Logic Design

Chapter 1: Design Concepts

Binary Numbers

- In logic circuits information is represented as electronic signals
- Each signal provides one digit of information
- Each digit is allowed to take on only two possible values, usually denoted as 0 and 1
- In decimal system a number consists of digits that have 10 possible values 0 to 9

$$8547 = 8 \times 10^3 + 5 \times 10^2 + 4 \times 10^1 + 7 \times 10^0$$

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Binary Numbers

- In general

$$D = d_{n-1}d_{n-2}\cdots d_1 d_0$$
$$V(D) = d_{n-1} \times 10^{n-1} + d_{n-2} \times 10^{n-2} + \cdots + d_1 \times 10^1 + d_0 \times 10^0$$

- Because digits have 10 possible values decimal numbers are called base-10 or radix-10
- In logic circuits there are only two possible values so the numbers are called binary or base-2

$$B = b_{n-1}b_{n-2}\cdots b_1 b_0$$
$$V(B) = b_{n-1} \times 2^{n-1} + b_{n-2} \times 2^{n-2} + \cdots + b_1 \times 2^1 + b_0 \times 2^0$$

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Binary Numbers

$$B = 1101$$
$$V(B) = 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$$
$$(1101)_2 = (13)_{10}$$

- In a binary number the right most bit is called least-significant bit (LSB)
- The left most bit is called the most significant bit (MSB)
- A group of four bits: nibble
- A group of eight bits: byte

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Conversion between Decimal and Binary

- Converting a decimal number into a binary number: successively divide the decimal number by 2.

$$V = b_{n-1} \times 2^{n-1} + b_{n-2} \times 2^{n-2} + \cdots + b_1 \times 2^1 + b_0 \times 2^0$$
$$\frac{V}{2} = b_{n-1} \times 2^{n-2} + b_{n-2} \times 2^{n-3} + \cdots + b_1 + \frac{b_0}{2}$$

- Do an example on the board

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