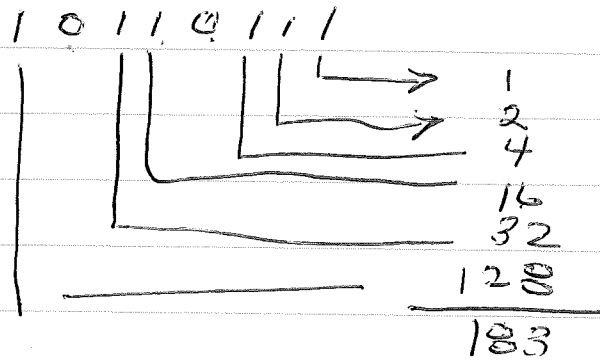


①

# CS 234 Binary Examples.

BIN  $\Rightarrow$  DEC



DEC  $\Rightarrow$  BIN

2 | 183    1  
 2 | 91    1  
 2 | 45    1  
 2 | 22    0  
 2 | 11    1  
 2 | 5    1  
 2 | 2    0  
 2 | 1    1



1 0 1 1 0 1 1 1

check by converting back to dec.

ADDING BINARY

				1
0	0	1	1	1
<u>0</u>	<u>1</u>	<u>0</u>	<u>1</u>	<u>1</u>
0	1	1	1 0	1 1

↑  
make  
carry,

# CS 234 Binary Examples (con'td)

## "2's Complement"

- ① (A is -45) convert to binary (use positive value)

$$\begin{array}{r} 2 \overline{) 45} \quad 1 \\ 2 \overline{) 22} \quad 0 \\ 2 \overline{) 11} \quad 1 \\ 2 \overline{) 5} \quad 1 \\ 2 \overline{) 2} \quad 0 \\ 2 \overline{) 1} \quad 1 \end{array}$$



101101

check if

$$\begin{array}{r} 1 \\ 4 \\ 8 \\ 32 \\ \hline 45 \checkmark \end{array}$$

-A is 00101101

Use 8 bits!

- ② get complement 11010010

- ③ add 1 1

this is A  $\Rightarrow$  11010011

A is 11010011

-A is 00101101

add them

$$1 \overline{) 00000000} \checkmark$$

$\nearrow$   
Answer  
0000

# CS 234 Binary Examples on '2's complement'

① B is 57 convert to binary (in power of 2)

$$\begin{array}{r} 2 \overline{) 57} \quad 1 \\ 2 \overline{) 28} \quad 0 \\ 2 \overline{) 14} \quad 0 \\ 2 \overline{) 7} \quad 1 \\ 2 \overline{) 3} \quad 1 \\ 2 \overline{) 1} \quad 1 \end{array}$$



$$\begin{array}{r} 111001 \\ \begin{array}{l} \text{---} \\ \text{---} \\ \text{---} \\ \text{---} \end{array} \begin{array}{l} 1 \\ 8 \\ 16 \\ 32 \end{array} \\ \hline 57 \quad \checkmark \end{array}$$

B is 00111001

② get complement 11000110

③ add 1  
this is -B → 11000111

$$\begin{array}{r} B \text{ is } 00111001 \\ -B \text{ is } 11000111 \\ \hline \text{add them } 1 \overline{) 00000000} \end{array}$$

throw away

# Binary Examples (cont'd)

## 2's Complement

Do the following with 2's complements.

$$A+B$$

$$A-B$$

$$-A+B$$

$$-A-B$$

(A+B)  $\Rightarrow$  A is 11010011  
B is 00111001

$$\begin{array}{r} 11010011 \\ + 00111001 \\ \hline 00001100 \end{array}$$

from  $\rightarrow$  4  
8  
12

12

45  
+57  
12

12

12

(A-B) A is 11010011  
- B is 11000111

$$\begin{array}{r} 11010011 \\ - 11000111 \\ \hline 00001100 \end{array}$$

from  $\rightarrow$  10001101  
01100101  
+1  
01100110

2  
4  
8  
16  
32  
64  
102

45  
57  
102

102

5

# Binary Examples Cont'd

## 2's comp

$(-A + B)$      $-A$  is     $00101101$     45  
                   $B$  is     $00111001$     57  
                               $01100110$   
                               $\begin{array}{r} \text{---} 2 \\ \text{---} 4 \\ \text{---} 32 \\ \text{---} 64 \\ \hline 102 \end{array}$      $\swarrow$   
   $102 \checkmark$

$(-A - B)$      $-A$  is     $00101101$   
                   $-B$  is     $11000111$   
                               $\hline 11110100$      $+12$   
                               $00001011$      $\text{comp}$   
                                       $+1$      $+1$   
                                       $\hline 1100$   
                                       $\begin{array}{r} \text{---} 4 \\ \text{---} 8 \\ \hline 12 \end{array}$      $\checkmark$