CHAPTER-2
ENCODING SYSTEM AND NUMBER SYSTEM

INTRODUCTION

- In general term computer represent information in different types of data forms i.e. number , character, picture ,audio , video etc.
- Computers are made of a series of switches/ gates. Each switch has two states: ON(1) or OFF(0).That's why computer works on the basis of binary number system(0/1).But for different purpose different number systems are used in computer world to represent information. E.g.
  Octal, Decimal, Hexadecimal.

NUMBER SYSTEM		
SYSTEM	BASE	DIGIT
Binary	2	0 1
Octal	8	0 1 2 3 4 5 6 7
Decimal	10	0 1 2 3 4 5 6 7 8 9
Hexadecimal	16	0 1 2 3 4 5 6 7 8 9 A B C D E F

By: Vijeta Vashisth

Decimal Number System

- The decimal number system is used by us in our day-to day life. It is known as base-10 system since 10 digits (0 to 9) are used. A number is presented by its two values — symbol value (any digit from 0 to 9) and positional value (in terms of base value).

Digit	1	2	3	.	4	5
Position Number	2	1	0		–1	–2
Positional Value	$(10)^2$	$(10)^1$	$(10)^0$		$(10)^{-1}$	$(10)^{-2}$

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Binary Number System

Characteristic:

- Two symbols – 0 and 1.
- Most (digital) computers use the binary number system
  Why?
  Computers are made of a series of switches/ gates. Each switch has two states: ON(1) or OFF(0).That's why computer works on the basis of binary number system(0/1).

Decimal	Binary
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001

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Binary – Decimal Conversion

Q) Convert 1011_2 into decimal equivalent?

place values:	2^3	2^2	2^1	2^0
binary:	1	0	1	1
conversion:	1×2^3	0×2^2	1×2^1	1×2^0
decimal:	8	0	2	1

= 11 (ANS)

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PRACTICE TIME:

- Convert $(1100011)_2$ into equivalent decimal?
- Convert $(111000)_2$ into equivalent decimal?
- Convert $(111.10)_2$ into equivalent decimal?
- Convert $(101.101)_2$ into equivalent decimal?

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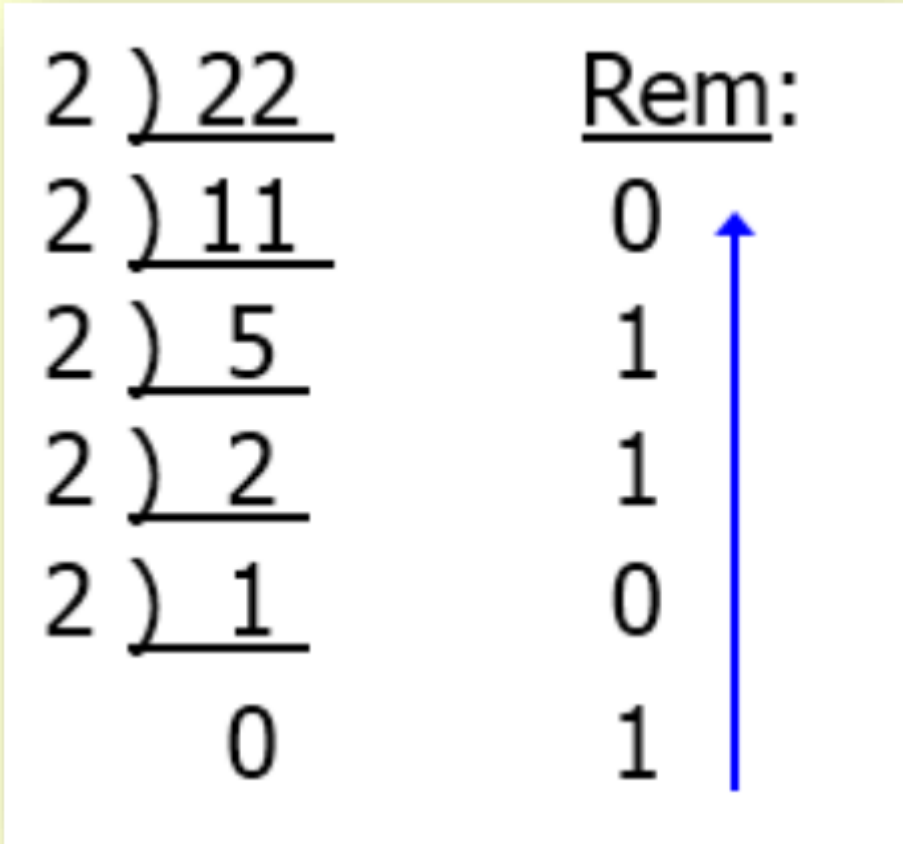
Decimal-Binary Conversion

- **Using the Division Method:**
  Divide decimal number by 2 until you reach zero, and then collect the remainders in reverse.

Example: $(22)_{10} = (10110)_2$



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Decimal-Binary Conversion

- Convert $(0.25)_{10}$ to binary.

	Integer part
$0.25 \times 2 = 0.50$	0
$0.50 \times 2 = 1.00$	1

$= (0.25)_{10} = (0.01)_2$

- Convert $(0.675)_{10}$ to binary.

	Integer part
$0.675 \times 2 = 1.350$	1
$0.350 \times 2 = 0.700$	0
$0.700 \times 2 = 1.400$	1
$0.400 \times 2 = 0.800$	0
$0.800 \times 2 = 1.600$	1
$0.600 \times 2 = 1.200$	1
$0.200 \times 2 = 0.400$	0

$= (0.675)_{10} = (0.1010110)_2$

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Practice time:

- Convert $(546)_{10}$ into binary equivalent?
- Convert $(26.17)_{10}$ into binary equivalent?
- Convert $(234)_{10}$ into binary equivalent?
- Convert $(389.234)_{10}$ into binary equivalent?

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Octal Number System

Characteristics:

- eight symbols
- 0 1 2 3 4 5 6 7

Computer programmers often use the octal number system, Why?
Octal and hex use the human advantage that they can work with lots of symbols while it is still easily convertible back and forth between binary.

Octal Digit	Decimal Value	3 -bit Binary Number
0	0	000
1	1	001
2	2	010
3	3	011
4	4	100
5	5	101
6	6	110
7	7	111

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Octal to decimal conversion

Q) Convert 357_8 into decimal equivalent?

place values:	8^2	8^1	8^0
octal:	3	5	7
conversion:	3×8^2	5×8^1	7×8^0
decimal:	192	40	7

= 239 (ANS)

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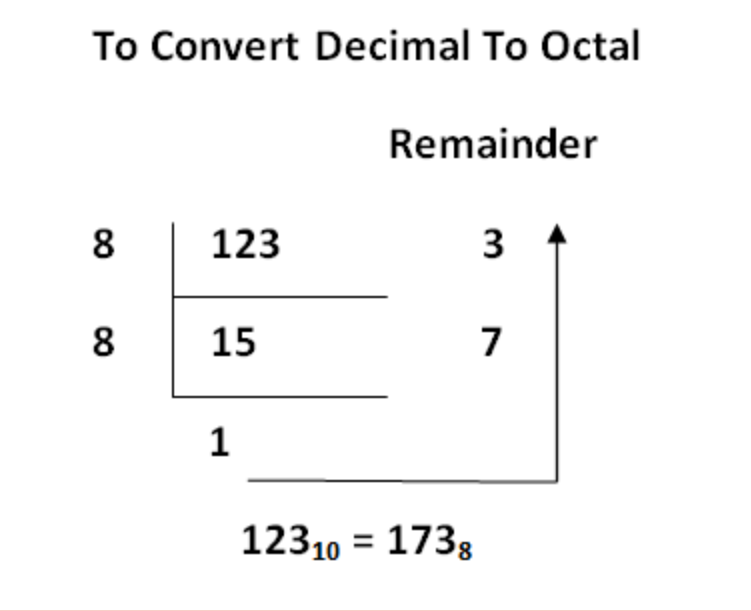
Decimal to octal

- **Using the Division Method:**
- Example:



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Practice time

- Convert $(456)_8$ into decimal equivalent?
- Convert $(1261)_8$ into decimal equivalent?
- Convert $(200)_{10}$ into octal equivalent?
- Convert $(789)_{10}$ into octal equivalent?

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Binary to Octal

- Given a binary number, an equivalent octal number represented by 3 bits is computed by grouping 3 bits from right to left and replacing each 3-bit group by the corresponding octal digit.

- Example: Convert $(10101100)_2$ to octal number.
  Make group of 3 bits: $\underline{010}$ $\underline{101}$ $\underline{100}$
  Binary equivalent: 2 5 4

$$(10101100)_2 = (254)_8$$

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Octal to binary

- Each octal digit is an encoding for a 3-digit binary number. Octal number is converted to binary by replacing each octal digit by a group of three binary digits.
- Example: Convert $(705)_8$ to binary number.

octal digits:	7	0	5
its binary:	111	000	101

$(705)_8 = (111000101)_2$

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Hexadecimal Number System

Characteristics:

- sixteen symbols
- 0 1 2 3 4 5 6 7 8 9 A B C D E F

- Computer programmers often use the hexadecimal number system,Why? Computers only work on the binary number system. The hexadecimal number system is commonly used to describe locations in computer memory. They are also used in assembly language instructions.

Hexadecimal Symbol	Decimal Value	4-bit Binary Number
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
A	10	1010
B	11	1011
C	12	1100
D	13	1101
E	14	1110
F	15	1111

not to be

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Application of hexadecimal numbers

- Hexadecimal Number System is commonly used in Computer programming and Microprocessors.
- It is also helpful to describe colors on web pages. Each of the three primary colors (i.e., red, green and blue) is represented by two hexadecimal digits to create 255 possible values, thus resulting in more than 16 million possible colors.
- Hexadecimal number system is used to describe locations in memory for every byte.
- These hexadecimal numbers are also easier to read and write than binary or decimal numbers for Computer Professionals.

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HEXADECIMAL TO DECIMAL

Q) Convert 57_{16} into decimal equivalent?

place values:	16^1	16^0
hexadecimal:	5	7
conversion:	5×16^1	7×16^0
decimal:	80	7

= 87 (ANS)

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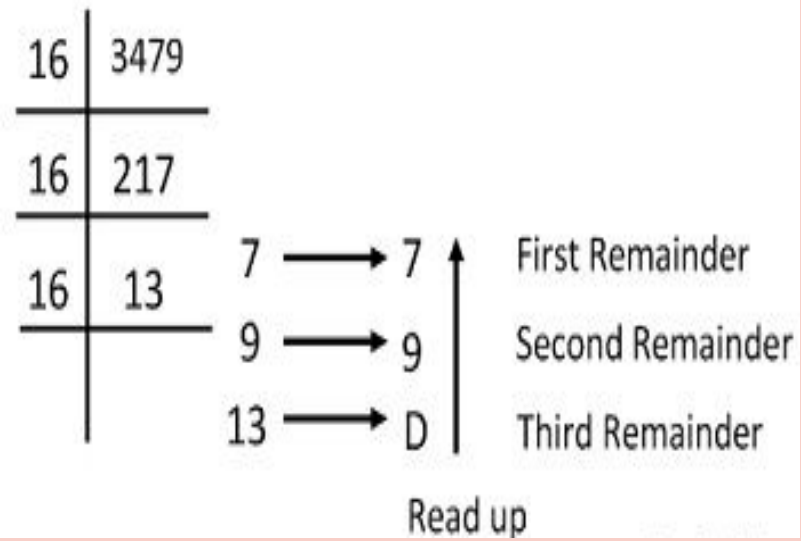
Decimal to hexadecimal

- **Using the Division Method:**

- Example:



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Binary to hexadecimal

- Given a binary number, an equivalent hexadecimal number represented by 4 bits is computed by grouping 4 bits from right to left and replacing each 4-bit group by the corresponding octal digit.

- Example: Convert $(10101100)_2$ to octal number.
  Make group of 4 bits: 0110 1100
  Binary equivalent: 6 C

$$(10101100)_2 = (6C)_{16}$$

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Hexadecimal to Binary

- Each hexadecimal digit is an encoding for a 4-digit binary number. hexadecimal number is converted to binary by replacing each hexa digit by a group of four binary digits.
- Example: Convert $(23D)_{16}$ to binary number.

Hex digits:	2	3	D
its binary:	0010	0011	1101

$(23D)_{16} = (001000111101)_2$

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ENCODING SYSTEM

- What do we mean by **cipher**?

Cipher means something converted to a coded form to hide/conceal it from others. It is also called encryption (converted to cipher) and sent to the receiver who in turn can decrypt it to get back the actual content.

- **Encoding:**

The mechanism of converting data into an equivalent cipher using specific code is called encoding. Some of the well-known encoding schemes are:

- **American Standard Code for Information Interchange (ASCII):** was developed for standardizing the character representation. ASCII is still the most commonly used coding scheme. It is a 7-bit code. Its 8th bit is unused (or used for a parity bit).
- Two general types of codes:

95 are “Graphic” codes (displayable on a console)
33 are “Control” codes (control features of the console or communications channel)

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Table 2.1 ASCII code for some printable characters

Character	Decimal Value	Character	Decimal Value	Character	Decimal Value
Space	32	@	64	`	96
!	33	A	65	a	97
”	34	B	66	b	98
#	35	C	67	c	99
$	36	D	68	d	100
%	37	E	69	e	101
&	38	F	70	f	102
‘	39	G	71	g	103
(	40	H	72	h	104
)	41	I	73	i	105

not to be

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Q) Encode the word DATA and convert the encoded value into binary values which can be understood by a computer.

- ASCII value of D is 68 and its equivalent 7-bit binary code = 1000100
- ASCII value of A is 65 and its equivalent 7-bit binary code = 1000001
- ASCII value of T is 84 and its equivalent 7-bit binary code = 1010100
- ASCII value of A is 65 and its equivalent 7-bit binary code = 1000001

ENCODING (CONTD.)

- **Indian Script Code for Information Interchange (ISCII)** : ISCII was developed in India during mid 1980s. It is an 8-bit code representation for Indian languages which means it can represent 28=256 characters. It retains all 128 ASCII codes and uses rest of the codes (128) for additional Indian language character set. These codes are used for 10 Indian scripts- Devanagri, Punjabi, Gujrati, Udia, Bengali, Asami, Telgu, Kannad, Malayalam and Tamil.

  UNICODE: It is a worldwide character-encoding standard .Its main objective is to enable a single, unique character set that is capable of supporting all characters from all scripts, as well as symbols, that are commonly utilized for computer processing throughout the world.

Q A session

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