Final Exam
Digital Design

Time Allowed: 2 hrs.
Dr: Ahmed Saleh
Total Marks: 50
MTE, BME Students.
2017 - 2018

- يسمح باستخدام القلم الرصاص (شرط وضوح الخط).
- الرجاء وضوح الرسم قدر المستطاع (ليس شرطا استخدام المسطرة)
- الامتحان في ورقتين.
- عدد الاسئله = 3

Solve the following:

Question 1

(A) **Using Equations**, simplify the following function:

(i) F(X,Y,Z)= XY+X'Z+YZ
(ii) F(X,Y,Z)=(X+Y)(X'+Z)(Y+Z)

(B) **Using a Map**, simplify the following function:

F(A,B,C,D)= BCD+A'D'+A'B'D

Use:

- Sum of product form.
- Product of sum form.

(C) **Implement (Draw) the function** → F(A,B,C,D)= (A'BD+CD+A'B'C)BD' Using:

(i) AND – NOT only.
(ii) OR – NOT only.

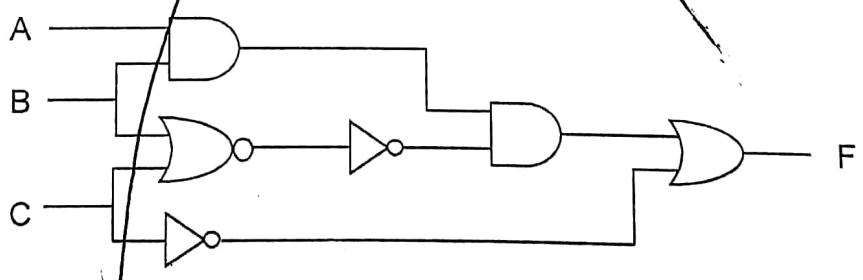
(D) **Find the complement of the following function**: F(A,B,C,D)=B'D+A'BC'+A'BC+A'D

(E) **Using Equations:**

(i) Express the function: F(A,B,C)=A+B'C in **Sum of minterms**, what are the corresponding Maxterms?

(ii) Express the function: F(A,B,C)=(A+B)(B'+C) in **Product of Maxterms**, what are the corresponding minterms?

(F) **Find the Truth table for the following circuit:**



(G) **Assuming** four variables in the order (A, B, C, D), Simplify the following functions (F1, F2, F3, F4) using the shown maps

1	0	x	1
x	x	1	1
x	1	0	1
1	0	0	x

F1

1	1	1	1
x	1	1	x
1	x	0	1
x	0	0	x

F2

1	0	x	0
x	x	0	1
x	x	x	1
1	0	1	0

F3

1	x	x	1
x	x	1	1
1	x	x	1
1	x	x	x

F4

(27 marks)

TURN THE PAGE

Question 2

(A) **Using Decoder and OR gates, Design digital circuit** that accepts 4 bit input number **A** (i.e., $A=A_3A_2A_1A_0$). The circuit has 3 outputs: **X, Y,** and **Z**. so that:

- **X=1** if the number of ones in the input number Greater than the number of zeros.
- **Y=1** if the number of ones in the input number Less than the number of zeros.
- **Z=1** if the number of ones in the input number Equals the number of zeros.

(B) **Define**:

- 3-bit parallel Adder.
- 2-bit comparator.

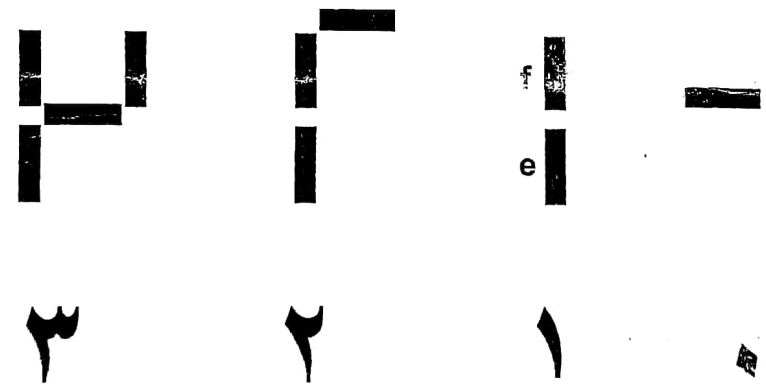
(C) **Show the internal structure of** 2X1 Multiplexer.

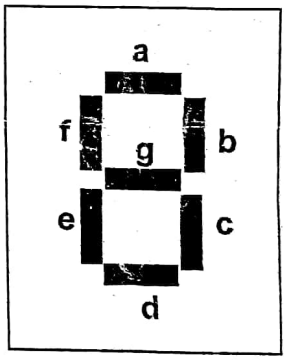
(D) **Implement** the function F(A,B,C)=A'B+BC. **Using:** **Decoder** and an **And** gate,

Question 3

(17 marks)

Design a digital circuit that accepts **2-bit binary number** and the output is the numbers (0, 1, 2, 3) appeared on the seven segments in the Arabic fashion as shown in the following figure. (Note: the only used of the seven segments are the segments: a, b, e, f, g).





(6 marks)

---------- End of Questions ----------

With Best Wishes

Dr: Ahmed Saleh

Plz, send feedback about the exam to:

aisaleh@yahoo.com

Final Exam
Digital Design
- Solution -

Question (1)

(A) (i) $F = xy + \bar{x}z + yz$

$= xy + \bar{x}z + yz(x + \bar{x})$

$= xy + xyz + \bar{x}z + \bar{x}yz$

$= xy(1 + z) + \bar{x}z(1 + y)$

$= xy + \bar{x}z$

(ii) $F = \left((x+y)(\bar{x}+z)(y+z) \right)''$

$= \left((x+y)' + (\bar{x}+z)' + (y+z)' \right)'$

$= \left(\bar{x}\bar{y} + x\bar{z} + \bar{y}\bar{z} \right)'$

$= \left(\bar{x}\bar{y} + x\bar{z} + \bar{y}\bar{z}(x + \bar{x}) \right)'$

$= \left(\bar{x}\bar{y}(1 + \bar{z}) + x\bar{z}(1 + \bar{y}) \right)'$ ($1 + \bar{z} \to 1$, $1 + \bar{y} \to 1$)

$= (\bar{x}\bar{y} + x\bar{z})'$

$= (x + y)(\bar{x} + z)$.

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

AB \ CD	00	01	11	10
00	1	1	1	1
01	1	0	1	1
11	0	0	1	0
10	0	0	0	0

Sum of product $= \bar{A}\bar{B} + \bar{A}\bar{D} + BCD$

$= \Sigma (0, 1, 2, 3, 4, 6, 7, 15)$

product of sum =

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

$= \Pi (5, 8, 9, 10, 11, 12, 13, 14)$

(C) $F = (A, B, C, D) = (\bar{A}BD + CD + \bar{A}B\bar{C})B\bar{D}$

$= \bar{A}BDB\bar{D} + CDB\bar{D} + \bar{A}B\bar{C}B\bar{D}$

$= 0 + 0 + 0$

$= 0$

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

$= (B'D)' \cdot (A'BC')' \cdot (A'BC)' \cdot (A'D)'$

$= (B + D')(A + B' + C)(A + B' + C)(A + D')$

(E)(i) $F = A + B'C$

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

$= A(BC + B'C + BC' + B'C') + ABC + A'B'C$

$= ABC + AB'C + ABC' + AB'C' + \cancel{AB'C} + A'B'C$

1 1 1 1 0 1 1 1 1 0 1 0 0 1 0 1 0 0 1

$F = \Sigma(m_1, m_4, m_5, m_6, m_7)$

$\Pi(M_0, M_2, M_3)$

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

$= ((A + B) + CC')((B' + C) + AA')$

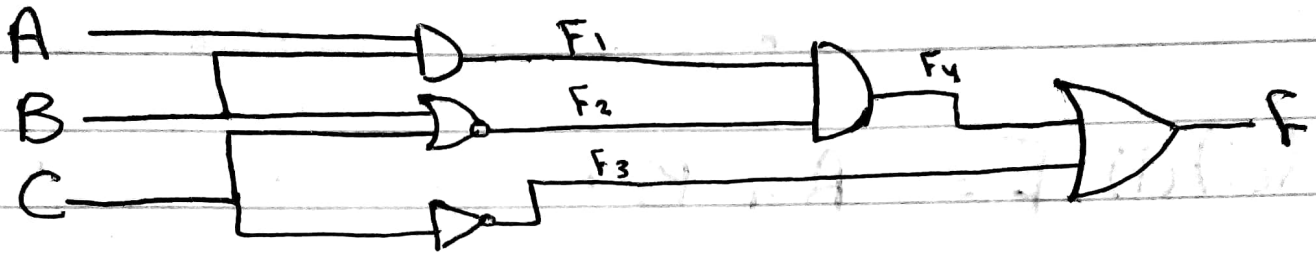
$= \cancel{ABC + A}$

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

$$F = \Pi (M_0, M_1, M_2, M_6)$$

$$= \Sigma (m_3, m_4, m_5, m_7)$$

(F) Find Truth table



A	B	C	F1	F2	F3	F4	F
0	0	0	0	1	1	0	1
0	0	1	0	0	0	0	0
0	1	0	0	0	1	0	1
0	1	1	0	0	0	0	0
1	0	0	0	1	1	0	1
1	0	1	0	0	0	0	0
1	1	0	0	0	1	0	1
1	1	1	1	0	0	0	0

(G)

AB \ CD	00	01	11	10
00	1	0	X	1
01	X	X	1	1
11	X	1	0	1
10	1	0	0	X

$F_1 = \bar{D} + \bar{C}\bar{B} + \bar{A}\bar{B}$

AB \ CD	00	01	11	10
00	1	1	1	1
01	X	1	1	X
11	1	X	0	1
10	X	0	0	X

$F_2 = \bar{A} + \bar{D}$

AB \ CD	00	01	11	10
00	1	0	X	0
01	X	X	0	1
11	X	X	X	1
10	1	0	1	0

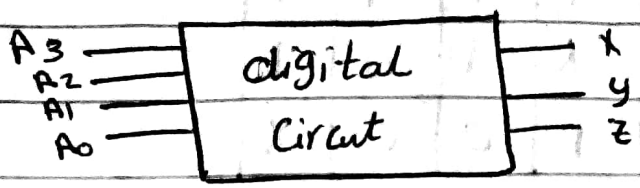
$F_3 = \bar{C}\bar{D} + B + ACD$

AB \ CD	00	01	11	10
00	1	X	X	1
01	X	X	1	1
11	1	X	X	1
10	1	X	X	X

$F_4 = 1$

Question [2]

(A)

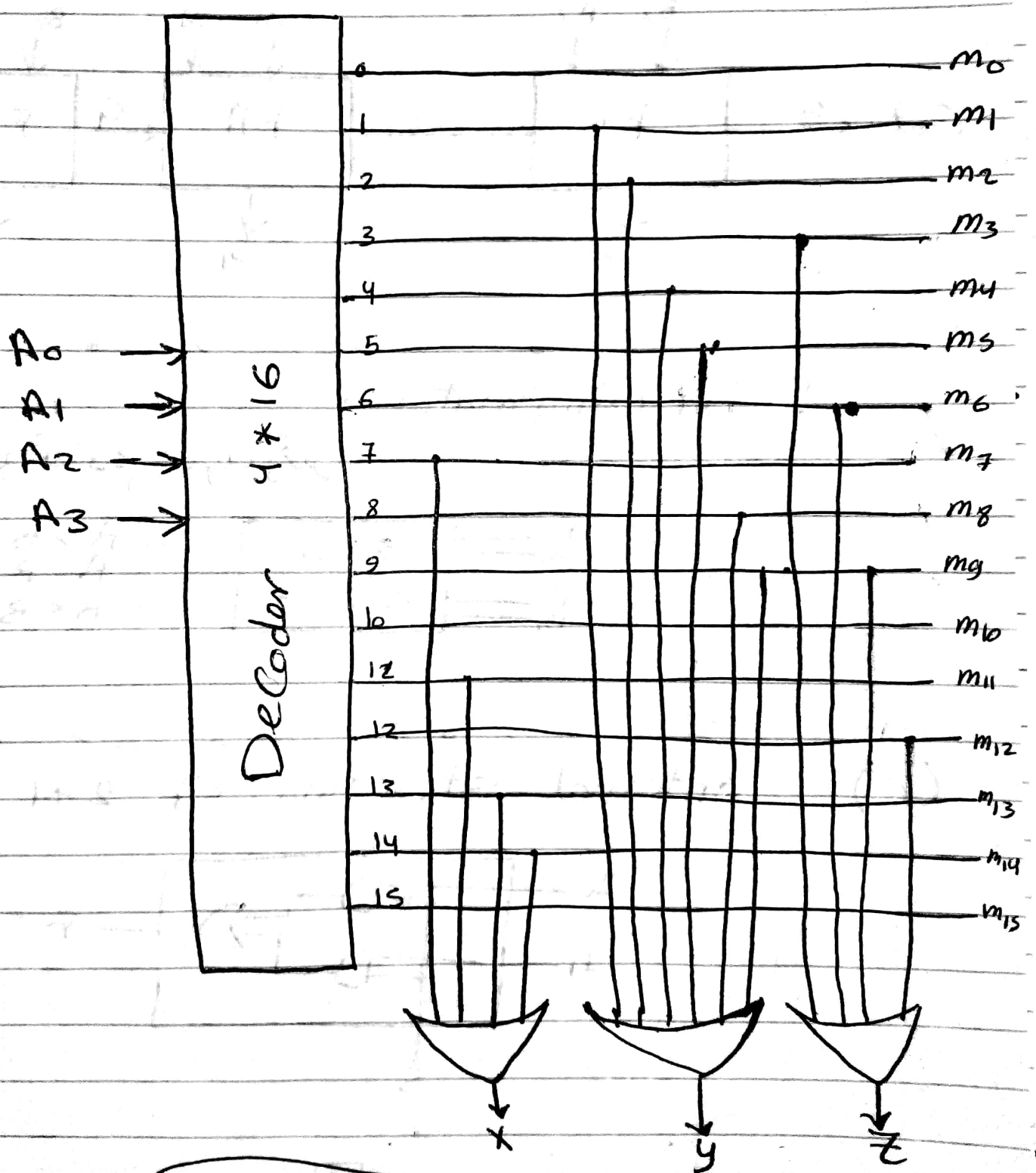


A_0	A_1	A_2	A_3	x	y	z	minterms
0	0	0	0	0	0	0	m_0
0	0	0	1	0	1	0	m_1
0	0	1	0	0	1	0	m_2
0	0	1	1	0	0	1	m_3
0	1	0	0	0	1	0	m_4
0	1	0	1	0	1	0	m_5
0	1	1	0	0	0	1	m_6
0	1	1	1	1	0	0	m_7
1	0	0	0	0	1	0	m_8
1	0	0	1	0	1	1	m_9
1	0	1	0	0	0	0	m_{10}
1	0	1	1	1	0	0	m_{11}
1	1	0	0	0	0	1	m_{12}
1	1	0	1	1	0	0	m_{13}
1	1	1	0	1	0	0	m_{14}
1	1	1	1	0	0	0	m_{15}

$X = m_7 + m_{11} + m_{13} + m_{14} = \Sigma(7, 11, 13, 14)$

$Y = m_1 + m_2 + m_4 + m_5 + m_8 + m_9 = \Sigma(1, 2, 4, 5, 8, 9)$

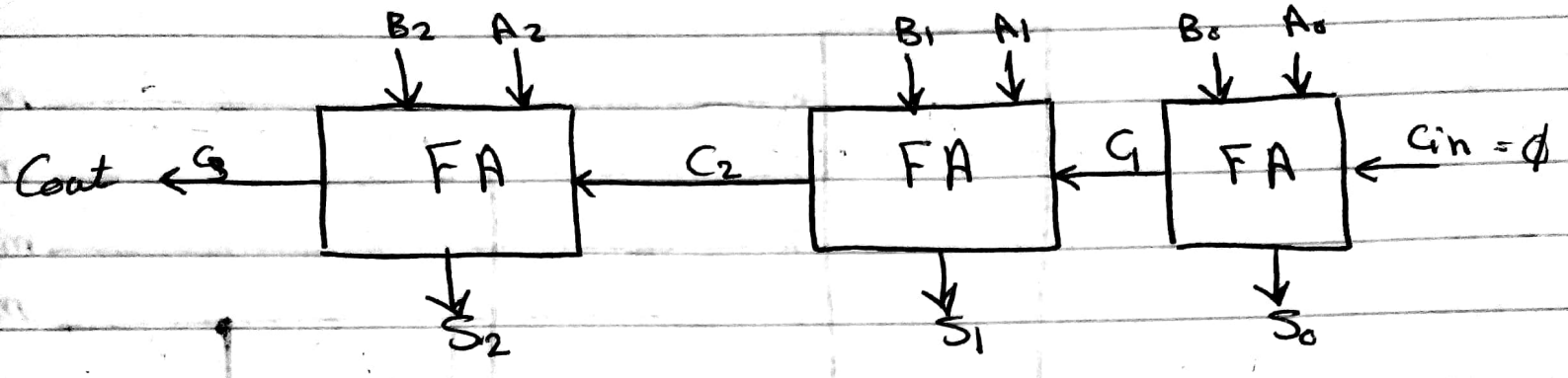
$Z = m_3 + m_6 + m_9 + m_{12} = \Sigma(3, 6, 9, 12)$



(B)

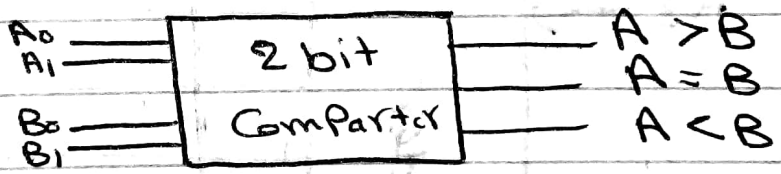
3-bit adder:

هو جهاز يقوم بجمع رقمين كل رقم
مكون من 3bit وبالتالي فإن الناتج
قد يصل إلى 4bit = 3bit + 1

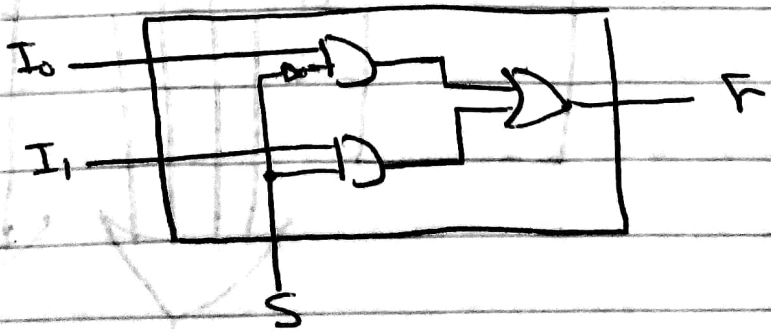


2-bit Comparator :

دائرة رقمية تستخدم لمقارنة رقمين



(C) Internal structure of 2*1 mux



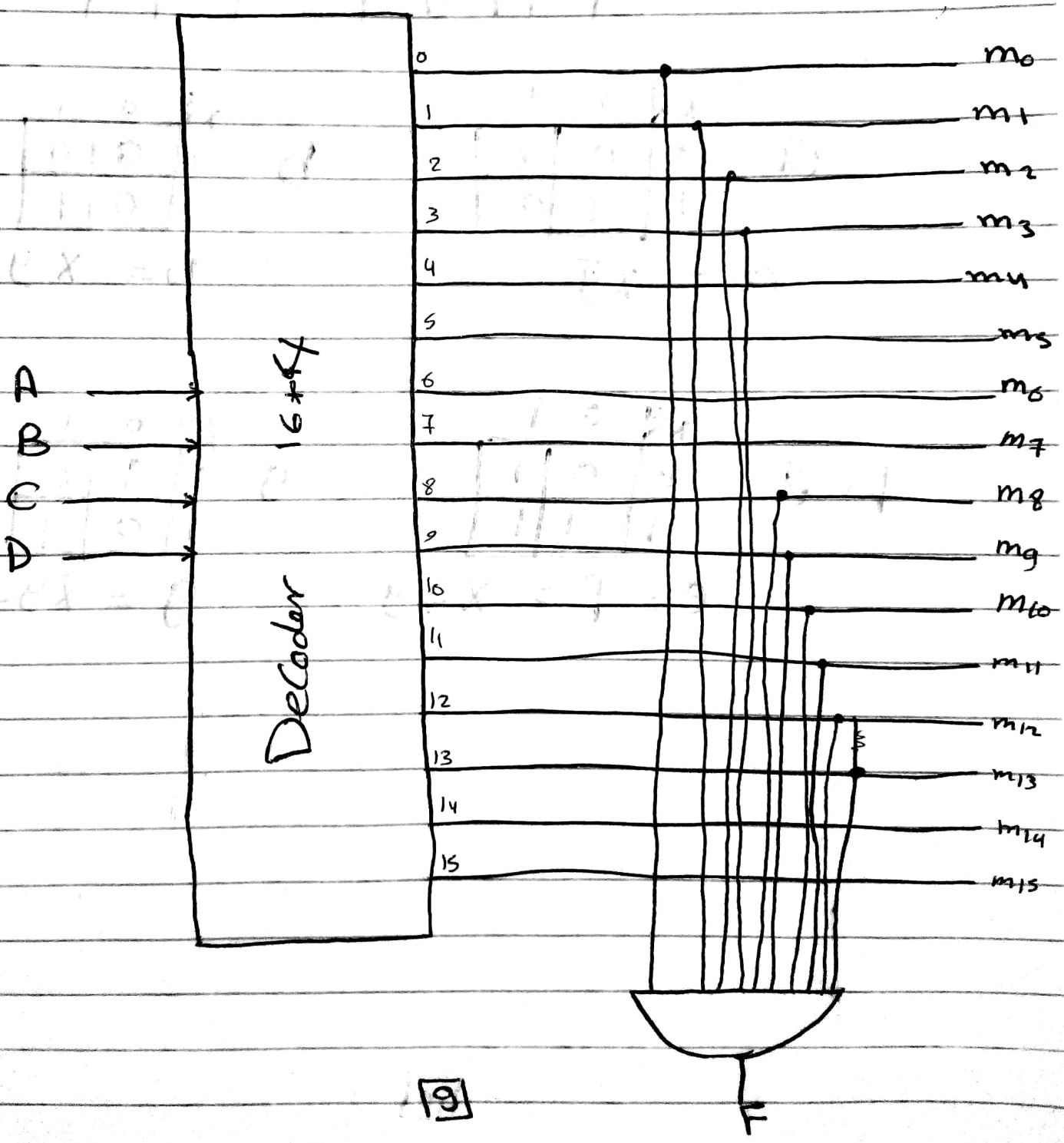
(D)

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

$F = \Sigma(4,5,6,7,14,15)$

$= \Pi(0,1,2,3,8,9,10,11,12,13)$

A B \ C D	0 0	0 1	1 1	1 0
0 0	0	0	0	0
0 1	1	1	1	1
1 1	0	0	1	1
1 0	0	0	0	0



Qu 3)

	x	y	a	b	e	f	g
٠	0	0	0	0	0	0	1
١	0	1	0	0	1	1	0
٢	1	0	1	0	1	1	0
٣	1	1	0	1	1	1	1

a

x \ y	0	1
0	0	0
1	1	0

$a = x\bar{y}$

b

x \ y	0	1
0	0	0
1	0	1

$b = xy$

f ، e

x \ y	0	1
0	0	1
1	1	1

$e = f = x + y$

g

x \ y	0	1
0	1	0
1	0	1

$g = \bar{x}y + x\bar{y}$