11/10/2021

20XC14 : DIGITAL SYSTEM DESIGN

NUMBER SYSTEMS - WORKSHEET 2

S. VARUN
D21PC35

① a) $(42)_{10} = 00101010_2$

b) -63_{10} = 00 11 11 11

11 0000 00

(+) 1

11 00 0001

$-63_{10} = 11000001_2$

c) $124_{10} = 01111100_2$

d) $-128_{10} = 10000000_2$

e) $133_{10} = 10000101_2$

② a) 00000101_2

b) 11111010_2

③ min : -2^{n-1}

max : $2^{n-1}-1$

For 5 bits,

$-2^{(5-1)} = -2^4 = -16$

$2^{(5-1)}-1 = 2^4-1 = 15$

5 bit 2's complement numbers > 0 = 15

5 bit 2's complement number < 0 = -16

④ No. of rows in the processor = 2^8 bits.

No. of columns in the processor = 2^9 bits.

Total no. of bits = $2^8 \times 2^9 = 2^{17} = 2^{10} \times 2^7$

= 2^7 kilobytes = 128 kilobytes.

Scanned with CamScanner

⑤ a) 10011001 $\Rightarrow 153_{10}$

01000100 $\rightarrow 68_{10}$

11011101 $\rightarrow 221_{10}$

b) 11010010 $\rightarrow 210_{10}$

10110110 $\rightarrow 182_{10}$

1|10001000 Result overflows.

c) 1011011 $\rightarrow$ 91

\- 101110 $\rightarrow$ 46

101101 $\rightarrow$ 45

d) 1001001 $\rightarrow$ 73

\- 10101 $\rightarrow$ 21

0110100 $\rightarrow$ 52

⑥ a) $1001_2 \times 1100_2$ = 1001 × 1100

0000

0000

1001

1001

1101100

= 1101100_2

b) $11011_2 \times 1001_2$

$$
\begin{array}{r}
11011 \times 1001 \\
\hline
11011 \\
000000 \\
00000 \\
11011 \\
\hline
11110011
\end{array}
$$

$= 11110011_2 \rightarrow 243$

c) $101101_2 / 11_2$

$$
\begin{array}{r}
1111 \\
11 \overline{)\,101101} \\
11 \\
\hline
101 \\
11 \\
\hline
100 \\
010 \\
\hline
011 \\
11 \\
\hline
0
\end{array}
$$

$= 1111_2$

d) $111111_2 / 110_2$

$$
\begin{array}{r}
1010.1 \\
110 \overline{)\,111111} \\
110 \\
\hline
111 \\
110 \\
\hline
110 \\
110 \\
\hline
0
\end{array}
$$

$= 1010.1_2$

7 a) $16_{10} + 9_{10}$

$16_{10} = 0\ 1\ 0\ 0\ 0\ 0$

$9_{10} = 0\ 0\ 1\ 0\ 0\ 1$

$0\ 1\ 1\ 0\ 0\ 1_2 = 25_{10}$

b) $27_{10} + 31_{10}$

$27_{10} = 0\ 1\ 1\ 0\ 1\ 1$

$31_{10} = 0\ 1\ 1\ 1\ 1\ 1$

$1\ 1\ 1\ 0\ 1\ 0_2 = 58_{10}$

c) $-4_{10} + 19_{10}$

$4 \Rightarrow 0\ 0\ 0\ 1\ 0\ 0$

$1\ 1\ 1\ 0\ 1\ 1$

1

$-4 \Rightarrow 1\ 1\ 1\ 1\ 0\ 0$

$19_{10} + (-4)_{10}$

$0\ 1\ 0\ 0\ 1\ 1$

$1\ 1\ 1\ 1\ 0\ 0$

$\boxed{1}\ 0\ 0\ 1\ 1\ 1\ 1$

ans : $001111_2 = (15_{10})$

d) $3_{10} + 32_{10}$

$3_{10} = 000011_2$

$32_{10} = 100000_2$

$3_{10} + 32_{10} = 35_{10}$

100011_2

Scanned with CamScanner

8 a) $9_{10} - 7_{10} = 9_{10} + (-7_{10}) =$

$7_{10} = 00111$

11000

1

11001 = -7_{10}

$9_{10} + (-7_{10})$

01001 → 9

11001 → -7

1] 00010 → 4_{10}

b) $12_{10} - 15_{10} = 12_{10} + (-15)_{10}$

$15_{10} = 01111$

10000

1

10001 = -15_{10}

$12_{10} + (-15)_{10}$

01100 → 12

10001 → -15

11101 → -3_{10}

c) $-6_{10} - 11_{10} = -6_{10} + (-11)_{10}$

6_{10} → 00110

11001

1

11010 = -6_{10}

11_{10} → 01011

10100

1

10101 → -11_{10}

$-6_{10} + (-11)_{10}$

11010

10101

1] 0 ~~0~~ 111

As range btw -16 to 15, -17 cannot be represented in a 5 bit 2's complement

d) $4_{10} - 8_{10} = 4_{10} + (-8)_{10}$

$$
\begin{array}{l}
8_{10} \rightarrow 01000 \\
\phantom{8_{10} \rightarrow} 10111 \\
\phantom{8_{10} \rightarrow 1011} 1 \\
\hline
\phantom{8_{10} \rightarrow} 11000 \rightarrow -8_{10}
\end{array}
\qquad
\begin{array}{l}
00100 \\
11000 \\
\hline
11100 \rightarrow -4_{10}
\end{array}
$$

9 a) $3 + (-7)$

$$
\begin{array}{rl}
3 \rightarrow & 0011 \\
+(-7) \rightarrow & 1001 \\
\hline
& 1100 \Rightarrow -4_{10}
\end{array}
\qquad
\begin{array}{rl}
7 \Rightarrow & 0111 \\
& 1000 \\
& 1 \\
\hline
& 1001
\end{array}
$$

b) $-3 + 7$

$$
\begin{array}{rl}
7 \Rightarrow & 0111 \\
-3 \Rightarrow & 1101 \\
\hline
& 1\,]0100 \\
= & 0100
\end{array}
\qquad
\begin{array}{rl}
3 \Rightarrow & 0011 \\
& 1100 \\
& 1 \\
\hline
& 1101 \Rightarrow -3
\end{array}
$$

c) $11 + (-11)$

$$
\begin{array}{rl}
11 \Rightarrow & 01011 \\
-11 \Rightarrow & 10101 \\
\hline
& 1\,]00000
\end{array}
\qquad
\begin{array}{rl}
11 \Rightarrow & 01011 \\
& 10100 \\
& 1 \\
\hline
& 10101 \Rightarrow -11
\end{array}
$$

$11 + (-11) = 0.$

d) $18-(-3) = 18+3$

$18 \Rightarrow 1\,0\,0\,1\,0$

$3 \rightarrow 0\,0\,0\,1\,1$

$\underline{1\,0\,1\,0\,1} \Rightarrow 21$

(10) I disagree with both Ben and Alyssa;

Ben: All integers divisible by 6 have exactly 2 1's in their binary.

But,

30 = 011110

It has 4 1's in their binary.

Alyssa: All integers divisible by 6 have an even number of 1's in their binary.

But,

42 = 101010

It has 3 1's in their binary.