Lesson 5

Digital Logic

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FROM ZERO TO ONE

ELSEVIER

In-class Test 1 Answers

- 1.1 (12 points)
  - (a) $2^{32}-1$
  - (b) $2^{31}-1$
  - (c) $2^{31}-1$

- 1.2 (12 points)
  - (a) 0
  - (b) -2^{31}
  - (c) $-2^{31}+1$

- Some students wrote: 1.1(a) 11…1 (32 1's)
- OK but troublesome.

FROM ZERO TO ONE

In-class Test 1 Answers

- 1.3 (8 points)
  - (a) $100100_2 = 2^5 + 2^2 = 36_{10}$
  - (b) 0111010101000100_2
    $= 2^{13} + 2^{12} + 2^{11} + 2^9 + 2^7 + 2^5 + 2^2 = 15012_{10}$

- Some students did estimation for the 1.3 (b)'s result.
- Inaccurate and unnecessary.

In-class Test 1 Answers

- 1.4 (8 points)
  - (a) $4E_{16}=4\times 16^1+14\times 16^0=78_{10}$
  - (d) $403FB001_{16}$

    $=4\times 16^7+3\times 16^5+15\times 16^4+11\times 16^3+1\times 16^0$

    $=1077915649_{10}$

  - Some students treated E = 15.
  - It should be E=14, and F=15.

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In-class Test 1 Answers

- 1.5 (8 points)
  - (a) ① Inverting $1110_2 = 0001_2$.
    ② $0001_2 + 1 = 0010_2$ ③ $= 2_{10}$.
    ④ Hence, $1110_2 = -2_{10}$.

  - (b) Inverting $100011_2 = 011100_2$.
    $011100_2 + 1 = 011101_2 = 29_{10}$.
    Hence, $100011_2 = -29_{10}$.

In-class Test 1 Answers

- 1.6 (8 points)
  - (a) Unsigned binary number representation and two's complement number representation have the same form for positive numbers, hence,

    $24_{10} = 2^4 + 2^3 = 00011000_2$.

  - (b) The most negative 8-bit number represented by two's complement numbers is $-2^{(8-1)} = -128_{10}$, and $-150_{10} < -128_{10}$, therefore, **Overflow!**

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In-class Test 1 Answers

- 1.7 (8 points)
- sign-extension

  - (a) 00000111_2
  - (b) 11111001_2

In-class Test 1 Answers

- 1.8 (8 points)
  - (a)

$$1001_2$$
$$+\ 0100_2$$
$$1101_2$$

  - • No overflow.

  - (b) 1111

$$1101_2$$
$$+\ \ 1011_2$$
$$11000_2$$

  - • Overflow!

- Some wrote: No result.
- It is not "no result". It is "overflow".

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FROM ZERO TO ONE

In-class Test 1 Answers

- 1.9 (8 points)
    - (a) $16_{10} = 2^4 = 010000_2$

      $9_{10} = 2^3 + 2^0 = 001001_2$

$$\begin{array}{r} 010000_2 \\ + \ 001001_2 \\ \hline 011001_2 \end{array}$$

- No overflow

- Verification: $011001_2 = 2^4 + 2^3 + 2^0 = 25_{10} = 16_{10} + 9_{10}$

In-class Test 1 Answers

- 1.9
  - (b) $27_{10} = 2^4 + 2^3 + 2^1 + 2^0 = 011011_2$

    Inverting $011011_2 = 100100_2$

    $100100_2 + 1 = 100101_2$

    Hence, $-27_{10} = 100101_2$

    $31_{10} = 2^4 + 2^3 + 2^2 + 2^1 + 2^0 = 011111_2$

    Inverting $011111_2 = 100000_2$

    $100000_2 + 1 = 100001_2$

    Hence, $-31_{10} = 100001_2$

$$
\begin{array}{r}
1 \qquad\quad 1 \qquad\quad \\
100101_2 \\
+ \quad 100001_2 \\
\hline
1000110_2
\end{array}
$$

- Overflow!

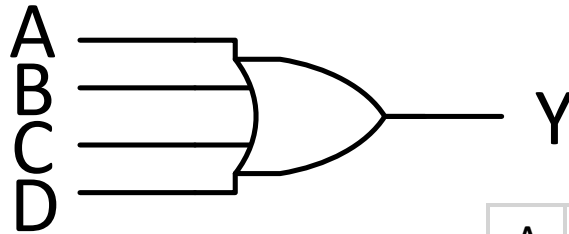- Verification: $000110_2 = 2^2 + 2^1 = 6_{10} \neq -27_{10} + -31_{10}$

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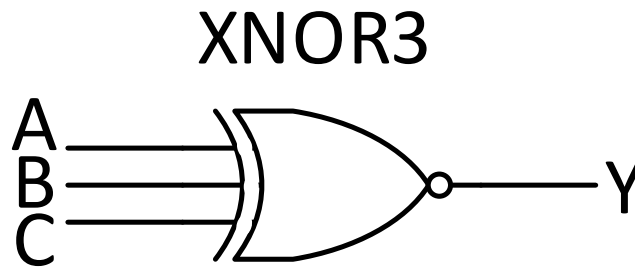# In-class Test 1 Answers

- 1.10 (20 points)
  - (a)

OR4

Y=A+B+C+D

A	B	C	D	Y
0	0	0	0	0
0	0	0	1	1
0	0	1	X	1
0	1	X	X	1
1	X	X	X	1

A	B	C	D	Y
0	0	0	0	0
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

- 1.10
  - (b)

XOR XNOR

XNOR3

A
B
C
Y

$$Y = \overline{A \oplus B \oplus C}$$

A	B	C	Y'	Y
0	0	0	0	1
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	0

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- 1.10
  - (c)

NAND5
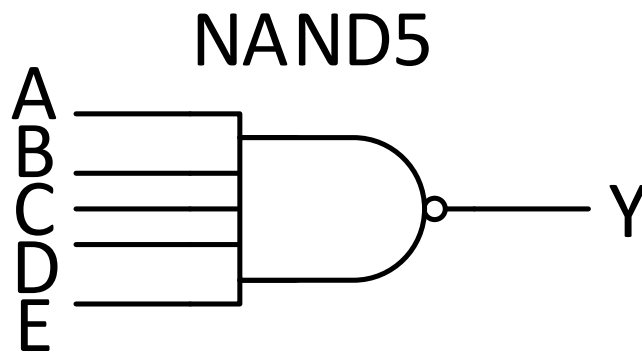
$$Y = \overline{ABCDE}$$

A	B	C	D	E	Y
0	X	X	X	X	1
1	0	X	X	X	1
1	1	0	X	X	1
1	1	1	0	X	1
1	1	1	1	0	1
1	1	1	1	1	0

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In-class Test 1 Answers

- 1.10 typical mistakes:
  - (1) Symbols:
    - Incorrect gate bodies.
    - Conjunctive inputs.
  - (2) Boolean equations:
    - Inputs on the left, output on the right. (Unusual!)
  - (3) Truth tables:
    - Only numbers, no variables.
    - Incomplete truth tables (Not include all the input value combinations).
    - Two truth tables for one Boolean equation.
    - Wrote functional descriptions instead.

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