Problem #1 (20 points)

Fill in the following table. Show your work as illustrated for (a).

<table>
<thead>
<tr>
<th></th>
<th>Decimal</th>
<th>32-bit binary</th>
<th>Hexadecimal number (8 hex digits)</th>
<th>4-byte packed BCD number</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>12,348</td>
<td>0000.0000.0000.0011.0000.0011.1100</td>
<td>0000_303C</td>
<td>00. 00.30.3?</td>
</tr>
<tr>
<td>(b)</td>
<td></td>
<td></td>
<td>CA03_2F0D</td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>3,845</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(d)</td>
<td></td>
<td>0110.1011.0010.1100.1011.0100.0010.1101</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(e)</td>
<td></td>
<td></td>
<td></td>
<td>43.28.99.89</td>
</tr>
</tbody>
</table>

(a)

\[
\begin{align*}
12348/16 &= 771 \,
\lfloor 12 \\
771/16 &= 48 \,
\lfloor 3 \\
48/16 &= 3 \,
\lfloor 0 \\
3/16 &= 0 \,
\lfloor 3
\end{align*}
\]

\[
12348_{10} = 303C_{16} = 0000.303C_{16} = 0000.0000.0000.0011.0000.0011.1100_2 = 00.00.30.3?
\]  
(“?” marks an illegal BCD digit).
Consider the following 16-bit hexadecimal numbers (second column). Each of these values can be interpreted as an unsigned 16-bit integer, a signed 16-bit integer represented in 2’s complement, or as a sign-and-magnitude integer. Provide the decimal value for each number and interpretation. Show your work as illustrated in (a).

<table>
<thead>
<tr>
<th></th>
<th>16-bit hex</th>
<th>Unsigned int</th>
<th>Signed int</th>
<th>Sign-and-magnitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>A223</td>
<td>41507</td>
<td>-24029</td>
<td>-8739</td>
</tr>
<tr>
<td>(b)</td>
<td>01A2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>4089</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(d)</td>
<td>22FF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(e)</td>
<td>FF00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(a) unsigned: \(A223_{16} = 10^3 \times 2 + 2^2 \times 16 + 2^1 \times 16 + 3 \times 16^0 = 41507_{10}\)

signed: \(A223_{16} = 1010.0010.0010.0011_2\) => this is a negative number;
two’s complement is: \(0101.1101.1101.1101 = 5DDD_{16} = 24029_{10}\) => \(A223_{16} = -24029\)
sign-and-magnitude: \(-2223_{16} = -8739\)
Problem #3 (20 points)

Consider the following arithmetic operations. Find the results and set the flags C, V, N, and Z accordingly.

(a) 8-bit, two’s complement
\[ 45_{10} + 88_{10} \]

(b) 8-bit, two’s complement
\[ (-35)_{10} - 88_{10} \]

(c) 16-bit, two’s complement
\[ -39_8 - 88_{16} \]

(d) 16-bit, two’s complement
\[ -AF_{16} + 34_{10} \]
Problem #4 (20 points)

(a) Convert the following number from decimal to the IEEE 32-bit floating point.
98.03125\(_{10}\)

(b) Convert the following number from the binary IEEE floating point to decimal.
60E3AB00\(_{16}\)
Problem #5 (20 points)

You would like to store the following variables in memory. Show the content of memory starting from the address 100h assuming (a) a little-endian architecture, and (b) a big-endian architecture. Memory is byte-addressable.

Note:
The DC8 assembly directive is used to allocate and initialize an 8-bit constant; similarly DC16 and DC32 allocate and initialize 16-bit and 32-bit constants, respectively.
The .ORG directive moves the location pointer at the specified address (100 hexadecimal in this case).

```
.ORG 100h
myfb  DC8 25 ; 8-bit integer
mysb  DC8 -2
my345 DC32 345 ; 32-bit integer
mym2  DC16 -12, 200 ; 16-bit integer
mya   DC8 “CPE323” ; ascii string
```

(a) (b)
<table>
<thead>
<tr>
<th>Address[15:0] HEX</th>
<th>Label</th>
<th>Memory [7:0] HEX</th>
<th>Memory [7:0] HEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x0100</td>
<td></td>
<td>0x19</td>
<td>0x19</td>
</tr>
<tr>
<td>0x0101</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>