Conversion between various number systems

- **Binary-to-Hexadecimal Conversion**
- Simply break the binary number into 4-bit groups, starting at the right-most bit and replace each 4-bit group with the equivalent hexadecimal symbol as in the following example.
- Convert the binary number to hexadecimal:
- 1100101001010111
- Solution:
- 1100 1010 0101 0111

  ↓ ↓ ↓ ↓
- C A 5 7 = CA57

Hexadecimal-to-Decimal Conversion

- One way to find the decimal equivalent of a hexadecimal number is to first convert the hexadecimal number to binary and then convert from binary to decimal.
- Convert the hexadecimal number 1C to decimal:

  1 C
- 0001 1100 $= 2^4 + 2^3 + 2^2 = 16 + 8 + 4 = (28)_D$

Decimal-to-Hexadecimal Conversion

- Repeated division of a decimal number by 16 will produce the equivalent hexadecimal number, formed by the remainders of the divisions. The first remainder produced is the least significant digit (LSD). Each successive division by 16 yields a remainder that becomes a digit in the equivalent hexadecimal number. When a quotient has a fractional part, the fractional part is multiplied by the divisor to get the remainder.

- Convert the decimal number 650 to hexadecimal by repeated division by 16.

Number		Q	R
650 / 16	⟶	40	10 = A (LSD)
40 / 16	⟶	2	8
2 / 16	⟶	0	2 (MSD)

- The hexadecimal number is 28A

Octal Numbers

- Like the hexadecimal system, the octal system provides a convenient way to express binary numbers and codes.
- However, it is used less frequently than hexadecimal in conjunction with computers and microprocessors to express binary quantities for input and output purposes.
- The octal system is composed of eight digits, which are:
- 0, 1, 2, 3, 4, 5, 6, 7
- To count above 7, begin another column and start over:
- 10, 11, 12, 13, 14, 15, 16, 17, 20, 21 and so on.
- Counting in octal is similar to counting in decimal, except that the digits 8 and 9 are not used.

Octal-to-Decimal Conversion

- Since the octal number system has a base of eight, each successive digit position is an increasing power of eight, beginning in the right-most column with 8^o. The evaluation of an octal number in terms of its decimal equivalent is accomplished by multiplying each digit by its weight and summing the products.
- Let's convert octal number 2374 in decimal number.
- Weight 8^3 8^2 8^1 8^o
- Octal number 2 3 7 4
- $2374 = (2 \times 8^3) + (3 \times 8^2) + (7 \times 8^1) + (4 \times 8^o)$
- $= (1276)_{10}$

Decimal-to-Octal Conversion

- A method of converting a decimal number to an octal number is the repeated division-by-8 method, which is similar to the method used in the conversion of decimal numbers to binary or to hexadecimal.
- Let's convert the decimal number 359 to octal. Each successive division by 8 yields a remainder that becomes a digit in the equivalent octal number. The first remainder generated is the least significant digit (LSD).

Number		Q	R
$\frac{359}{8}$	→	44	7 (LSD)
$\frac{44}{8}$	→	5	4
$\frac{5}{8}$	→	0	5 (MSD)

- The number is $(547)_8$.

Octal-to-Binary Conversion

- Because each octal digit can be represented by a 3-bit binary number, it is very easy to convert from octal to binary..
- Octal/Binary Conversion
- Octal Digit 0 1 2 3 4 5 6 7
- Binary 000 001 010 011 100 101 110 111

Let's convert the octal numbers 25 and 140.

2	5		1	4	0
010	101		001	100	000

Binary-to-Octal Conversion

- Conversion of a binary number to an octal number is the reverse of the octal-to-binary conversion.
- Let's convert the following binary numbers to octal:

$$\underline{1\,1\,0}\ \ \underline{1\,0\,1} \qquad\qquad \underline{1\,0\,1}\ \ \underline{1\,1\,1}\ \ \underline{0\,0\,1}$$

$$6\quad 5 \;=\; (65)_D \qquad 5\quad 7\quad 1 \;=\; (571)_D$$