1. Convert the decimal numbers $+75$ and $+32$ to 8-bit hexadecimal numbers, using the signed 2's complement representation. Then perform the following operations: (a) $(+75) + (-32)$, (b) $(-75) + (+32)$, (c) $(-75) + (-32)$. Convert the answers back to decimal and verify that they are correct.

$+75_{10} = 4B_{16}$
$+32_{10} = 20_{16}$

For use below, we need the 2’s complement negative representations:

$-75_{10} = B5_{16}$
$-32_{10} = E0_{16}$

(a) $(+75_{10}) + (-32_{10}) = 4B_{16} + E0_{16} = 2B_{16} = +43_{10}$, correct.

Note: $4B_{16} + E0_{16} = 112B_{16}$, but you drop the leading 1 because the result must be 8 bits long. The first bit of the 8-bit result is 0, so the answer is positive.

(b) $(-75_{10}) + (+32_{10}) = B5_{16} + 20_{16} = D5_{16} = -43_{10}$, correct. The first bit of the eight-bit answer is 1, so the result is negative; the 2’s complement of $D5_{16}$ is $2B_{16} = 43_{10}$, so the answer is $-43$.

(b) $(-75_{10}) + (-32_{10}) = B5_{16} + E0_{16} = 95_{16} = -107_{10}$, correct. Drop the 9’th bit; the first bit of the of the 8-bit answer is 1, so the result is negative; the 2’s complement of $95_{16}$ is $6B_{16} = 107_{10}$, so the answer is $-107$.

2. Convert the following binary numbers to ASCII code:

```
1001110 1100101 1110111 0100000 1001101 1100101 1111000 1101001
1100011 1101111 0100000 1011000 1100101 1100011 1101000
```

New Mexico Xech

(I meant to put New Mexico Tech, put wrote it down wrong.)

3. By means of a timing diagram similar to Figure 1.5, show the signals of the outputs $f$ and $g$ in the figure below as functions of the two inputs $a$ and $b$. Use all four possible combinations of $a$ and $b$. 

![Timing Diagram](attachment:diagram.png)
Start with a truth table:

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>g = ab</th>
<th>(a ⊕ b)'</th>
<th>f = (g + (a ⊕ b)')'</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Now draw the timing diagram:

```
a     0  1  1  0  0
b     0  0  1  1  0
f     0  1  1  0  0
g     0  0  1  0  0
```

4. Use Boolean algebra to prove that the following Boolean equalities are true:

(a) \( a'b' + ab' + a'b = a' + b' \)

\[ a'b' + ab' + a'b = a'b' + a'b' + a'b + ab' = a'(b' + b) + (a' + a)b' = a' + ab' = a' + b \]

(b) \( abc + bc' = b(a + c') \)

\[ abc + bc' = b(ac + c') = b(c' + a)(c' + c) = b(c' + a) \]

(c) \( (a + b)'bc = 0 \)

\[ (a + b)'bc = (a'b'bc = a'(b'b)c = 0 \]

(d) \( (ab' + a'b)' = a'b + ab \)

\[ (ab' + a'b)' = (ab')' = (a' + b)(a + b') = aa + a'b' + ab + bb' = a'b' + ab \]

(e) \[ (a + b(c + a'))' = a'b' \]

\[ [a + b(c + a')]' = a'[b(c + a')]' = a'[b' + (c + a')] = a'[b' + ac'] = a'b' + a'ac' = a'b' \]

5. Simplify the following Boolean expressions to a minimum number of literals:

(a) \[ [(a' + bc')d]' = (a' + bc') + d = a(bc')' + d = \overline{a(b' + c)} + d \] Four literals

(b) \[ \{ab + c[(ab)' + c']\}' = (ab + c)' + (ab)c = (ab)'c' + abc = \overline{(a' + b)c' + ab} \] All have four literals

(c) \[ (x + y)'(x' + y') = (x'y')(xy) = 0 \] No literals

(d) \[ abc' + a'bc' + a'b'c' = abc' + a'bc' + a'bc' + a'b'c' = (a + a')bc' + a'c'(b + b') = bc' + a'c' \] Four literals
6. Draw logic diagrams of the circuits that implement the original and simplified expressions in Problem 5 (c) and (d)

(c)

\[
\begin{array}{c}
\text{Original} \\
\begin{array}{c}
x \\
y \\
\end{array} \\
\text{Simplified} \\
\end{array}
\]

(d)

\[
\begin{array}{c}
\text{Original} \\
\begin{array}{c}
a \\
b \\
c \\
\end{array} \\
\text{Simplified} \\
\begin{array}{c}
b \\
c \\
\end{array} \\
\end{array}
\]

7. Find the complements of the following expressions:

(a) \((x + y')(x' + y)\): \([(x + y')(x' + y)]' = (x + y')' + (x' + y)' = x'y + xy'


(c) \((x' + y' + z)(x + y)(x + z')\): \([(x' + y' + z)(x + y)(x + z')]' = (x' + y' + z)' + [(x + y)(x + z')]' = xz' + (x + y)' + (x + z)' = xz' + x'y' + x'z