**Process Documentation: Number System Conversions**

**1. Decimal ↔ Binary**

* **Decimal → Binary:**
  1. Divide the decimal number repeatedly by 2.
  2. Record the remainders.
  3. Write the remainders in reverse order (last remainder = most significant bit).
  4. *Example:* 25 ÷ 2 = 12 remainder **1**, → ÷2 = 6 remainder **0**, → ÷2 = 3 remainder **0**, → ÷2 = 1 remainder **1**, → ÷2 = 0 remainder **1** → **11001**.
* **Binary → Decimal:**
  1. Multiply each binary digit by 2 raised to its positional power (from right, starting at 0).
  2. Sum all results.
  3. *Example:* 11001 = (1×2⁴) + (1×2³) + (0×2²) + (0×2¹) + (1×2⁰) = 16 + 8 + 1 = **25**.

**2. Decimal ↔ Octal**

* **Decimal → Octal:**
  1. Divide decimal number repeatedly by 8.
  2. Record remainders.
  3. Write remainders in reverse order.
  4. *Example:* 125 ÷ 8 = 15 remainder **5**, → ÷8 = 1 remainder **7**, → ÷8 = 0 remainder **1** → **175**.
* **Octal → Decimal:**
  1. Multiply each octal digit by 8 raised to its positional power.
  2. Sum results.
  3. *Example:* 175 = (1×8²) + (7×8¹) + (5×8⁰) = 64 + 56 + 5 = **125**.

**3. Decimal ↔ Hexadecimal**

* **Decimal → Hexadecimal:**
  1. Divide decimal number repeatedly by 16.
  2. Record remainders (10–15 → A–F).
  3. Write remainders in reverse order.
  4. *Example:* 255 ÷ 16 = 15 remainder **15 (F)**, → ÷16 = 0 remainder **15 (F)** → **FF**.
* **Hexadecimal → Decimal:**
  1. Multiply each hex digit by 16 raised to its positional power.
  2. Convert letters (A=10 … F=15).
  3. Sum results.
  4. *Example:* FF = (15×16¹) + (15×16⁰) = 240 + 15 = **255**.

**4. Binary ↔ Octal**

* Conversion is easier through **Decimal as an intermediate** OR by grouping bits:
  + 1 octal digit = exactly 3 binary bits.
* **Binary → Octal:** Group binary digits in threes from right.
  + *Example:* 110101 (binary) → group as 110 101 → (6)(5) = **65 (octal)**.
* **Octal → Binary:** Convert each digit into its 3-bit binary form.
  + *Example:* 65 (octal) → (6=110)(5=101) → **110101 (binary)**.

**5. Binary ↔ Hexadecimal**

* Grouping:
  + 1 hex digit = 4 binary bits.
* **Binary → Hex:** Group in fours from right, convert to hex digits.
  + *Example:* 11010111 → group 1101 0111 → D7 (hex).
* **Hex → Binary:** Expand each hex digit into 4-bit binary.
  + *Example:* D7 → (D=1101)(7=0111) → **11010111**.

**6. Octal ↔ Hexadecimal**

* -Convert **Octal → Decimal → Hex** OR **Octal → Binary → Hex**.
* *Example:*
  + Octal 175 → Decimal = 125 → Hex = **7D**.
  + OR: Octal 175 = (1=001)(7=111)(5=101) binary = 001111101 = group → 0111 1101 = **7D**.