

ACOL 215

(03 Sept. 2025)

## Number systems

→ Binary, Octal, Decimal,  
Hexadecimal

$$(B65F)_{16} = (1011011001011111)_2$$

$$\begin{array}{ccccccc} (1 & 1 & 0 & 1 & 0 & 1) & \\ \downarrow & \downarrow & & \downarrow & & & \\ 2^5 & 2^4 & 2^3 & 2^2 & 2^1 & 2^0 & \end{array} \quad \begin{array}{l} = 32 + 16 + 4 + 1 \\ = (53)_{10} \end{array}$$

Electrical signals  $\rightarrow$  bits  $\rightarrow 0, 1$

Groups of bits  $\rightarrow$  represent information

1 byte = 8 bits

can encode one keyboard character

$(FF)_{16}$

$$= f \times 16^1 + f \times 16^0$$

0... 255 in decimal  
00 to FF in hexadecimal

$$= 15 \times 16 + 15 = 255$$

Computer memory capacity is usually given in bytes.

(Kilo byte) KB  $2^{10}$  bytes

(Mega byte) MB  $2^{20}$  bytes

(Giga byte) GB  $2^{30}$  bytes

(Tera byte) TB  $2^{40}$  bytes

# Arithmetic operations

Same rules ; but only the  $r$ -allowable digits should be used while operating in base  $r$ .

$$\begin{array}{r} \phantom{+} 1111 \\ 101101 \\ + 100111 \\ \hline 1010100 \end{array}$$

$$\begin{array}{r} \phantom{-} 100001 \\ - 100111 \\ \hline 000110 \\ \phantom{000} \uparrow \end{array}$$

# Number - base conversions

(base-r to decimal)

equivalent

$$(0011)_8$$

=



$$+ 1 \times 8^1 + 1 \times 8^0$$

$$= 9$$

$$(1001)_2$$

$$= 1 \times 2^3$$

+

$$+ \underbrace{0}_0$$

$$+ 1 \times 2^0$$

=

8

+

1

$$= 9$$

# Decimal to binary

$(41)_{10}$

to binary

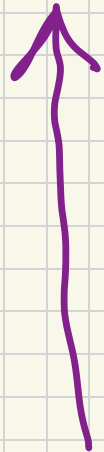
Quotient

$(101001)_2$

Remainder

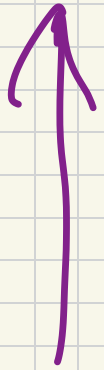
$41/2$	$20$
$\rightarrow 20/2$	$10$
$\rightarrow 10/2$	$5$
$\rightarrow 5/2$	$2$
$\rightarrow 2/2$	$1$
$\rightarrow 1/2$	$0$

1  
0  
0  
1  
0  
1



Convert (153)<sub>10</sub> to Octal

	Quotient	Remainder
153/8	19	1
19/8	2	3
2/8	0	2



(231)<sub>8</sub>

$(0.6875)_{10}$  to binary


$$0.6875 \times 2 = 1.3750$$

$$0.3750 \times 2 = 0.7500$$

$$0.7500 \times 2 = 1.5000$$

$$0.5000 \times 2 = \underline{1.0000}$$

1  
0  
1  
1



$(0.1011)_2$



$$\underline{(41.6875)}_{10}$$

$$(101001.1011)_2$$

Idea: convert the integer and the fraction separately

$$(0.513)_{10}$$

to octal

$$(153.513)_{10}$$

↓ octal

$$(231.4065)_8$$

$$0.513 \times 8$$

=

$$4.104$$

$$0.104 \times 8$$

=

$$0.832$$

0

$$0.832 \times 8$$

=

$$6.656$$

6

$$0.656 \times 8$$

=

$$5.248$$

5

$$0.248 \times 8$$

=

$$1.984$$

1

$$0.984 \times 8 :$$

$$(0.4065)_8$$

up to 4 significant digits

# Complement of numbers

→ radix complement  $r$ 's complement

→ diminished radix complement

$(r-1)$ 's complement

where  $r$  is the radix / base.

binary

2's complement

1's complement

decimal

10's complement

9's complement

Def<sup>n</sup> Given a number  $N$  in base  $r$  having  $n$  digits, the  $(r-1)$ 's complement of  $N$  is defined as

$$(r^n - 1) - N$$

Example

9's complement of

546700

$n=6$

$$\begin{aligned} & (10^6 - 1) - 546700 \\ = & 999999 - 546700 \end{aligned}$$

Another example

1's complement of 1011000 ←

$$(2^n - 1) - \underline{1011000}$$

127

1111111

7 digits  
 $n = 7$

1111111

1011000 ←

0100111

$$\begin{array}{r} 999999 \\ 546700 \leftarrow \\ \hline 453299 \\ \hline \hline \end{array}$$

Radix complement  
Arithmetic operations

Lab  
8th and 9th

In-person class on Monday,  
Sept. 8th.