Section 1.4: Octal and Hexadecimal

Key Concepts

- Octal (base-8) and hexadecimal (base-16) systems are widely used in digital systems because they provide a compact representation of binary numbers.
- Each octal digit corresponds to **3 binary digits**, and each hexadecimal digit corresponds to **4 binary digits**.
- Conversion between binary, octal, and hexadecimal is straightforward due to the direct relationship between their bases.

Binary to Octal Conversion

- Partition the binary number into groups of **3 digits** (starting from the binary point).
- Convert each group to its corresponding octal digit.
- Example:

$$(10\,110\,001\,101\,011.\,111\,100\,000\,110)_2 = (26153.7406)_8$$

Binary to Hexadecimal Conversion

- Partition the binary number into groups of **4 digits** (starting from the binary point).
- Convert each group to its corresponding hexadecimal digit.
- Example:

$$(10\,1100\,0110\,1011.\,1111\,0010)_2 = (2C6B.F2)_{16}$$

Octal/Hexadecimal to Binary Conversion

- Convert each octal digit to its **3-digit binary equivalent**.
- Convert each hexadecimal digit to its **4-digit binary equivalent**.
- Examples:

– Octal to Binary:

$$(673.124)_8 = (110\,111\,011.\,001\,010\,100)_2$$

– Hexadecimal to Binary:

$$(306.D)_{16} = (0011\,0000\,0110.\,1101)_2$$

Advantages of Octal and Hexadecimal

- Binary numbers are long and difficult to work with, but octal and hexadecimal provide a compact representation.
- Example: The binary number 111111111111 (12 digits) can be represented as:
  - Octal: 7777 (4 digits)
  - Hexadecimal: FFF (3 digits)
- Hexadecimal is particularly useful for representing bytes (8 bits) with just 2 digits.

Table of Numbers with Different Bases

Decimal (base 10)	**Binary (base 2)**	**Octal (base 8)**	**Hexadecimal (base 16)**
0	0000	00	0
1	0001	01	1
2	0010	02	2
3	0011	03	3
4	0100	04	4
5	0101	05	5
6	0110	06	6
7	0111	07	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F

Table 1: Numbers with Different Bases