



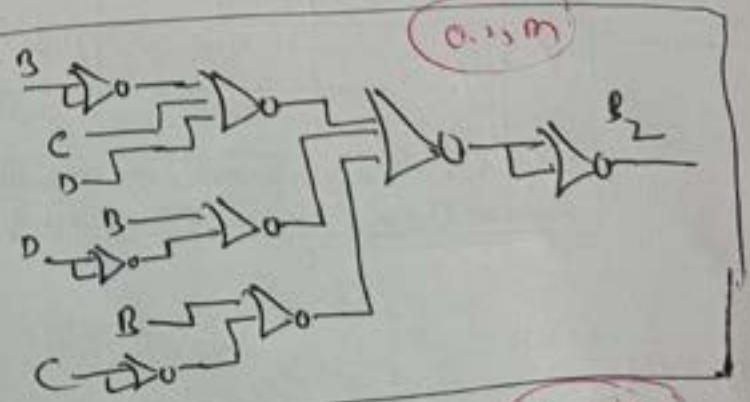
$B_1 = \bar{C}D + C\bar{D}$ (0.5m)

$B_0 = D$ (0.5m)

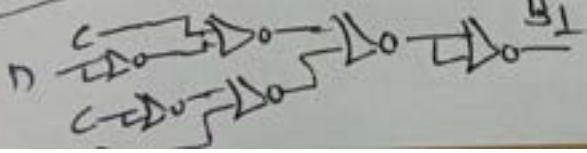
(0.5m)



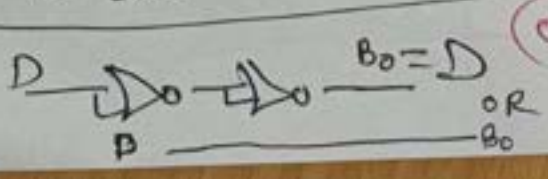
(0.5m)



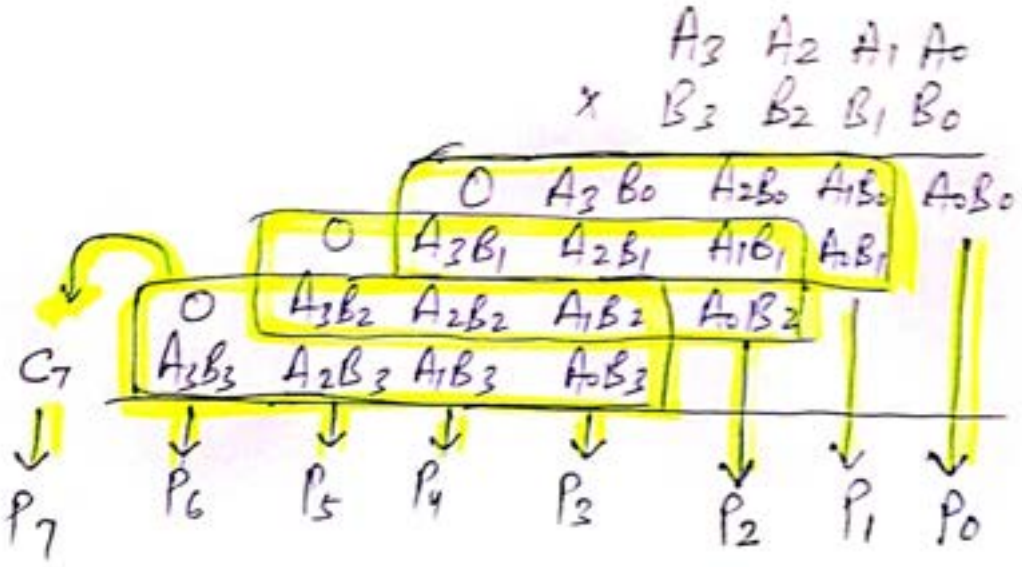
(0.5m)



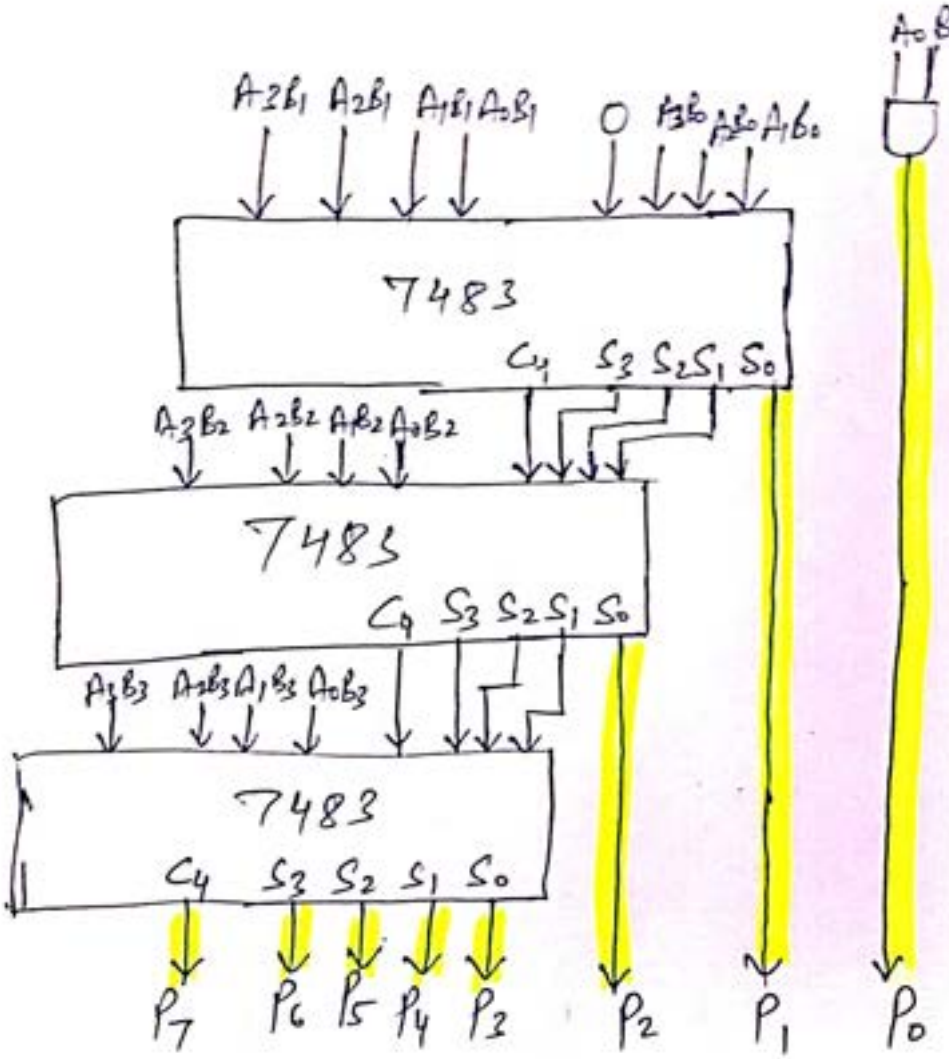
(0.5m)



Q) 4×4 Bit Multiplier

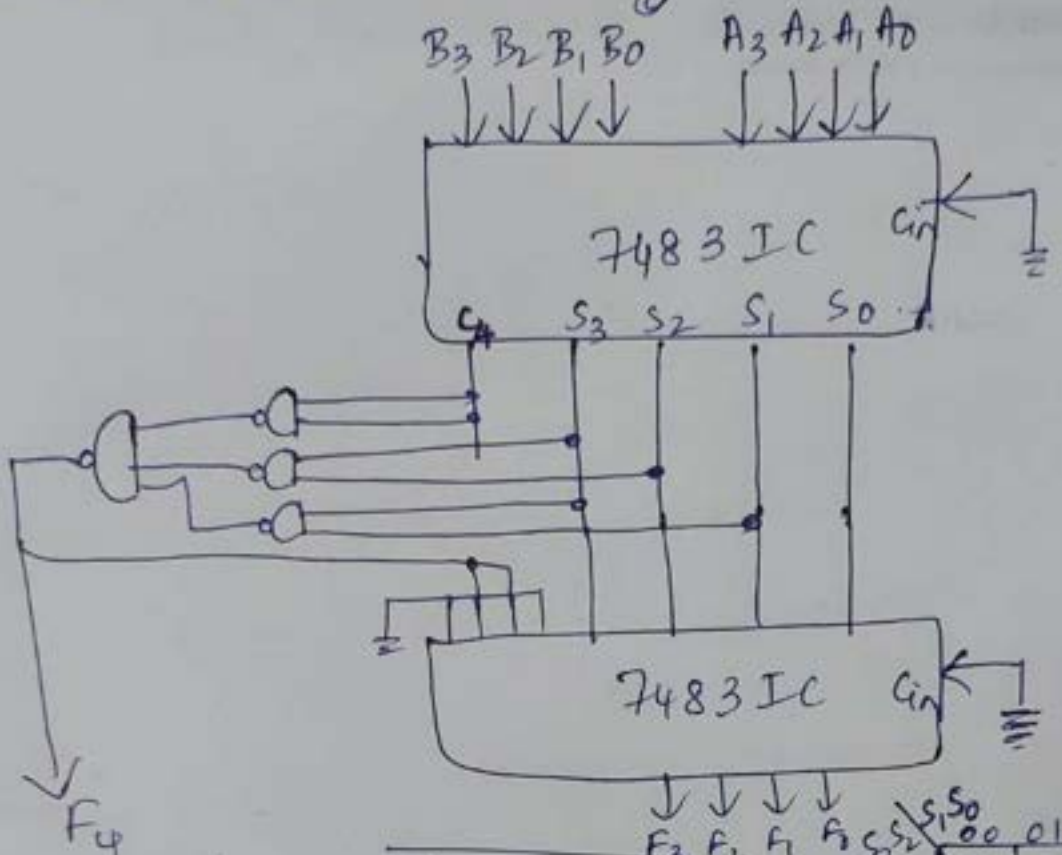


1.5 Marks



1.5 Marks.

(15). Design a 4-bit decimal adder using 7483 IC and external NAND gates.



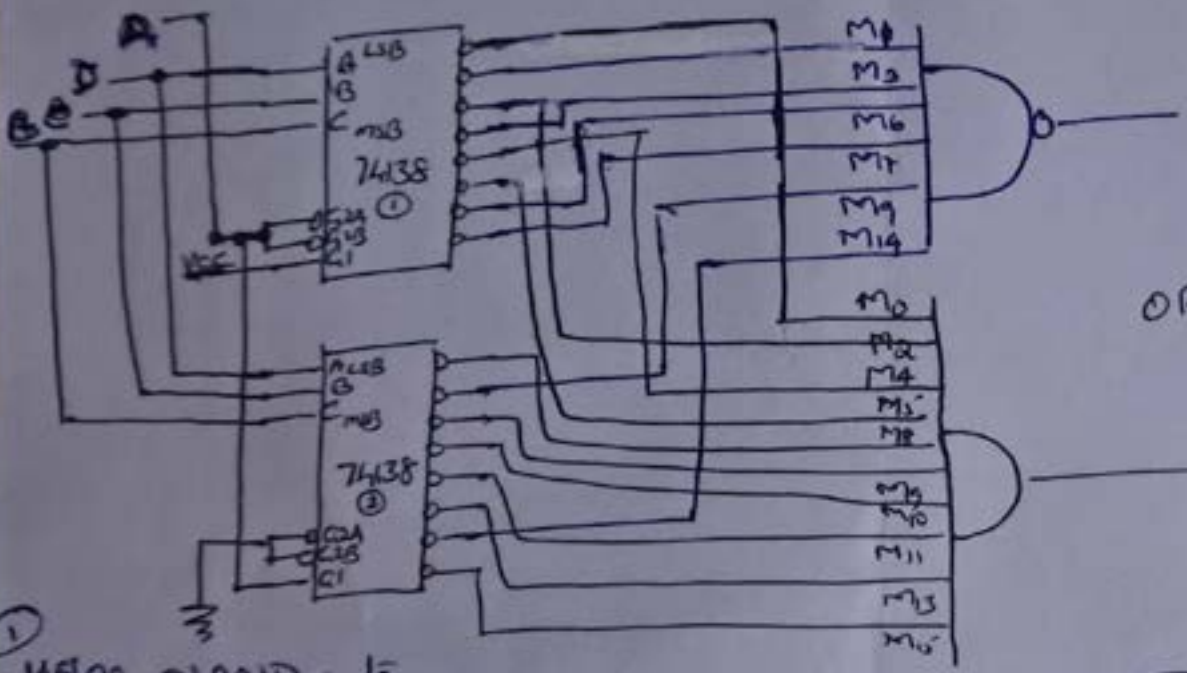
S_3S_2 \ S_1S_0	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	1	1	1	1
10	0	0	1	1

$$Y = \overline{C_4 + S_3S_2 + S_3S_1}$$

$$= \bar{C}_4 \cdot \overline{S_3S_2} \cdot \overline{S_3S_1}$$

Equation:- 1 Mark.
1st Addition:- ½ Mark
ckt for Y:- ½ Mark.
2nd Addition:- ½ Mark.
Final carry :- ½ Mark.

$F = \sum_m (1, 3, 6, 7, 9, 14) = \prod_M (0, 2, 4, 5, 8, 10, 11, 12, 13, 15)$
(ABCD)



① using NAND gate

$$F = \overline{m_1 + m_3 + m_6 + m_7 + m_9 + m_{14}} = \overline{\overline{m_1} \cdot \overline{m_3} \cdot \overline{m_6} \cdot \overline{m_7} \cdot \overline{m_9} \cdot \overline{m_{14}}}$$

$$= \overline{M_1 \cdot M_3 \cdot M_6 \cdot M_7 \cdot M_9 \cdot M_{14}}$$

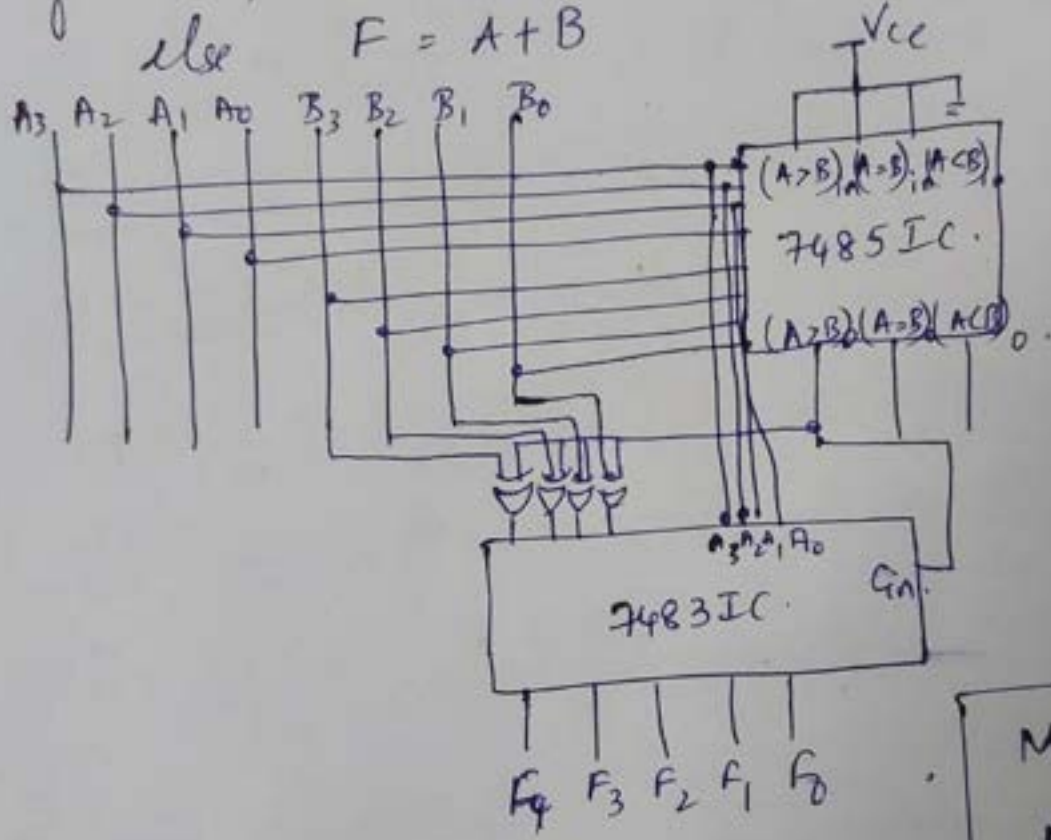
② using AND gate

$$F = M_0 \cdot M_2 \cdot M_4 \cdot M_5 \cdot M_8 \cdot M_{10} \cdot M_{11} \cdot M_{12} \cdot M_{13} \cdot M_{15}$$

(14) Design a combinational circuit using 7485 IC, 7483 IC & min ext gates to perform.

If $A > B$, $F = A - B$. A & B are 4-bit numbers

else $F = A + B$



Mag comp ⇒ ½ Mark

ADDER ⇒ ½ Mark.

XOR ⇒ ½ Mark.

Mag initial cond, Cin } ½ Mark.

Q.18 4:2 priority encoder

1 mark

D_3	D_2	D_1	D_0	A	B	V
0	0	0	0	x	x	0
1	0	0	0	0	0	1
x	1	0	0	0	1	1
x	x	1	0	1	0	1
x	x	x	1	1	1	1

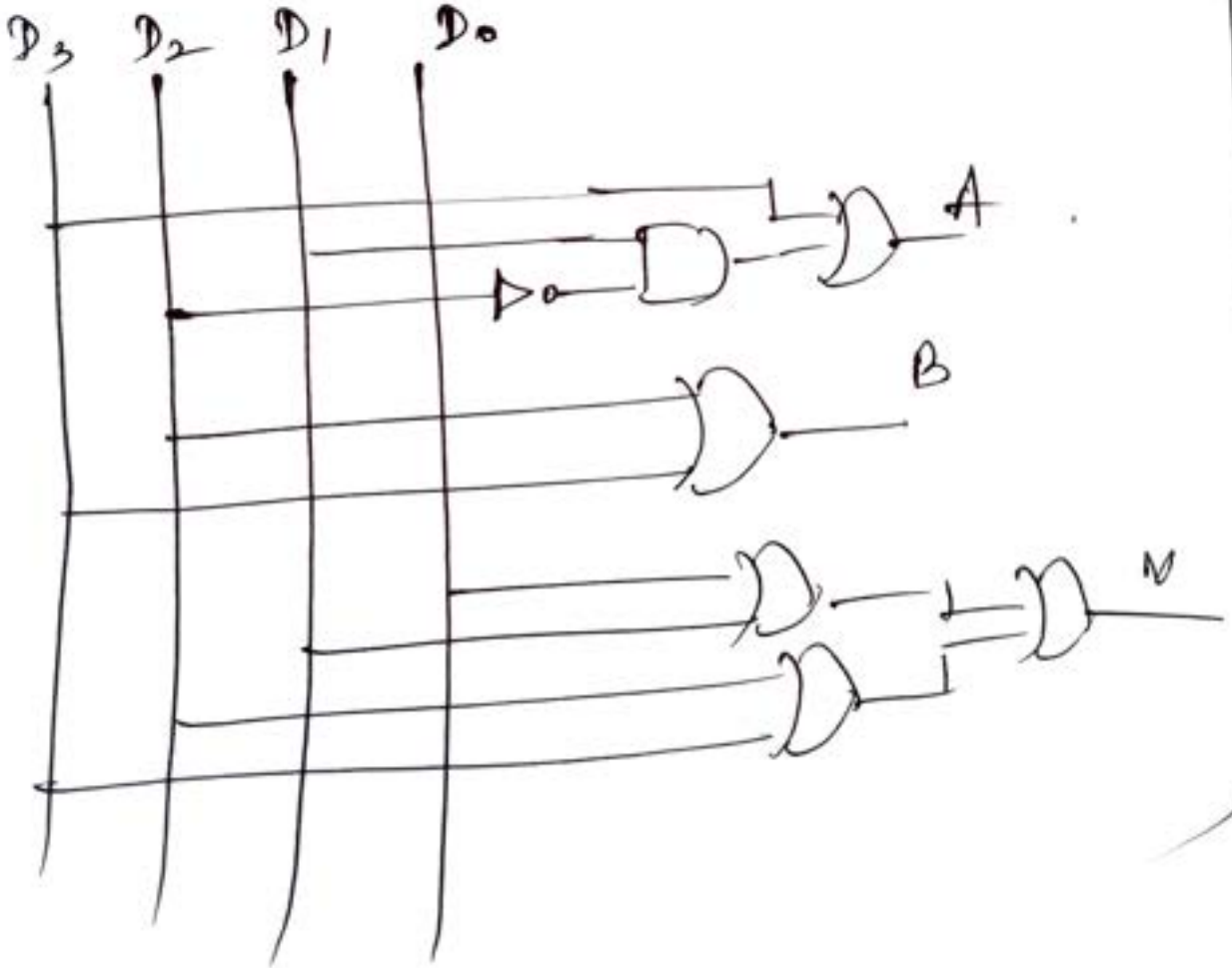
→ 1 mark

$A = D_3 + D_1 D_2'$

$B = D_2 + D_3$

$V = D_0 + D_1 + D_2 + D_3$

1 mark



(19) 1- bit Mag Comp with Cascading inputs.

A B	(A>B)	(A=B)	(A<B)
0 0	0	1	0
0 1	0	0	1
1 0	1	0	0
1 1	0	1	0

$(A>B) = A\bar{B}$

$(A<B) = \bar{A}B$

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

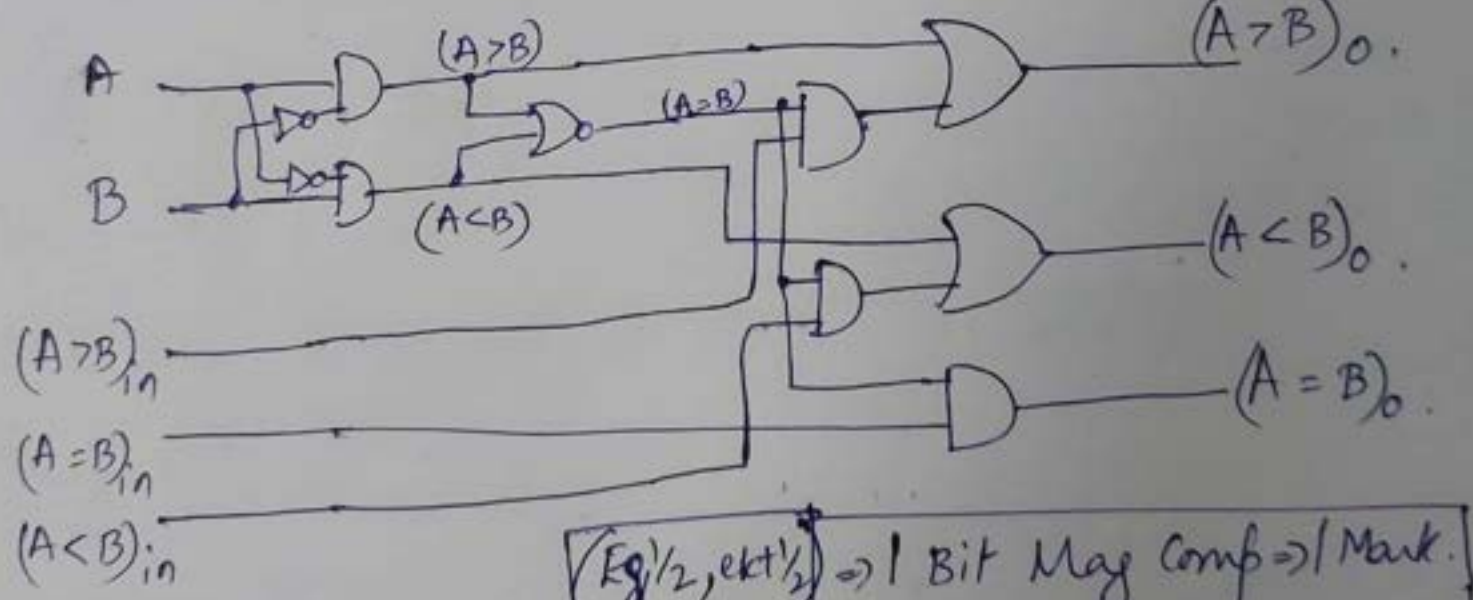
$= \overline{(\bar{A}B + A\bar{B})}$

Cascade Input to Comparator:-

$(A>B)_0 = (A>B) + (A=B)(A>B)_{in}$.

$(A<B)_0 = (A<B) + (A=B)(A<B)_{in}$.

$(A=B)_0 = (A=B)(A=B)_{in}$.



(Eg 1/2, ckt 1/2) ⇒ 1 Bit Mag Comp ⇒ 1 Mark.

(Eg 1/2, ckt 1/2) ⇒ Cascade I/P ⇒ 1 Mark.