6.004 Spring 2019 Tutorial Problems
L01 – Model of computing

Binary representation:

1. What is the 5-bit binary representation of the decimal number 21?

2. What is the hexadecimal representation for decimal 219 encoded as an 8-bit binary number?

3. What is the hexadecimal representation for decimal 51 encoded as a 6-bit binary number?

4. The hexadecimal representation for an 8-bit binary number is 0x9E. What is its decimal representation?

5. What is the range of integers that can be represented with a single 8-bit quantity?

6. Since the start of official pitching statistics in 1988, the highest number of pitches in a single game has been 172. Assuming that remains the upper bound on pitch count, how many bits would we need to record the pitch count for each game as a binary number?
7. Compute the sum of these two 4-bit binary numbers. Express the result in hexadecimal.

\[
\begin{align*}
1101 \\
+0110 \\
\end{align*}
\]
Assembly Language:

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Description</th>
<th>Assembly Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>LW</td>
<td>lw rd, offset(rs1)</td>
<td>reg(rd) &lt;= mem(reg(rs1) + offset)</td>
</tr>
<tr>
<td>SW</td>
<td>sw rs2, offset(rs1)</td>
<td>mem(reg(rs1) + offset) &lt;= reg(rs2)</td>
</tr>
<tr>
<td>ADDI</td>
<td>addi rd, rs1, constant</td>
<td>reg(rd) &lt;= reg(rs1) + constant</td>
</tr>
<tr>
<td>BEQ</td>
<td>beq rs1, rs2, label</td>
<td>pc &lt;= (reg(rs1) == reg(rs2)) ? label : pc + 4</td>
</tr>
<tr>
<td>BNE</td>
<td>bne rs1, rs2, label</td>
<td>pc &lt;= (reg(rs1) != reg(rs2)) ? label : pc + 4</td>
</tr>
<tr>
<td>BLT</td>
<td>blt rs1, rs2, label</td>
<td>pc &lt;= (reg(rs1) &lt; reg(rs2)) ? label : pc + 4</td>
</tr>
<tr>
<td>BGE</td>
<td>bge rs1, rs2, label</td>
<td>pc &lt;= (reg(rs1) &gt;= reg(rs2)) ? label : pc + 4</td>
</tr>
</tbody>
</table>

li rd, constant | Load Immediate | reg(rd) <= constant |

Compile the following expressions to RISCV assembly using the instructions above. Assume a is stored at address 0x1000, b is stored at 0x1004, and c is stored at 0x1008.

1. \( a = b + c; \)

2. if \((a > b)\) c = 17;

3. sum = 0;
   for \(i = 0; i < 10; i = i+1\)
     sum += i;