



CS 220 Computer Architecture

HW 05 - Digital Logic

Fall 2023

DEPARTMENT OF COMPUTER SCIENCE AND INFORMATION SYSTEMS

PART 0: READING AND WATCHING INSTRUCTIONAL VIDEOS

- **Chapter 12** - Digital Logic

PART 1: QUESTIONS ON TRUTH TABLE [60 Pts]

QUESTION 1

Given A and B, complete the truth table. [10 pts]

Input		Output						
		NOT		AND	OR	XOR	NOR	NAND
A	B	—	—	A*B	A + B	-----	-----	(A \oplus B)
0	0	1	1	0	0	1	1	0
0	1	1	0	0	1	1	0	1
1	0	0	1	0	1	1	0	1
1	1	0	0	1	1	0	0	0

QUESTION 2

Given A and B, complete the truth table. [10 pts]

Input		Output				
		AND	OR	XOR	NOR	NAND
A	B	$A * B$	$A + B$	----- $(A * B)$	----- $(A + B)$	$(A \oplus B)$
01	11	01	11	10	00	10
1110	0111	0110	0111	0001	1000	1001
101	110	100	111	011	000	011
0101	1010	0000	1111	1111	0000	1111

QUESTION 3

Construct a truth table for the following Boolean expressions. (Q12. 1 from the textbook) [40 pts]

1. $F = ABC + A'B'C'$, where A' represents the NOT operation.
2. $F = ABC + AB'C' + A'B'C'$
3. $F = A(BC' + B'C)$
4. $F = (A + B)(A + C)(A' + B')$

Input			Output			
A	B	C	F(a)	F(b)	F(c)	F(d)

0	0	0	0 1 = 1	0 0 1 = 1	0(0) = 1	1 1 0 = 0
0	0	1	0 0 = 0	0 0 0 = 0	0(1) = 0	1 1 0 = 0
0	1	0	0 0 = 0	0 0 0 = 0	0(1) = 0	1 1 1 = 1
0	1	1	0 0 = 0	0 0 0 = 0	0(0) = 1	1 1 1 = 1
1	0	0	0 0 = 0	0 1 0 = 1	1(0) = 0	1 1 1 = 1
1	0	1	0 0 = 0	0 0 0 = 0	1(1) = 1	1 0 1 = 0
1	1	0	0 0 = 0	0 0 0 = 0	1(1) = 1	0 1 1 = 0
1	1	1	1 0 = 1	1 0 0 = 1	1(0) = 0	0 0 1 = 0

Note: Add more rows if needed.

PART 2: QUESTIONS ON BOOLEAN EXPRESSIONS AND CIRCUIT DESIGN [40 PTS]

QUESTION 1

The following Questions (refer to the book - [Chapter 12 problems](#)) can be hand-written under the condition it is easy for the grader to read. You will be asked to type your solution and submit a digital version of your hand-written homework that is difficult to decipher. [40 pts]

[Show ALL Steps](#)

● Note: only providing the final result without showing all steps will result in a Zero grade in related questions specified as "Show ALL Steps".

1. 12. 2
 - a. $(A' + D)(A' + B + E)(A + B + C)$
 - b. $(X + Y)(Y + Z)$
 - c. $(A + B + C)(D + E + F)(X + Y)$
 - d. $(ABC) + (A'B'C') + (B'C') + A(B + C)$

12.2 ~~X~~

- $(\bar{A} + D)(D + \bar{A})(B + E + \bar{A})(\bar{A} + E + B)(A + B + C) \rightarrow (\bar{A} + D)(B + E + \bar{A})(A + B + C)$
- $(x + Y)(Y + Z)(Y + X) \rightarrow (x + Y)(Y + Z)$
- $(A + B + C)(D + E + F)(x + Y)(C + A + B) \rightarrow (A + B + C)(D + E + F)(x + Y)$
- $(ABC) + (\bar{A}\bar{B}\bar{C}) + (\bar{B}\bar{C}) + A(B + C) + (CBA) + (\bar{C}\bar{B})$

$\hookrightarrow (ABC) + (\bar{A}\bar{B}\bar{C}) + (\bar{B}\bar{C}) + A(B + C)$

2. 12.3

- $A = M' + N' + O' + P'$
- $B = (M + N + O + P + Q)'$

12.3

- $A = \overline{M N O P} \rightarrow M' + N' + O' + P'$
- $B = \overline{\bar{M} \bar{N} \bar{O} \bar{P} \bar{Q}} \rightarrow (M + N + O + P + Q)'$

3. 12.4

- a. $S * T + V * W$
- b. $T * U * V + Y$
- c. $F(E + G)$
- d. $S * T(P * Q + R)$
- e. 1
- f. $YZ(W + X)$
- g. $C(B * E + F)$

12.3

$\leftarrow I + R = I, S \cdot T(U) = S \cdot T$

a. $A = S \cdot T + V \cdot W + R \cdot S \cdot T \rightarrow S \cdot T(I + R) + VW \rightarrow S \cdot T + V \cdot W$

b. $T \cdot U \cdot V + X \cdot Y + Y \rightarrow T \cdot U \cdot V + Y(X + I) \rightarrow T \cdot U \cdot V + Y$

c. $A = F \cdot (E + F + G) \rightarrow FE + FF + FG \rightarrow F(E + G)$

d. $(P \cdot Q + R + S \cdot T) S \cdot T \rightarrow S \cdot T(P \cdot Q + R)$

e. $(D' \cdot D + E') \rightarrow (D' \cdot D + E \rightarrow I + E \rightarrow I)$

f. $Y \cdot (W + X + (Y + Z)) \cdot Z \rightarrow YZ(W + X + Y \cdot Z) \rightarrow YZ(W + X)$

g. $(B \cdot E + C \cdot F) \cdot C \rightarrow BC \cdot EC + CC + CF \rightarrow C(B \cdot E + F)$

4. 12.9

