



كلية تكنولوجيا الصناعة والطاقة

Information Technology Department
2nd Year



جامعة برج العرب التكنولوجية
BORG AL ARAB TECHNOLOGICAL UNIVERSITY

جامعة برج العرب التكنولوجية

Course: Digital Engineering

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Tutorial 2: Truth Tables

Question 1 — Write down the truth table for the following logic expressions

a) $F = (A + B)' + A' \cdot (C + B')$

Truth Table:

A	B	C	$(A+B)'$	A'	B'	$(C+B)'$	$A' \cdot (C+B)'$	F
0	0	0	1	1	1	1	1	1
0	0	1	1	1	1	1	1	1
0	1	0	0	1	0	0	0	0
0	1	1	0	1	0	1	1	1
1	0	0	0	0	1	1	0	0
1	0	1	0	0	1	1	0	0
1	1	0	0	0	0	0	0	0
1	1	1	0	0	0	1	0	0

Final Output for Expression 1: $F = 1$ when $(A,B,C) = (0,0,0), (0,0,1), (0,1,1)$

Question 2 — Write down the truth table for the following word expressions:

a) Given a 3-bit input $N = ABC$, design a circuit that outputs $f = 1$ if N represents a prime number, otherwise $f = 0$.

Ans:

Output $f = 1$ when N (binary ABC) is a prime number (2,3,5,7).

Truth table:

Decimal N	A	B	C	f
0	0	0	0	0
1	0	0	1	0
2	0	1	0	1
3	0	1	1	1
4	1	0	0	0
5	1	0	1	1
6	1	1	0	0
7	1	1	1	1



b) Given a 3-bit input $X = ABC$, design a circuit that outputs $f = 1$ when the number of 1s in the input is odd (odd parity checker).

Ans:

Output $f = 1$ when the number of ones in A, B, C is odd.

Truth table:

# of 1s	A	B	C	f
0	0	0	0	0
1	0	0	1	1
1	0	1	0	1
2	0	1	1	0
1	1	0	0	1
2	1	0	1	0
2	1	1	0	0
3	1	1	1	1

c) Given a 3-bit input $N = ABC$, design a circuit that outputs $f = 1$ if N is divisible by 3, otherwise $f = 0$.

Ans:

Output $f = 1$ when decimal N is divisible by 3 (including 0): $\{0, 3, 6\}$.

Truth table:

Decimal N	A	B	C	f
0	0	0	0	1
1	0	0	1	0
2	0	1	0	0
3	0	1	1	1
4	1	0	0	0
5	1	0	1	0
6	1	1	0	1
7	1	1	1	0



d) Design a 3-input circuit with inputs A, B, C that outputs $f = 1$ if at least two consecutive bits are 1s.

Ans:

Output $f = 1$ if the 3-bit input A,B,C contains at least two adjacent 1s (patterns 011,110,111).

Truth table:

Has the
pattern

yes

yes

yes

A	B	C	f
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

Question 3 — Find the Duals (dual of the inner expression X; $+ \leftrightarrow \cdot$)

Reminder: To form the dual F_d of an expression X, interchange $+$ and $\cdot$ everywhere. Complements and variables remain unchanged; constants $0 \leftrightarrow 1$ if present.

$$a) X = \overline{AB} + \overline{C} (E + \overline{D})$$

Dual: replace $\cdot$ with $+$ and $+$ with $\cdot$:

$$\text{Dual: } X^d = \overline{A + B} \cdot \overline{C} + (E \cdot \overline{D})$$

$$b) X = \overline{(A + B)(A + \overline{A}B)}$$

$$\text{Dual: } X^d = \overline{(A \cdot B) + (A \cdot (\overline{A} + \overline{B}))}$$

$$\text{Simplify second term: } A(\overline{A} + \overline{B}) = A\overline{A} + A\overline{B} = 0 + A\overline{B} = A\overline{B}.$$

$$\text{So } X^d = \overline{AB} + A\overline{B} = \overline{B}(\overline{A} + A) = \overline{B}$$

$$\text{Thus: } X^d = \overline{B}.$$