CSE 410 - Spring 2004

Homework 4

due on Friday, April 30 at 9:30 AM, at the beginning of class

25 points

Name _____

Student # _____

1a. (2pt) Fill in the "usage", "available?" and "restore required" columns in the following chart.

Usage? Brief description of the conventional usage of the register.
Available? Is the register available for use in user code, or is it reserved?
Restore? If the register is available for use, does a procedure have to restore the value of the register after using it? (If not available for use, put n/a.)

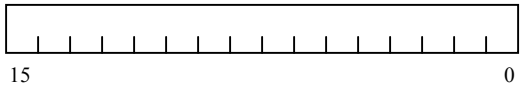
name	*available?*	*restore?*	*usage?*
zero	yes	no	read-only, always returns 0
at	no	n/a	reserved for use as assembler temporary
v0,v1			
a0-a3			
t0-t9			
s0-s7			
fp (s8)			
sp			
ra			
gp			
k0,k1			

1b. (2pt) The registers listed above are remarkably general purpose, compared to designs of earlier systems. A different set of conventions could assign most of the functions to different registers without changing the underlying MIPS hardware. However, this isn't true of all the registers. Identify two registers listed above for which a change in usage would require a change in the hardware. Describe why you selected these two registers.

2. Consider a machine that has a 16-bit program address space (logical address space). This is considerably smaller than the systems we have been studying.

a. (2pt) What is the largest logical address that a program in this system can use? Give your answer in both decimal base 10 and hexadecimal base 16 notation.

b. (2pt) The designers have implemented a Virtual Memory system that uses 1KB pages, so the page offset field is 10 bits wide (2^{10}=1024). Using the drawing of a 16-bit logical address word given below, indicate the Virtual Page Number Field and the offset field.



c. (2pt) How many Virtual Page Numbers are there in this system? Give your answer in 2^n notation, using the correct number for "n".

d. (2pt) If the physical addresses are 24 bits wide, how many Physical Page Numbers are there? Give your answer in 2^n notation, using the correct number for "n".

e. (2pt) How much physical memory is required to implement a system with 24-bit physical addresses? Give your answer in MegaBytes, where 1 MB = 1048576 bytes.

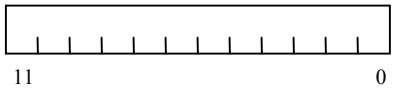
3. (2pt) Draw a simple picture showing a program address space as we have studied it indicating where the program code, the data (the heap), and the stack are located. Show the directions that the heap and the stack grow while the program is executing.

4a. (2pt) Describe the general characteristics of a program that would exhibit high temporal locality of data references but low spatial locality of data references.

4b. (2pt) Describe the general characteristics of a program that would exhibit high temporal locality of instruction fetches and high spatial locality of instruction fetches.

5. (5pt) The cache shown in this problem is direct mapped, and there are 16 4-word blocks in the cache. The cache is initially empty. Memory is byte-addressed using 12-bit addresses.

a. Show how you will divide up a 12-bit address into the required fields for accessing the cache: tag, index, and offset. Clearly identify how many bits are allocated to each field.



b. Consider the sequence of data memory references to the right. Fill in the cache contents by considering each memory reference in turn. Show if it's a hit or a miss, then fill in the data in the proper places below. You may need to overwrite some entries as you proceed.

Sequence of memory references

Referenced Address$_{16}$	Hit or Miss?	Address Contents$_{16}$
2A1		F0
B03		F1
133		F2
134		F3
1A0		F4
CCC		F5
210		F6

	Cache contents		Data (draw a line across a cell if data is valid but not given in the problem statement)														
Index$_{16}$	Tag	Valid?	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0																		
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
A																		
B																		
C																		
D																		
E																		
F																		