The Objective. The goal of this assignment is to make sure you have a good understanding of materials in Chapters 1 and 2 of the textbook. You should read relevant chapters and check the slides to answer the questions.

Questions. If you have a difficulty with any question, please contact me, TA or post a question on Piazza. Do not post answers on Piazza. If you want to check something of the form 'am I on right track with this question', post it as a PRIVATE question on Piazza. TA/I will make it public whenever appropriate.

How to submit the assignment. Submit your answers using pdf files via Handin. You can find the link on course’s website.

1. (4 points) In virtually all systems that include DMA modules, DMA access to main memory is given higher priority than processor access to main memory. Why?

2. (8 points) A DMA module is transferring characters to main memory from an external device transmitting at 9600 bits per seconds (bps). The processor can fetch instructions at the rate of 1 million instructions per second. By how much will the processor be slowed down due to the DMA activity? Assume that the CPU fetches an instruction in every clock cycle if it is able to access the bus. Also, assume that when the DMA accesses the bus, it transmits 32 bits to/from memory at a time.

3. (8 points) Consider the following code
   for (i = 0; i < 128; i++)
       for(j = 0; j < 64; j++)
           a[i] = a[i] * j
   a) Give one example of the spatial locality in the code.
   b) Give one example of the temporal locality in the code.

4. (8 points) A computer has a cache and main memory. If a referenced word is in the cache, 25 ns are required to access it. If it is in main memory but not in cache, 70 ns are needed to load it into the cache (this includes the time to originally check the cache), and then the reference is started again. The cache hit ratio is 0.9.
   a) What is the average time in ns required to access a referenced word on this system?
b) If the hit ratio is changed from 90% to 80%, what is the average time in ns required to access a referenced word on this system?

5. (4 points) Please answer the following questions about system calls.
   a. What is the purpose of system calls and how do system calls relate to the OS and to the concept of dual mode (kernel-mode and user-mode) operations?
   b. Generally, systems provide a library or API (Application Programming Interface) that sits between user-mode program and the operating system. The API is usually part of an implementation of programming language (e.g., C or C++) library and provides wrapper functions for the system calls. Please justify why working with API is preferable to directly calling system calls provided by the OS?

6. Other questions to think about though not to answer for this homework.
   c) In Q. 3, what would be the hit rate if cache size is 16 bytes, 32 bytes, etc
   d) In Q. 3, what if the statement is changed to a[i]= a[j] * j
   e) Look up Amdahl's law [http://en.wikipedia.org/wiki/Amdahl%27s_law] if you are not familiar with it.
   f) If the hit ratio is 90% and memory access time is 100ns, plot a graph of effective memory access time vs cache access time.