Digital Systems - Homework 05 - Group 5

Group members

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Problem 1. Add the following decimal numbers after converting each to its BCD code.

Decimal	BCD
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001

(a) $74 + 23$

- Converting to BCD:
  - $74 = 0111\ 0100$
  - $23 = 0010\ 0011$
- Adding:

$$\begin{array}{r} 0111\ 0100 \\ +\ 0010\ 0011 \\ \hline 1001\ 0111 \end{array}$$

- Converting result back to decimal: $1001\ 0111 = 97$.

(b) $58 + 37$

- Converting to BCD:
  - $58 = 0101\ 1000$
  - $37 = 0011\ 0111$
- Adding:

$$\begin{array}{r} 0101\ 1000 \\ +0011\ 0111 \\ \hline 1000\ 1111 \\ +\ 0110 \\ \hline 1001\ 0101 \end{array}$$

- Converting result back to decimal: $1001\ 0101 = 95$.

(c) $147 + 380$

- Converting to BCD:
  - $147 = 0001\ 0100\ 0111$
  - $380 = 0011\ 1000\ 0000$

- Adding:

$$\begin{array}{r} 0001\ 0100\ 0111 \\ +0011\ 1000\ 0000 \\ \hline 0100\ 1100\ 0111 \\ +\ 0110\ 0000 \\ \hline 0101\ 0010\ 0111 \end{array}$$

- Converting result back to decimal: 0101 0010 0111 = 527.

(d) $385 + 118$

- Converting to BCD:
  - $385 = 0011\ 1000\ 0101$
  - $118 = 0001\ 0001\ 1000$
- Adding:

$$\begin{array}{r} 0011\ 1000\ 0101 \\ +0001\ 0001\ 1000 \\ \hline 0100\ 1001\ 1101 \\ +\ \ 0110 \\ \hline 0100\ 1010\ 0011 \\ +\ 0110\ 0000 \\ \hline 0101\ 0000\ 0011 \end{array}$$

- Converting result back to decimal: 0101 0000 0011 = 503.

(e) $998 + 3$

- Converting to BCD:
  - $998 = 1001\ 1001\ 1000$
  - $3 = 0011$
- Adding:

$$\begin{array}{r} 1001\ 1001\ 1000 \\ +\ 0011 \\ \hline 1001\ 1001\ 1011 \\ +\ \ 0110 \\ \hline 1001\ 1010\ 0001 \\ +\ 0110\ 0000 \\ \hline 1010\ 0000\ 0001 \\ +\ 0110\ 0000\ 0000 \\ \hline 0001\ 0000\ 0000\ 0001 \end{array}$$

- Converting result back to decimal: 0001 0000 0000 0001 = 1001.

(f) $623 + 599$

- Converting to BCD:

    - 623 = 0110 0010 0011
    - 599 = 0101 1001 1001
- Adding:

$$
\begin{array}{r}
0110\ 0010\ 0011 \\
+\ 0101\ 1001\ 1001 \\
\hline
1011\ 1011\ 1100 \\
+\ \ 0110 \\
\hline
1011\ 1100\ 0010 \\
+\ 0110\ 0000 \\
\hline
1100\ 0010\ 0010 \\
+\ 0110\ 0000\ 0000 \\
\hline
0001\ 0010\ 0010\ 0010
\end{array}
$$

- Converting result back to decimal: 0001 0010 0010 0010 = 1222.

Problem 2. Find the additions or the subtractions on the following pairs of hex numbers.

(a) 91B + 6F2

$$\begin{array}{r} 91B \\ +6F2 \\ \hline 100D \end{array}$$

(b) FFF + 0FF

$$\begin{array}{r} FFF \\ +0FF \\ \hline 10FE \end{array}$$

(c) D191 + AAAB

$$\begin{array}{r} D191 \\ +AAAB \\ \hline 17C3C \end{array}$$

(d) 91B - 6F2

- Converting the subtrahend to its 2's-complement:

$$\begin{array}{r} FFF \\ -6F2 \\ \hline 90D \\ +1 \\ \hline 90E \end{array}$$

- Adding the minuend and the 2's-complement of the subtrahend:

$$\begin{array}{r} 91B \\ +90E \\ \hline \not{1}229 \end{array}$$

- Result: 229_{16}

(e) 0200 - 0003

- Converting the subtrahend to its 2's-complement:

$$\begin{array}{r} FFFF \\ -0003 \\ \hline FFFC \\ +1 \\ \hline FFFD \end{array}$$

- Adding the minuend and the 2's-complement of the subtrahend:

$$\begin{array}{r} 0200 \\ +FFFD \\ \hline \not{1}01FD \end{array}$$

- Result: $1FD_{16}$

(f) 2F00 - 4000

- Converting the subtrahend to its 2's-complement:

$$\begin{array}{r} \texttt{FFFF} \\ -\texttt{4000} \\ \hline \texttt{BFFF} \\ +\texttt{1} \\ \hline \texttt{C000} \end{array}$$

- Adding the minuend and the 2's-complement of the subtrahend:

$$\begin{array}{r} \texttt{2F00} \\ +\texttt{C000} \\ \hline \texttt{EF00} \end{array}$$

- Result: $EF00_{16}$

Problem 3. Modify the circuit of Slide 49 (page 13) so that a single control input, X, is used in place of ADD and SUB. The circuit is to function as an adder when X=0 and as a subtractor when X = 1. Then simplify each set of gates. (Hint: Note that now each set of gates is functioning as a controlled inverter.)

Problem 4. Determine the $\sum$ outputs of 74LS32 for the following set of inputs:

(a) $[S] = 110, [A] = 10101100, [B] = 00001111$

$[S] = 100 \Rightarrow$ Operator: AND

$$\begin{array}{r} 10101100 \\ 00001111 \\ \hline 00001100 \end{array}$$

Result: $\sum = 00001100$

(b) $[S] = 100, [A] = 11101110, [B] = 00110010$

$[S] = 100 \Rightarrow$ Operator: XOR

$$\begin{array}{r} 11101110 \\ 00110010 \\ \hline 11011100 \end{array}$$

Result: $\sum = 11011100$