This homework assignment must be completed by you alone. You may not copy from others. However, you may study with others or use external references to determine general solutions. Then you must complete the problems as your own work, not copying others’ work.

Questions about this homework should be addressed to your TA first. You can find your TA’s email at the class website: http://www.cise.ufl.edu/~mssz/CompOrg/TA-hours.html

This homework has three parts: (I) Regular Questions, (II) Problems to Solve, (III) Extra Credit. Complete all the work you can – there is no penalty for guessing.

Part I. Regular Questions [20 points total]

1. Vocabulary: (terms you need to know to discuss the subject intelligently) – Define the following terms using 1-3 sentences (and a diagram, if needed): [3 points each]
   a. Amdahl’s Law
   b. GFLOPs (performance measure)
   c. LINPACK (benchmark)
   d. Kernel Benchmark
   e. SPEC (organization, what does it do)

2. Concept Discussion: Explain and give an example of the following design principles: (a) “smaller is faster”; and (b) “make the common case fast”? [2 pts for a), 3 pts for b)]

Part II. Problems to Solve [20 points total]

3. Performance Equation: (a) A program $P$ has 33,177 instructions, an average CPI of 1.7, and $P$ runs on a computer $M_1$ with clock rate of 3.4 GHz. What is $P$’s runtime on $M_1$?
   
   (b) If we change $P$’s instruction count in a), above to 28,295 instructions and we slow the clock rate to 2.7 GHz to get a new machine $M_2$, what percent faster (or slower) will $P$ running on $M_2$ be, versus $P$ running on $M_1$? Show all your work to get full credit. [3 pts for a), 3 pts for b)]
4. **Calculate Average CPI:** Given program \( P \) having four types of instructions (A, B, C, and D), also their CPIs and instruction counts as described in the table below: (a) calculate average CPI for \( P \), (b) calculate average CPI for \( P \) if Type B instructions are speeded up by 29 percent, and (c) calculate the runtime for a 3.4 GHz machine for parts a) and b), above. *Hint: THINK carefully...*  

<table>
<thead>
<tr>
<th>Instruction Type</th>
<th>CPI for this Type</th>
<th>Instruction Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.1</td>
<td>289</td>
</tr>
<tr>
<td>B</td>
<td>2.3</td>
<td>343</td>
</tr>
<tr>
<td>C</td>
<td>1.7</td>
<td>834</td>
</tr>
<tr>
<td>D</td>
<td>2.9</td>
<td>119</td>
</tr>
</tbody>
</table>

5. **Amdahl’s Law:** Suppose a computer \( M_3 \) has an average CPI of 1.7 and a clock rate of 3.4 GHz. Please answer the following: (a) Calculate the runtime for a program \( P \) with 38,967 instructions that uses an hardware accelerator 27 percent of the time, and (b) determine how much faster the accelerator needs to run for \( P \) to run 1.3 times faster on \( M_3 \) with the faster accelerator. *Hint: Set up your equation for Amdahl’s Law, then see if it can indeed be solved... a negative result means that the requested improvement is infeasible...*  

Part III. Extra Credit

[10 points total]

6. **Benchmarks:** You are a hardware accelerator developer at ABC Computer Corp. Your managers want you to develop an accelerator just for graphics artists who perform rendering operations with image compression. Determine the following (a) which CPU benchmark(s) you would use from SPEC2006 CPU benchmarks (floating point as well as integer), and (b) tell why and how your answer to a) would be different from the benchmarks you would have chosen from SPEC2000 (if SPEC2000 was not retired, which it is). *Explain your answer to get full credit.*  

You will need to use information from [www.spec.org](http://www.spec.org).