Chapter 11 Homework

Mohibullah Meer

January 29, 2024

11.1.:

11.1a: Convert the binary numeral 111001 to decimal.

	2^5	2^4	2^3	2^2	2^1	2^0
$\#_2$	1	1	1	0	0	1
$\#_{10}$	32	16	8	0	0	1

$$111001_2 = 32_{10} + 16_{10} + 8_{10} + 1_{10}$$
$$111001_2 = 57_{10}$$

11.1b: Convert the decimal numeral 87 to binary.

$\#_{10}$	$\#_{10}/2$	R
87	0	1
43	1	1
21	2	1
10	3	0
5	4	1
2	5	0
1	6	1

$$87_{10} = 1010111_2$$

11.3.

11.3a:

11.3b:

11.3c:

11.3d:

11.3e:

11.5. Let $p \downarrow q$ denote the "nor" operator:

11.5a: Write the truth table for $p \downarrow q$.

p	q	$p \downarrow q$
F	F	T
F	T	F
T	F	F
T	T	F

11.5b: Using only the $\downarrow$ operator, write a formula equivalent to $\neg p$.

$$p \downarrow p \Leftrightarrow \neg p$$

p	$p \downarrow p$	$\neg p$
F	T	T
T	F	F

11.5c: Show that $\vee$ and $\wedge$ can also be expressed using just the $\downarrow$ operator.

$$(p \downarrow q) \downarrow (p \downarrow q) \Leftrightarrow p \vee q$$

p	q	$p \downarrow q$	$(p \downarrow q) \downarrow (p \downarrow q)$	$p \vee q$
F	F	T	F	F
F	T	F	T	T
T	F	F	T	T
T	T	F	T	T

$$(p \downarrow p) \downarrow (q \downarrow q) \Leftrightarrow p \wedge q$$

p	q	$p \downarrow p$	$q \downarrow q$	$(p \downarrow p) \downarrow (q \downarrow q)$	$p \wedge q$
F	F	T	T	F	F
F	T	T	F	F	F
T	F	F	T	F	F
T	T	F	F	T	T

11.7. Write the logical formulas for the values of Z_0, Z_1, and C_{out} of the two bit adder, in terms of the inputs X_0, Y_0, X_1, and Y_1.

$$Z_0 = X_0 \oplus Y_0$$

$$Z_1 = (X_0 \wedge Y_0) \oplus (X_1 \oplus Y_1)$$

$$C_{out} = (X_1 \wedge Y_1) \vee ((X_0 \wedge Y_0) \wedge (X_1 \vee Y_1))$$

X_0	Y_0	X_1	Y_1	Z_0	Z_1	C_{out}
F	F	F	F	F	F	F
F	F	F	T	F	T	F
F	F	T	F	F	T	F
F	F	T	T	F	F	T
F	T	F	F	T	F	F
F	T	F	T	T	T	F
F	T	T	F	T	T	F
F	T	T	T	T	F	T
T	F	F	F	T	F	F
T	F	F	T	T	T	F
T	F	T	F	T	T	F
T	F	T	T	T	F	T
T	T	F	F	F	T	F
T	T	F	T	F	F	T
T	T	T	F	F	F	T
T	T	T	T	F	T	T

11.9. In terms of a 7-segment display:

11.9a: Write out the strokes that should be turned on to represent each of the remaining digits.

#	A	B	C	D	E	F	G
0	T	T	T	F	T	T	T
3	T	F	T	T	F	T	T
4	F	T	T	T	F	T	F
5	T	T	F	T	F	T	T
6	T	T	F	T	T	T	T
7	T	F	T	F	F	T	F
9	T	T	T	T	F	T	T

11.9b: Write a truth table for the A segment and the binary representation of a number from 0-9.

2^3	2^2	2^1	2^0	A
F	F	F	F	T
F	F	F	T	F
F	F	T	F	T
F	F	T	T	T
F	T	F	F	F
F	T	F	T	T
F	T	T	F	T
F	T	T	T	T
T	F	F	F	T
T	F	F	T	T

11.9c: Write a DNF formula for A based on the truth table from part (b).

$$
\begin{gathered}
(\neg p_0 \wedge \neg p_1 \wedge \neg p_2 \wedge \neg p_3) \vee (\neg p_0 \wedge \neg p_1 \wedge p_2 \wedge \neg p_3) \vee (\neg p_0 \wedge \neg p_1 \wedge p_2 \wedge p_3) \\
\vee (\neg p_0 \wedge p_1 \wedge \neg p_2 \wedge p_3) \vee (\neg p_0 \wedge p_1 \wedge p_2 \wedge \neg p_3) \vee (\neg p_0 \wedge p_1 \wedge p_2 \wedge p_3) \\
\vee (p_0 \wedge \neg p_1 \wedge \neg p_2 \wedge \neg p_3) \vee (p_0 \wedge \neg p_1 \wedge \neg p_2 \wedge p_3)
\end{gathered}
$$

11.9d: Draw a logic circuit that implements the formula from part (c).

7-segment 0-9 display.

11.11. Regarding the Thue sequence:

11.11a: Prove that t_n is the exclusive or of the bits of the binary notation for n.

11.11b: Show that for every $n \geq 0$, $t_{2n} = t_n$, and t_{2n+1} is the complement of t_n.