MC48 Final Exam

Serial #:

This exam is an open-book, open-notes, individual-work exam. Please write your name only on this page. Do not turn the page until instructed, in order that everyone may have the same time. Then, be sure to look at all problems before deciding which one to do first. Some problems are easier than others, so plan your time accordingly. You have two hours to work.

Write the answer to each problem on the page on which that problem appears. You may use the back of that same sheet if you need additional space. You may also request additional paper.

Important: If any problem has a numerical answer, you are welcome to indicate the arithmetic that needs to be done rather than doing the arithmetic. For example, you could give as your answer $5\times12+3$ rather than 63. This will not result in any loss of credit.

Name: ______________________________

Problem	Page	Possible	Score
1	2	12	
2	3	12	
3	4	12	
4	5	12	
Total		48	

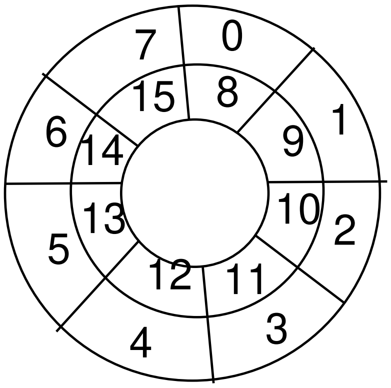
1. [**12 Points**] Suppose the MIPS instruction set architecture was changed to eliminate the 16-bit displacement in load and store instructions. (For compatability with existing machines, the 16 bit field could simply be required to be all zeros.)

   (a) How could the pipeline from chapter 6 be changed to take advantage of this restriction?

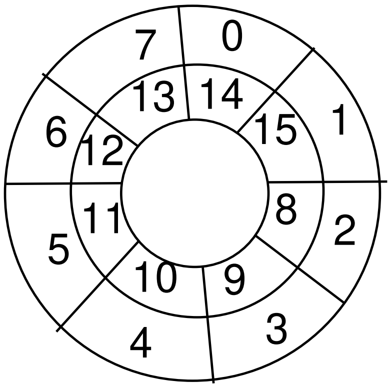
   (b) Of the three factors that that combine to give performance, which two are most likely to change from these modifications to the instruction set architecture and pipeline structure? Briefly explain the cause for each of the two and indicate the direction in which each of the two would change.

2. **[12 Points]** A system with 32-bit addresses that address bytes (so that each address of a full 32-bit word is a multiple of four) has a direct-mapped cache that can hold 16 kilobytes of data. Each cache block holds two 32-bit words. What is the total amount of memory needed for the cache? Show the reasoning behind your answer.

3. [**12 Points**] Consecutive blocks of data on a disk are not laid out like this:



but rather like this:



Explain why in terms of the disk's performance when reading all 16 blocks in order one right after another.

4. [**12 Points**] A program repeatedly performs a three-step process: it reads in a 4 kilobyte block of data from disk, does some processing on that data, and then writes out the result as another 4 kilobyte block elsewhere on the disk. Assume that the blocks are randomly located on the disk, but each block consists of a contiguous chunk of disk space. Assume that the disk drive is like the one in the example on page 544 (i.e., 4500 RPM, average seek time 20 ms, transfer rate 2 MB/sec, and controller overhead 2 ms). Assume no other program is using the disk or processor. Assume that there is no overlapping of disk operation with processing. Assume that the processing step takes ten million clock cycles, and that the clock rate is 40 MHz.

   (a) What is the overall speed of the system in blocks processed per second?

   (b) It is proposed to speed the system up by having the processing step done in parallel on 8 processors (each still running at 40 MHz). Ignoring overheads due to communication, coordination, and the like, what speedup would be achieved in the overall speed of the system? (That is, by what multiple would the number of blocks processed per second increase?)