Al-Mustansiriyah University
Faculty of Engineering
Computers Engineering Dept.
Undergraduate studies
Exam: Final (   )

Subject: Principles of Logic Techniques
Time: Three Hours
Class: 1st
Date: /   / 2019

2019 – 2018 Max. Mark: 100%

Notes: ANSWER **FOUR** QUESTIONS.
Using Scientific Calculator is **NOT Allowed**

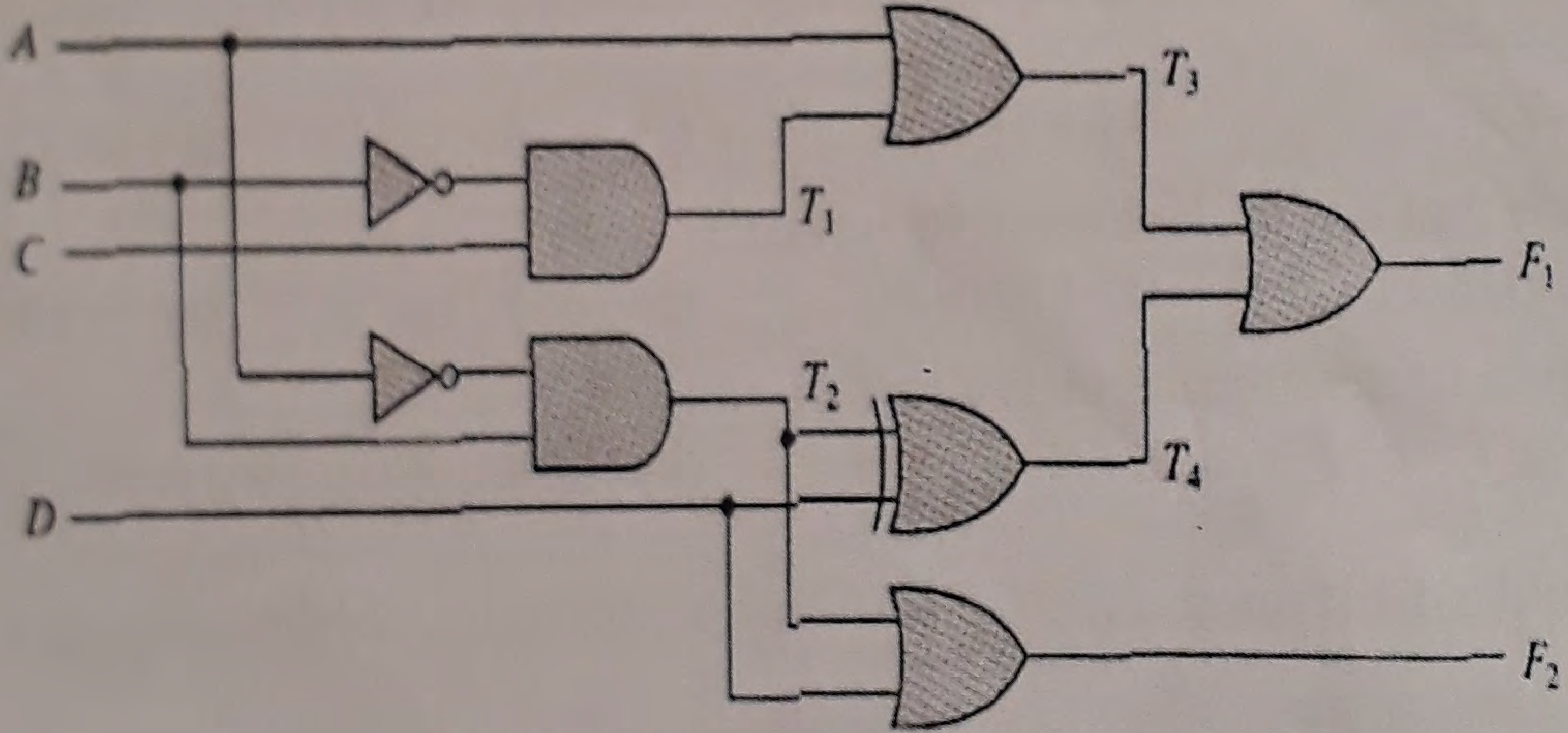
Q1: A **Half Adder** (H.A) is a circuit that adds two bits to give a **sum** and a **carry**. Give the **truth table** for a Half Adder, and **design** the circuit using **only two gates**. Then **design** a combinational circuit that converts a four-bit **Gray code** to a four-bit **Binary number**. Use **only** Half Adder **blocks (H.A's)**. **(25 Marks)**

Q2: A) Given $F = A\bar{B}\bar{D} + \bar{A}B + \bar{A}C + CD + ABC\bar{D}$. Use **Karnaugh map** to find

I. The **minimum SOP** expression for F. **(5 Marks)**
II. The **minimum POS** expression for F. **(5 Marks)**

Q2: B) For the circuit shown below:

(15 Marks)



i- Derive the Boolean expression for T_1, T_2, T_3, and T_4. Evaluate the outputs F_1 and F_2 as a function of the four inputs.
ii- List the truth table of the four input variables, then list the binary values for T_1, T_2, T_3, T_4 and outputs F_1 and F_2 in the table.
iii- Plot the Boolean output functions obtained in **part (ii)** on maps, and show that the simplified Boolean expressions are equivalent to the ones obtained in **part (i)**.

Q3: A) If $(10n01)_2 = (33)_r$. Find both n and **r**. **(12 Marks)**

Q3: B) Implement the following Boolean function $f(a, b, c, d) = \sum(0, 1, 2, 4, 6, 10, 12, 14)$ using **4x1 Multiplexer**, choose a and d as **select lines**. **(13 Marks)**

Q4: Choose the right answer (only one choice): **(25 Marks)**

1. The result of **$(23B)_{12}$** + **$(A87)_{12}$** = ----------.

A) $(CC5)_{12}$ **B)** $(1106)_{12}$ **C)** $(DB2)_{12}$ **D)** $(10B6)_{12}$.

2. ---------- is the 9's complement of the number **$(465)_9$**.

A) $(423)_9$ **B)** $(424)_9$ **C)** $(534)_9$ **D)** $(535)_9$.

3. The result of $(221)_3$ - $(102)_3$ = ----------- .

A) $(119)_3$. **B)** $(111)_3$. **C)** $(112)_3$ **D)** $(122)_3$.

4. In **5-variable Karnaugh** map, a **3-variable** product term is produced by

A) a 16-cell group of 1's **B)** an 8-cell group of 1's
C) a 4-cell group of 1's **D)** a 2-cell group of 1's

5. The **EX-OR** operation can be produced with

A) Two **NAND** gates **B)** Three **NAND** gates
C) Four **NAND** gates **D)** Five **NAND** gates

6. In the **2's complement** form, the binary number (**10110101**) is equal to the decimal number ----------- .

A) -75 **B)** +181 **C)** +75 **D)** -53

7. The code that has an **Even-parity error** is ---------------.

A)1010011 **B)** 1101011 **C)** 1001010 **D)** 1110101

8. According to the **commutative law** of addition,

A) $X+Y=Y+X$ **B)** $X+\overline{X}=1$ **C)** $X+(Y+Z)=(X+Y)+Z$ **D)** $X+0=X$

Q5: A) Build a **4-bit** magnitude Comparator, using only **2-bit** magnitude Comparators. **(15 Marks)**

Q5: B) Show how to configure each of the following two-input devices as an **inverter**:

i. Two input **NOR**. **(5 Marks)**

ii. Two input **Ex-OR**. **(5 Marks)**

Good Luck

Examiner: Asst. Prof. Dr. Walaa M. Khalaf **Head of Department. Asst. Prof. Nasir Ahmad**

①

الدور 1 / الكورس 1 ٢٠١٨-٢٠١٩

Q1:

i/P		o/P	
A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

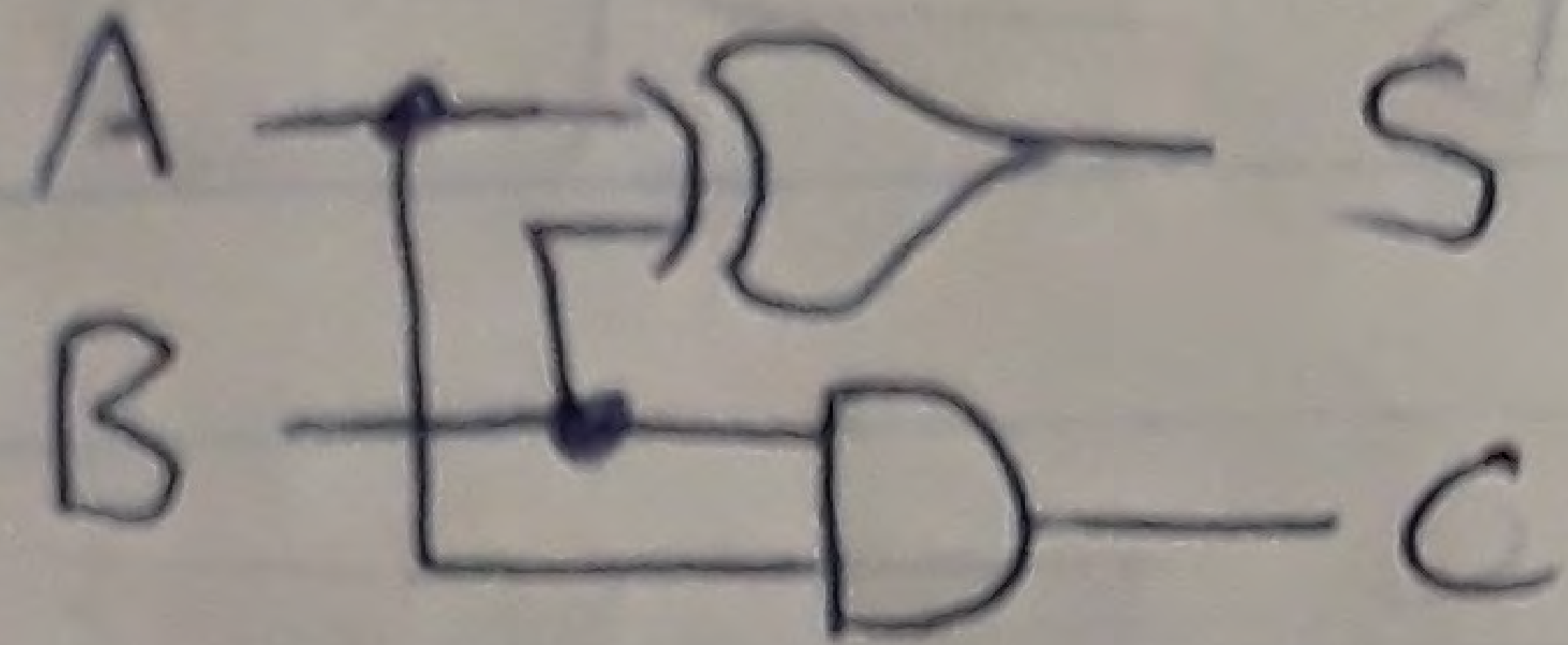
②

③

$S = A \oplus B$

$C = A.B$

③



i/P Gray				o/P binary			
A	B	C	D	W	X	Y	Z
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1
0	0	1	1	0	0	1	0
0	0	1	0	0	0	1	1
0	1	1	0	0	1	0	0
0	1	1	1	0	1	0	1
0	1	0	1	0	1	1	0
0	1	0	0	0	1	1	1
1	1	0	0	1	0	0	0
1	1	0	1	1	0	0	1
1	1	1	1	1	0	1	0
1	1	1	0	1	0	1	1
1	0	1	0	1	1	0	0
1	0	1	1	1	1	0	1
1	0	0	1	1	1	1	0
1	0	0	0	1	1	1	1

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	$\bar{A}$		A	
AB / CD	00	01	11	10
00			1	1
01			1	1
11			1	1
10	1		1	1
	$\bar{B}$	B	B	$\bar{B}$

$\boxed{W = A}$

AB / CD	00	01	11	10
00		1		1
01		1		1
11		1		1
10		1		1

$X = \bar{A}B + A\bar{B} = \boxed{A \oplus B}$

		$\bar{A}$		A		
	AB / CD	00	01	11	10	
$\bar{C}$	00		1		1	$\bar{D}$
$\bar{C}$	01		1		1	D
C	11	1		1		D
C	10	1		1		$\bar{D}$

$y = \bar{A}\bar{B}C + \bar{A}\bar{B}C + A\bar{B}\bar{C} + ABC$

$\boxed{y = A \oplus B \oplus C}$

AB / CD	00	01	11	10
00		1		1
01	1		1	
11		1		1
10	1		1	

$\boxed{Z = A \oplus B \oplus C \oplus D}$

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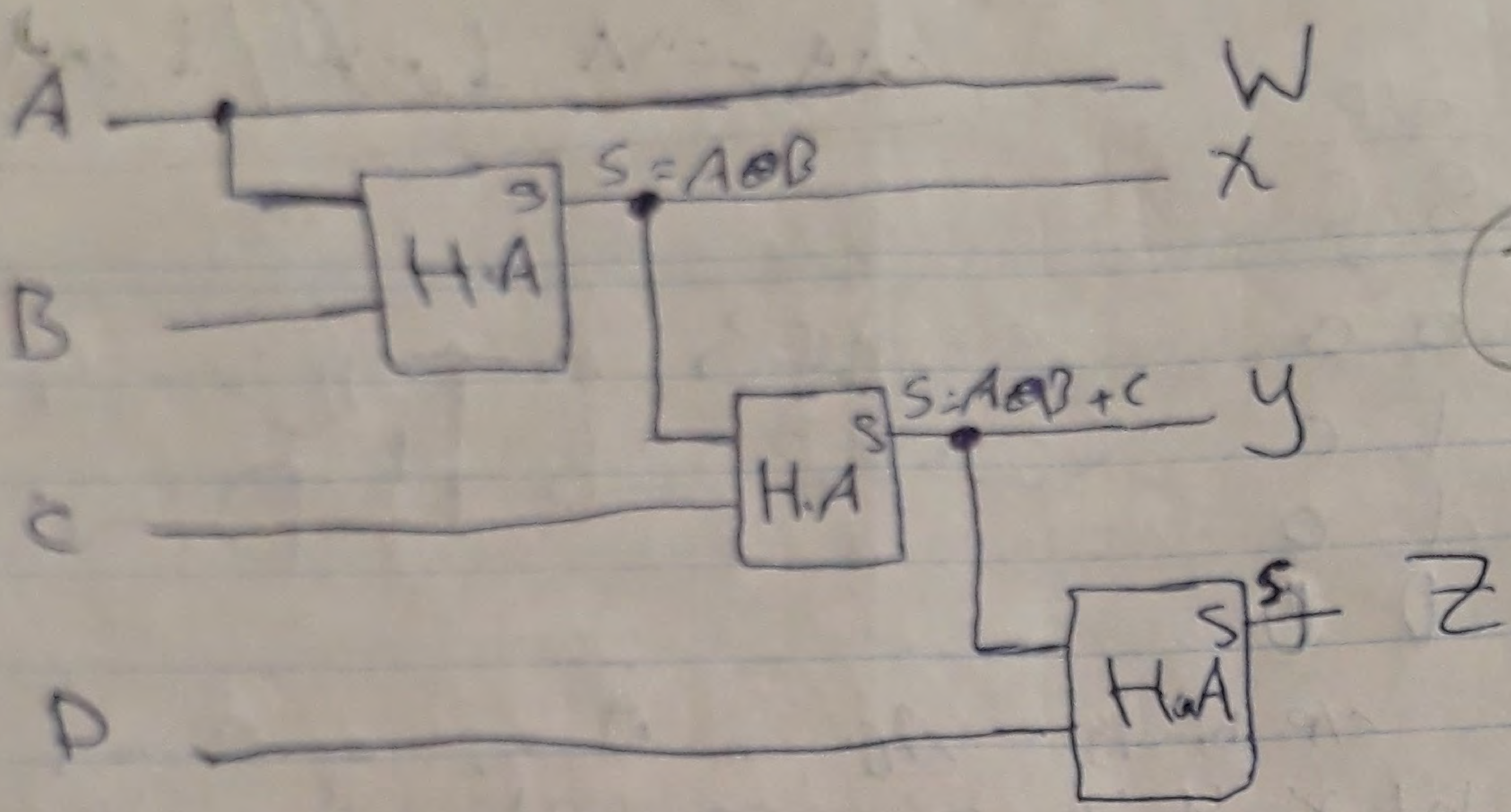

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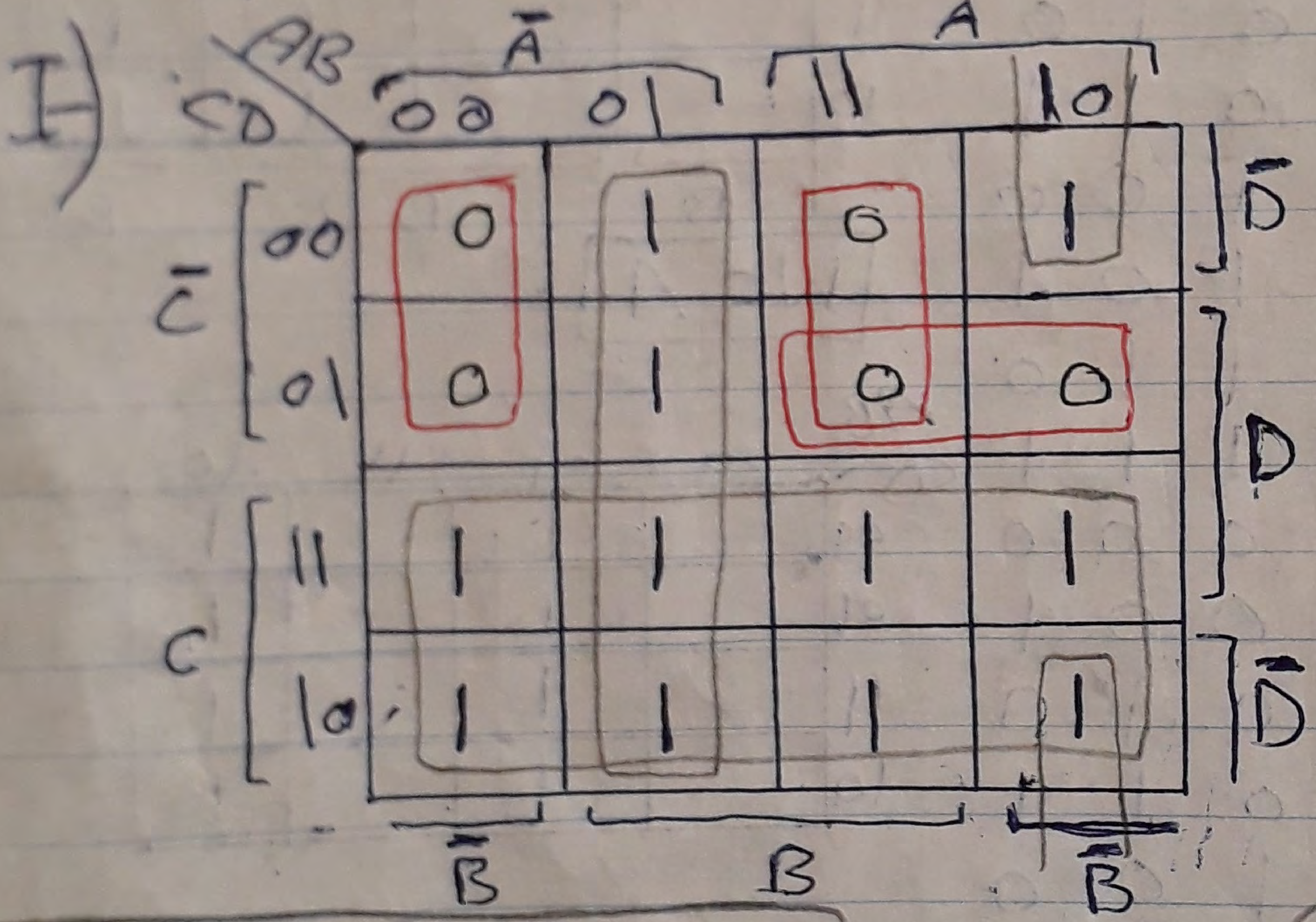
Q2: A) $F = A\bar{B}\bar{D} + \bar{A}B + \bar{A}C + CD + ABC\bar{D}$

I)



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

③

$\boxed{F = A\bar{B}\bar{D} + \bar{A}B + C}$ ③

II) $\bar{\bar{F}} = \overline{\bar{A}\bar{B}\bar{C} + AB\bar{C} + A\bar{C}D}$

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

OR $F = (A+B+C)(\bar{A}+\bar{B}+C)(B+C+\bar{D})$ ④

③

Q 2: B) i-) $\boxed{T_1 = \bar{B}C}$, $\boxed{T_2 = \bar{A}B}$

$T_3 = A + T_1 \Rightarrow \boxed{T_3 = A + \bar{B}C}$ ①

$T_4 = D \oplus T_2 \Rightarrow T_4 = \bar{D}T_2 + D\bar{T}_2$

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

$\boxed{T_4 = \bar{A}B\bar{D} + AD + \bar{B}D}$ ①

$F_1 = T_3 + T_4 \Rightarrow F_1 = A + \bar{B}C + \bar{A}B\bar{D} + AD + \bar{B}D$

$\boxed{F_1 = A + B\bar{D} + \bar{B}D + \bar{B}C}$ ②

$F_2 = T_2 + D \Rightarrow \boxed{F_2 = \bar{A}B + D}$ ①

ii- i/p

②

A	B	C	D	T_1	T_2	T_3	T_4	F_1	F_2
0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1	1	1
0	0	1	0	1	0	1	0	1	0
0	0	1	1	1	0	1	1	1	1
0	1	0	0	0	1	0	1	1	1
0	1	0	1	0	1	0	0	0	1
0	1	1	0	0	1	0	1	1	1
0	1	1	1	0	1	0	0	0	1
1	0	0	0	0	0	1	0	1	0
1	0	0	1	0	0	1	1	1	1
1	0	1	0	1	0	1	0	1	0
1	0	1	1	1	0	1	1	1	1
1	1	0	0	0	0	1	0	1	0
1	1	0	1	0	0	1	1	1	1
1	1	1	0	0	0	1	0	1	0
1	1	1	1	0	0	1	1	1	1
							①	①	①

iii) ④

CD \ AB	00 ($\bar{A}$)	01 ($\bar{A}$)	11 (A)	10 (A)	
00 ($\bar{C}$)		1	1	1	$\bar{D}$
01 ($\bar{C}$)	1		1	1	D
11 (C)	1		1	1	D
10 (C)	1	1	1	1	$\bar{D}$
	$\bar{B}$	B	B	$\bar{B}$	

②

$$\boxed{F_1 = A + B\bar{D} + \bar{B}C + \bar{B}D}$$ ①

CD \ AB	00 ($\bar{A}$)	01 ($\bar{A}$)	11 (A)	10 (A)	
00 ($\bar{C}$)		1			$\bar{D}$
01 ($\bar{C}$)	1	1	1	1	D
11 (C)	1	1	1	1	D
10 (C)		1			$\bar{D}$
	$\bar{B}$	B	B	$\bar{B}$	

①

$$\boxed{F_2 = D + \bar{A}B}$$ ①

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③

Q 3: A) $(10n01)_2 = 2^4 + n*2^2 + 1 = 17 + 4n = 3r + 3$ ③

If $n=0$, then $r = (17-3)/3$ is not an integ

If $\boxed{n=1}$, then $r = (21-3)/3 \Rightarrow \boxed{r=6}$ ③

$(10101)_2 = (33)_6 = (21)_{10}$ ③

⑤

الدور 1/ الكورس 1. ٢٠١٨ - ٢٠١٩

Q3: B) $F = \sum(0,1,2,4,6,10,12,14)$

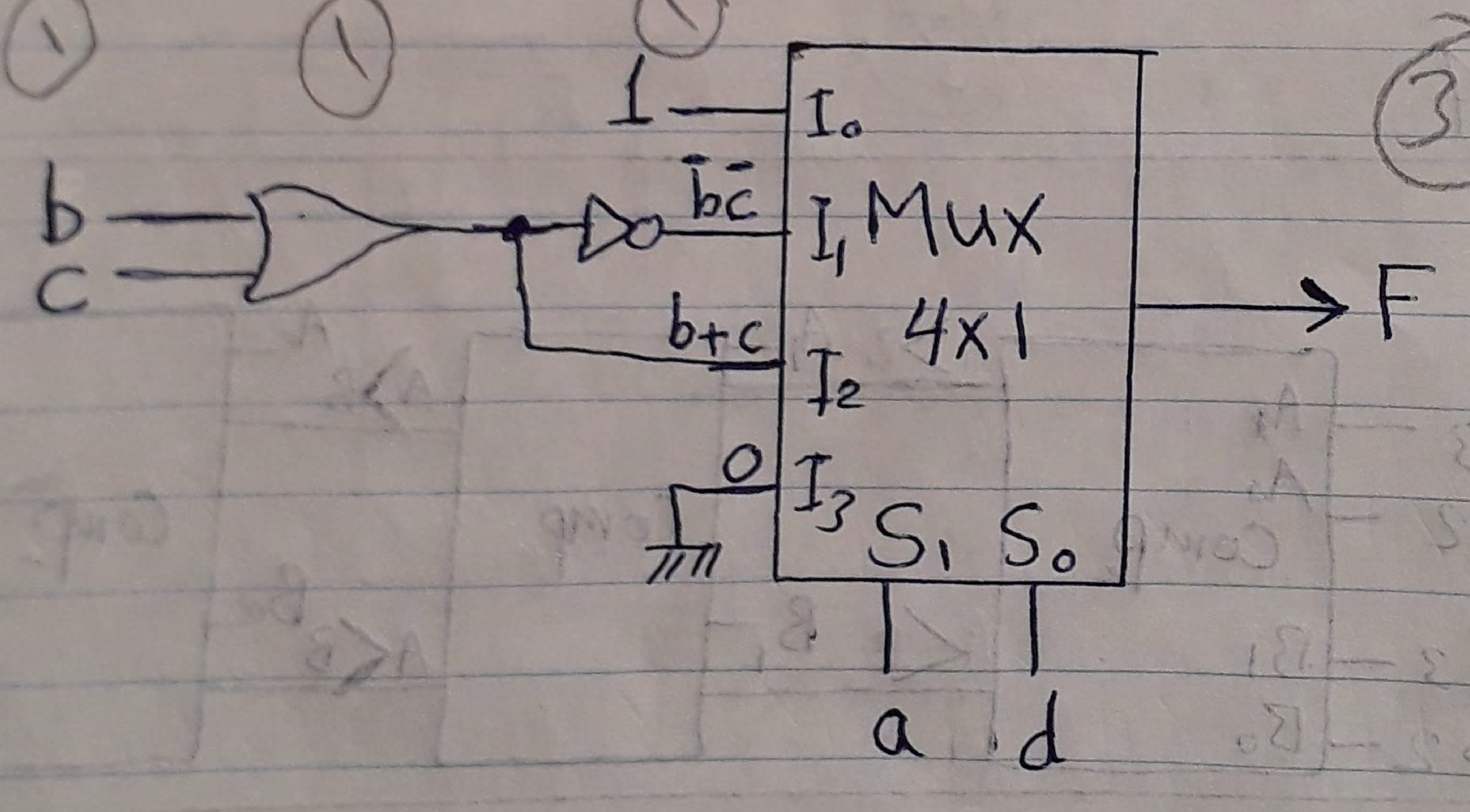
$I_0 = \bar{a}\bar{d}$, $I_1 = \bar{a}d$, $I_2 = a\bar{d}$, $I_3 = ad$

	I_0	I_1	I_2	I_3
$\bar{b}\bar{c}$	⓪	①	8	9
$\bar{b}c$	②	3	⑩	11
$b\bar{c}$	④	5	⑫	13
bc	⑥	7	⑭	15
	1	$\bar{b}\bar{c}$	$b+c$	0 ①
	①	①	①	

$\bar{b}c + b\bar{c} + bc$

$\bar{b}c + b$

⑥ $b + c$



③

⑥

Q4:
1- B ②

2- B ③

3- C ②

4- C ③

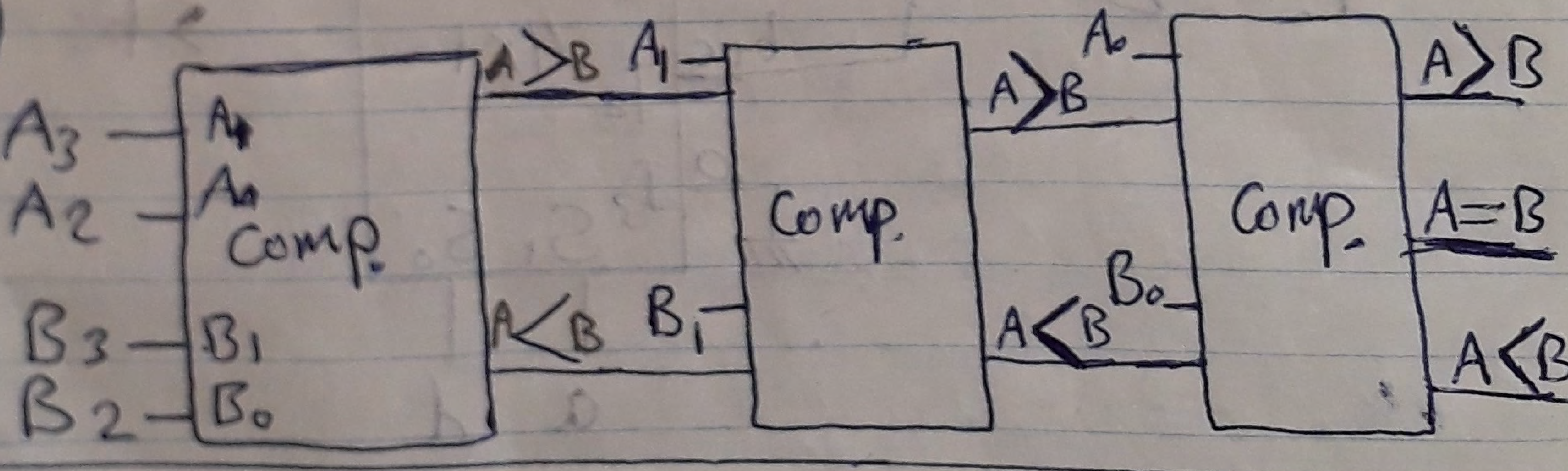
5- D ③

6- A ③

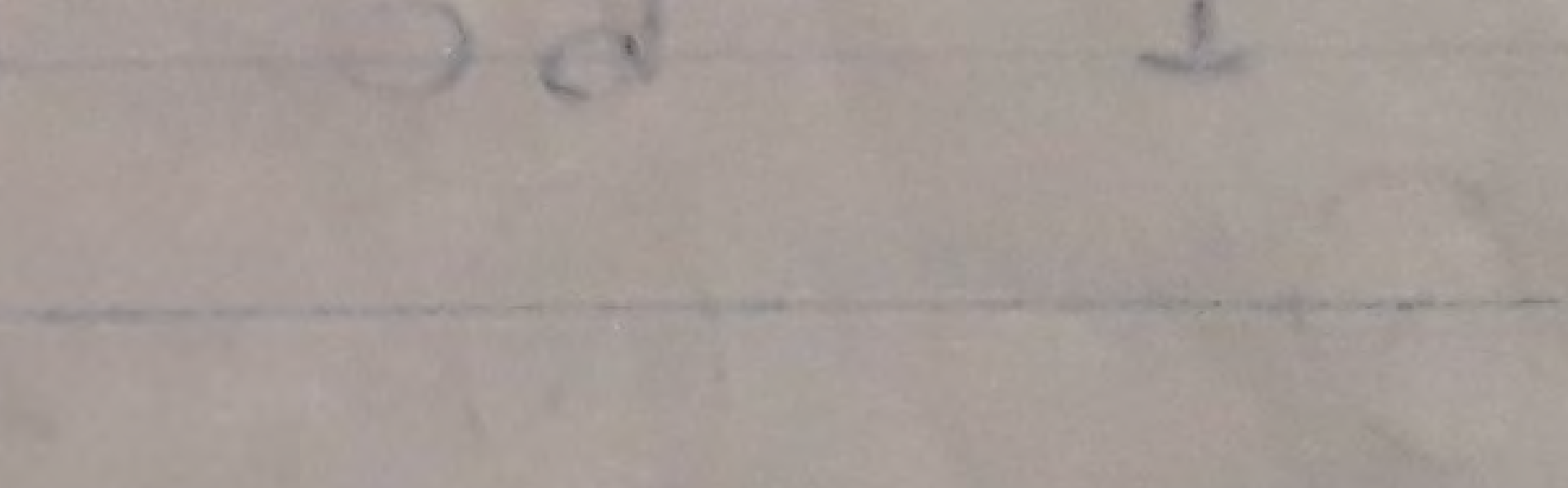
7- A ③

8- A ③

Q5: A)



Q5: B) i- $\overline{A+B} = \bar{A}\cdot\bar{B} = \bar{A}$



ii- $A\bar{B}+\bar{A}B = A\cdot\bar{1}+\bar{A}\cdot 1 = \bar{A}$