Digital Logic Design (CSNB163)

Module 1

Number Systems

- Number system consists of an ordered set of symbols called digit.
- The **radix (r)** or **base** is the total number of digits allowed in the system.
- Common number systems includes
  - **decimal (r = 10)** {0,1,2,3,4,5,6,7,8,9}
  - **binary (r = 2)** {0,1}
  - **octal (r =8)** {0,1,2,3,4,5,6,7}
  - **hexadecimal (r = 16)** {0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F}

Number Representations

- A number may appear in 2 parts:
  - **integer part**
  - **fractional part**

which are separated by radix point (.).

- Numbers can be represented in 2 notations:
  - **Position notation**

123.45

  - **Polynomial notation**

$1x10^{2} + 2x10^{1} + 3x10^{0} + 4x10^{-1} + 5x10^{-2}$

Arithmetic Operation

- Arithmetic operations can be performed on numbers regardless of their radixes.
- Common arithmetic operation includes:
  - Addition (+)
  - Subtraction (-)
  - Multiplication (×)
  - Division (÷)

Decimal
Binary
Octal
Hexadecimal

Arithmetic Operation (Addition)

- Decimal

$$1234_{10} + 4567_{10} = 5801_{10}$$

- Octal

$$2322_{8} + 10727_{8} = 13251_{8}$$

- Binary

$$10011010010_{2} + 1000111010111_{2} = 1011010101001_{2}$$

- Hexadecimal

$$4D2_{16} + 11D7_{16} = 16A9_{16}$$

Arithmetic Operation (Subtraction)

- Decimal

4567_{10}

$-\ 1234_{10}$

3333_{10}

- Octal

10727_{8}

$-\ 2322_{8}$

6405_{8}

- Binary

1000111010111_{2}

$-\ 10011010010_{2}$

$1101000001 01_{2}$

- Hexadecimal

$11D7_{16}$

$-\ 4D2_{16}$

$D05_{16}$

Arithmetic Operation (Multiplication)

- Decimal

$$4567_{10} \times 2_{10} = 9134_{10}$$

- Octal

$$10727_{8} \times 2_{8} = 21656_{8}$$

- Binary

$$1000111010111_{2} \times 10_{2} = 10001110101110_{2}$$

- Hexadecimal

$$11D7_{16} \times 2_{16} = 23AE_{16}$$

Arithmetic Operation (Division)

- Decimal

1234_{10}

$\div \quad 2_{10}$

617_{10}

- Octal

2322_{8}

$\div \quad 2_{8}$

1151_{8}

- Binary

10011010010_{2}

$\div \quad 10_{2}$

1001101001_{2}

- Hexadecimal

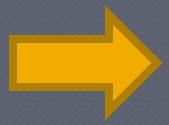
$4D2_{16}$

$\div \quad 2_{16}$

269_{16}

Number Base Conversion

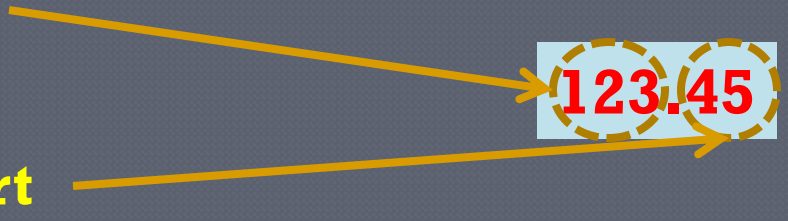
- To convert a number in one base to another.
- May involve conversion of fractional parts.

Decimal Binary Octal Hexadecimal		Decimal Binary Octal Hexadecimal

- There are many conversion techniques, however we shall concentrate on:
  - **Radix based conversion**
  - **Grouping based conversion**

Radix Based Conversion

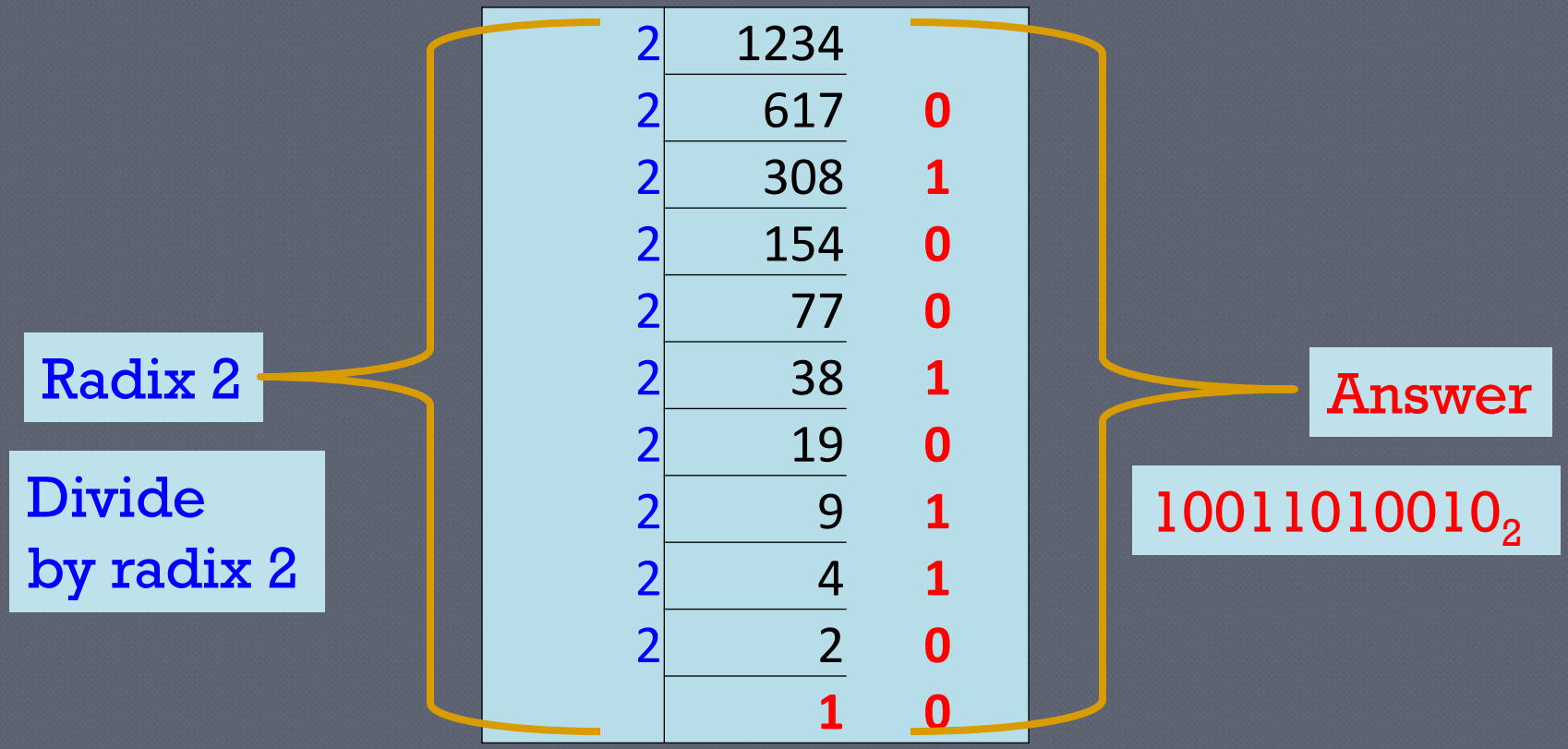
- Recaps: A number may appear in 2 parts:
  - **integer part**
  - **fractional part**



  which are separated by radix point (.).
- For radix based conversion:
  - integer part **– divide by radix**
  - fractional part **– multiply by radix**

Radix Based Conversion (Example1)

- Convert 1234 decimal into binary



Radix Based Conversion (Example2)

- Convert 1234 decimal into octal

Radix 8

Divide by radix 8

8	1234	
8	154	2
8	19	2
	2	3

Answer

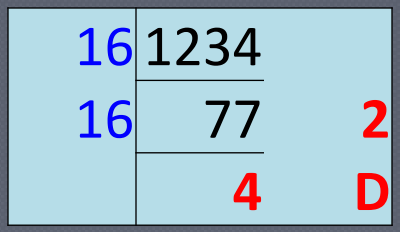
2322_8

Radix Based Conversion (Example3)

- Convert 1234 decimal into hexadecimal

Radix 16

Divide by radix 16



Answer

$4D2_{16}$

Radix Based Conversion (Example4)

- Convert 0.6875 decimal into binary

Radix 2

Multiply by radix 2

Fraction	Radix	Total (Fraction x Radix)	Integer	Fraction
0.6875	2	1.375	1	0.375
0.375	2	0.75	0	0.75
0.75	2	1.5	1	0.5
0.5	2	1	1	0

Answer

0.1011_2

Radix Based Conversion (Example5)

- Convert 0.513_{10} to base 16 (up to 4 fractional point)

Radix 16

Multiply by radix 16

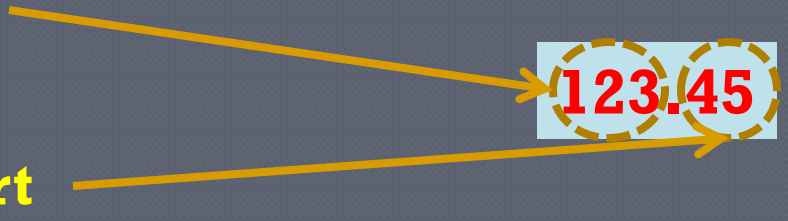
Fraction	Radix	Total (Fraction x Radix)	Integer	Fraction
0.513	16	8.208	8	0.208
0.208	16	3.328	3	0.328
0.328	16	5.248	5	0.248
0.248	16	3.968	3	0.968

Answer

0.8353_{16}

Grouping Based Conversion

- Recaps: A number may appear in 2 parts:
  - **integer part**
  - **fractional part**



  which are separated by radix point (.).
- For radix based conversion:
  - integer part **– divide by radix**
  - fractional part **– multiply by radix**

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End of Module 1