Problem 1: (20 points)

(A) 

\[ \begin{array}{c}
1110 \\
1101001 \\
1110 \\
10110 \\
10000 \\
1110 \\
101 \\
\end{array} \]

\[ \begin{array}{c}
\text{1110} \\
\text{1101001} \\
\text{1110} \\
\text{10110} \\
\text{10000} \\
\text{1110} \\
\text{101} \\
\end{array} \]

\[ 201 \div 14 = 14...5 \]

(B) 

\[ A - B = A + (-B) = 11001001 + 11110010 \]

\[ \begin{array}{c}
11001001 \\
+ 11110010 \\
\hline
10111011 \\
\end{array} \]

\[ (1) 10111011 \] (No overflow occurs.)

Problem 2: (30 points)

(A) 

(B) 

\[ ((A+B'C)D+A'(B+D'))' = (A'(B+C')+D')(A+B'D) \]
For AND operation of X and Y, convert the expression XY to

\[ \text{X} \quad \text{Y} \]

For OR operation of X and Y, convert the expression X+Y to

\[ \text{X} \quad \text{Y} \]

Apply two rules to the Boolean expression recursively until X and Y both contains only 1 literal.

**Problem 3: (30 points)**

(A)

\[ ABC' + (AC \equiv B) + (C \oplus AD) \]

**Solution:**

\[
\begin{align*}
ABC' &+ (AC \equiv B) + (C \oplus AD) \\
&= ABC' + (AC)B + (AC)'B' + C(AD)' + C'(AD) \\
&= ABC' + ABC + (A' + C)B' + C(A' + D') + AC'D \\
&= AB + A'B' + B'C' + A'C + CD' + AC'D \\
&= AB + B'C' + A'C + CD' + AC'D \\
&= AB + B'C' + AC' + A'C + CD' + AC'D \\
&= AB + B'C' + AC' + A'C + CD' + AC'D \\
&= AB + B'C' + A'C + CD' \\
&= AB + B'C' + A'C + CD' \\
\end{align*}
\]

(DeMorgan’s law)

(Uniting theorem)

(Consensus theorem)

(Consensus theorem)

(Absorption theorem)

(Consensus theorem)
Problem 4: (20 points)

(A) \(F_1 = \Sigma m(0, 2, 3, 7, 8, 12)\)
\[= \Pi M(1, 4, 5, 6, 9, 10, 11, 13, 14, 15)\]
\(F_1 \cdot F_2 = \Pi M(0, 1, 4, 5, 6, 7, 9, 10, 11, 13, 14, 15)\)

(B) \(F_1 = \Sigma m(0, 2, 3, 7, 8, 12)\)
\[\Rightarrow F_1' = \Sigma m(1, 4, 5, 6, 9, 10, 11, 13, 14, 15)\]
\(F_2 = \Pi M(0, 1, 4, 7, 10, 15)\)
\[= \Sigma m(2, 3, 5, 6, 8, 9, 11, 12, 13, 14)\]
\(F_1' + F_2 = \Sigma m(1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15)\)

Sum of minterms which are present in \(F_1\) or \(F_2\).