Number System Part 2

Number Bases:

1. **Decimal System (Base 10)**:
2.
   - Definition: The decimal system uses 10 digits (0-9) to represent numbers. Each position in a decimal number represents a power of 10.
   - Example: 365 = (3 * 10^2) + (6 * 10^1) + (5 * 10^0)
3. **Binary System (Base 2)**:
4.
   - Definition: The binary system uses 2 digits (0 and 1) to represent numbers. Each position in a binary number represents a power of 2.
   - Example: 1011_2 = (1 * 2^3) + (0 * 2^2) + (1 * 2^1) + (1 * 2^0) = 11_{10}
5. **Octal System (Base 8)**:
6.
   - Definition: The octal system uses 8 digits (0-7) to represent numbers. Each position in an octal number represents a power of 8.
   - Example: 64_8 = (6 * 8^1) + (4 * 8^0) = 52_{10}
7. **Hexadecimal System (Base 16)**:
8.
   - Definition: The hexadecimal system uses 16 digits (0-9, A-F) to represent numbers. Each position in a hexadecimal number represents a power of 16.
   - Example: AB_{16} = (10 * 16^1) + (11 * 16^0) = 171_{10}

Converting Between Number Bases:

1. **Decimal to Binary**:
2.
   - Divide the decimal number by 2 repeatedly, noting the remainders from each division.
   - Example: Convert 13_{10} to binary: 132=6 remainder 1_{213}=6 remainder 1, 62=3 remainder 0_{26}=3 remainder 0, 32=1 remainder 1_{23}=1 remainder 1, 12=0 remainder 1_{21}=0 remainder 1.
   - Answer: 13_{10} = 1101_2
3. **Binary to Decimal**:
4.
   - Multiply each digit of the binary number by the corresponding power of 2 and add the results.

- Example: Convert 10111_2 to decimal: (1* 24)+(0* 23)+(1* 22)+(1* 21)+(1* 20)$(1* 2_4)+(0* 2_3)+(1* 2_2)+(1* 2_1)+(1* 2_0)$.
- Answer: $10111_2 = 23_{10}$

5.

Decimal to Octal and Hexadecimal:

6.

- Follow a similar process to decimal to binary conversion, using the desired base.
- Example: Convert 42_{10} to octal: 428=5 remainder 2_{842}=5 remainder 2, 58=0 remainder 5_{85}=0 remainder 5.
- Answer: $42_{10} = 52_8$

7.

Octal and Hexadecimal to Decimal:

8.

- Multiply each digit of the number by the corresponding power of the base and add the results.
- Example: Convert $B3_{16}$ to decimal: (11* 161)+(3* 160)$(11* 16_1)+(3* 16_0)$.
- Answer: $B3_{16} = 179_{10}$

Applications of Different Number Bases:

- **Computing**: Binary numbers are used extensively in computer science and digital electronics for representing data and performing arithmetic operations.
- **Programming**: Hexadecimal numbers are commonly used in programming languages and computer systems for representing memory addresses and binary data more concisely.
- **Cryptocurrency**: Blockchain technology often employs hexadecimal numbers for encoding cryptographic keys and addresses.

Conclusion:

Understanding different number bases expands our mathematical toolkit and is essential in various fields, including computer science, engineering, and cryptography. Being able to convert between number bases allows for efficient communication and computation across different systems and applications. Whether working with decimal, binary, octal, or hexadecimal numbers, the principles of number representation and conversion remain fundamental in modern technology and mathematics.