DSA Study Notes Day 6:

Chapter 6: Binary Number System

1. Number Systems Overview

- **Decimal Number System (Base 10):**
  - Contains **10 digits (0-9)**.
  - This is the number system humans commonly use.
- **Binary Number System (Base 2):**
  - Contains **2 digits (0, 1)**.
  - This is the number system used by computers, where all data is represented in binary (0s and 1s).
- **Hexadecimal Number System (Base 16):**
  - Contains **16 digits (0-9, A-F)**.
  - Commonly used in computing as a more compact way to represent binary values.
- **Octal Number System (Base 8):**
  - Contains **8 digits (0-7)**.

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2. Binary Number System

- A binary number consists only of **0s and 1s**.
  - **Example:** `1101001` is a binary number, while `1234` is a decimal number.

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3. Decimal to Binary Conversion

To convert a decimal number into binary, perform repeated division by 2 and record the remainders:

Example: Convert decimal 42 to binary:

1. Divide 42 by 2 → **quotient = 21, remainder = 0**
2. Divide 21 by 2 → **quotient = 10, remainder = 1**
3. Divide 10 by 2 → **quotient = 5, remainder = 0**
4. Divide 5 by 2 → **quotient = 2, remainder = 1**
5. Divide 2 by 2 → **quotient = 1, remainder = 0**
6. Divide 1 by 2 → **quotient = 0, remainder = 1**

Reading the remainders from bottom to top, $\mathbf{(42)_{10} = (101010)_2}$.

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4. Binary to Decimal Conversion

To convert a binary number into decimal, multiply each binary digit by 2 raised to the power of its position (starting from 0) and sum the results.

Example: Convert binary `101010` to decimal:

1. 1×25=321 \times 2^5 = 321×25=32
2. 0×24=00 \times 2^4 = 00×24=0
3. 1×23=81 \times 2^3 = 81×23=8
4. 0×22=00 \times 2^2 = 00×22=0
5. 1×21=21 \times 2^1 = 21×21=2
6. 0×20=00 \times 2^0 = 00×20=0

Summing the values: 32+0+8+0+2+0=4232 + 0 + 8 + 0 + 2 + 0 = 4232+0+8+0+2+0=42.

Thus, **$(101010)_2 = (42)_{10}$.**

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5. Common Binary Conversions

Here are some common decimal numbers and their binary equivalents:

Decimal	Binary
0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010

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6. Binary Conversion Example

Example: Convert decimal 36 to binary.

Write the binary digits corresponding to powers of 2:

1. 1×25=321 \times 2^5 = 321×25=32
2. 0×24=00 \times 2^4 = 00×24=0
3. 0×23=00 \times 2^3 = 00×23=0
4. 1×22=41 \times 2^2 = 41×22=4
5. 0×21=00 \times 2^1 = 00×21=0
6. 0×20=00 \times 2^0 = 00×20=0

Thus, the binary representation of 36 is **100100**.

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7. Two's Complement

- **Two's Complement** is used to represent negative numbers in binary.

Steps to Find Two's Complement:

1. **Step 1:** Convert the number to its binary form.
2. **Step 2:** Invert the digits (change 0 to 1 and 1 to 0).
3. **Step 3:** Add 1 to the inverted number to get the two's complement.

Example: Convert -10 to binary (two's complement).

1. **Step 1:** Write the binary form of 10 → **1010**.
2. **Step 2:** Invert the digits → **0101**.
3. **Step 3:** Add 1 to the result → **0101 + 1 = 0110**.

Thus, the two's complement of -10 is **0110**.

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8. Two's Complement Example

Question: Convert -8 to binary (two's complement).

1. **Step 1:** Binary of 8 → **1000**.
2. **Step 2:** Invert the digits → **0111**.
3. **Step 3:** Add 1 → **0111 + 1 = 1000**.

Thus, the two's complement of -8 is **1000**.

HomeWork: Two's Complement of -12

Follow the same steps to find the two's complement of -12:

1. **Step 1:** Binary of 12 → **1100**.
2. **Step 2:** Invert the digits → **0011**.
3. **Step 3:** Add 1 → **0011 + 1 = 0100**.

Thus, the two's complement of -12 is **0100**.

Day 6 Notes

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