1. You're currently using a single core machine but you want to figure out if it's worth investing in a dual-core machine. If you were to go for a dual-core machine:

   a. Assuming your application is 60% parallelizable, by how much could you decrease the frequency and get the same performance?

   b. Assuming that the voltage decreases linearly with frequency, how much dynamic power would the dual-core system require as compared to the single-core system?

   c. If the voltage cannot be reduced by more than 20%, how much peak power would the dual core system consume compared to the single core system.


3. The whole processor industry is bent on reducing power consumption of chips. What factors affect, and why can/can't we scale down, the following parameters of power (in 1-2 sentences each):

   a. Capacitance
   b. Activity Factor
   c. Voltage
   d. Frequency

4. A revolutionary new technology in memory improves your memory subsystem so that memory latencies are reduced by a factor of 3.5. After replacing your memory with the new ones, you observe that you now spend half your time waiting for memory. What percentage of the original execution (with the older memory system) was spent waiting for memory?

5. The table below is from Intel's Turbo Boost specifications for two high end i7 processors (4th gen and 3rd gen).

   *The processors have 6 cores each and a frequency step up of 100 Mhz from base frequency.
   *The “Turbo Boost Bin Upside” is a measure of number of step ups from the base frequency.
   *The base voltage for both of them is 1.35V and voltage increases by 30mV for each step up.
   *The 3rd gen i7 is in 32nm and 4th gen i7 is in 22nm with a capacitance scaling factor of 1.4.

   Given these details:

   a. For both the processors, given a fixed power budget (decided by base frequency and voltage), if the CPU is running 1 active core and 5 idle cores with Turbo Boost, what would the CPU frequency
of the idle cores be?

b. Consider a single threaded application with ‘n’ instructions. Let’s assume the average number of cycles to execute these instructions (Instructions per cycle) is the same on both processors meaning that the execution time is a factor of the clock speed. You want the highest performance with lowest energy consumption. Would you run it on the 4960X or the 3970x (without turbo)? What if the 3970x was on turbo boost?

c. Keeping power aside, in the 4960X, how much speedup would you get for a program A if 50% of it could be parallelized to run on 5 cores instead of running all of it on 1 core? What if you had Turbo Boost switched on?

<table>
<thead>
<tr>
<th>Intel® Core™ i7 Processor Extreme Edition Turbo Boost Frequencies</th>
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<tbody>
<tr>
<td><strong>Processor</strong></td>
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<tr>
<td>Processor Cores</td>
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<tr>
<td>Active Cores</td>
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<tr>
<td>Max Intel® Turbo Boost Bin Upside</td>
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<tr>
<td>Max Intel® Turbo Boost Frequency</td>
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6. Answer the following with a True/False along with a short justification:

a. A high peak power is a certain indicator of high energy costs.
b. For a fixed workload, we can use a machine with only C-cores and no general purpose CPU.
c. In post-Dennard scaling the voltage does not increase but power density increases.
d. You can afford to not pay heed to Amdahl’s law because it isn’t applicable anymore.
e. Code compiled for CISC architecture has lower instruction count than that of RISC.