The University of Alabama in Huntsville
Electrical & Computer Engineering Department
CPE 431 01
Final Exam
December 4, 2014

Name: _____

1. (1 point) A _____ is a set of computers connected over a local area network that function as a single large multiprocessor.
2. (1 point) _____ is the speedup achieved on a multiprocessor without increasing the size of the problem.
3. (1 point) _____ parallelism achieved by performing the same operation on independent data.
4. (1 point) A _____ includes one or more threads, the address space, and the operating system state.
5. (1 point) A _____ is a function that processes a data structure and returns a single value.
6. (7 points) Write down the binary representation of the decimal number 159.375 assuming the IEE 754 double precision format. Express your answer in hexadecimal.

7. (15 points) Here is a series of address references given as hexadecimal word addresses: 1, 4, 8, 5, 20, 17, 19, 56, 209, 11, 4, 43, 5, 36, 8, 16, 59, 187. Assuming a direct mapped cache with four word blocks, a total size of 16 words that is initially empty, (a) label each reference in the list as a hit or a miss and (b) show the entire history of the cache

0x1		
0x4		
0x8		
0x5		
0x20		
0x17		
0x19		
0x56		
0x209		
0x11		
0x4		
0x43		
0x5		
0x36		
0x8		
0x16		
0x59		
0x187		

8. (8 points)) Consider the following portions of three programs running at the same time on three processors in a symmetric multicore processor (SMP). Assume that before this code is run, w is 2, x is 4 and y is 3 and z is 1. w, x, y, and z are type `int`.

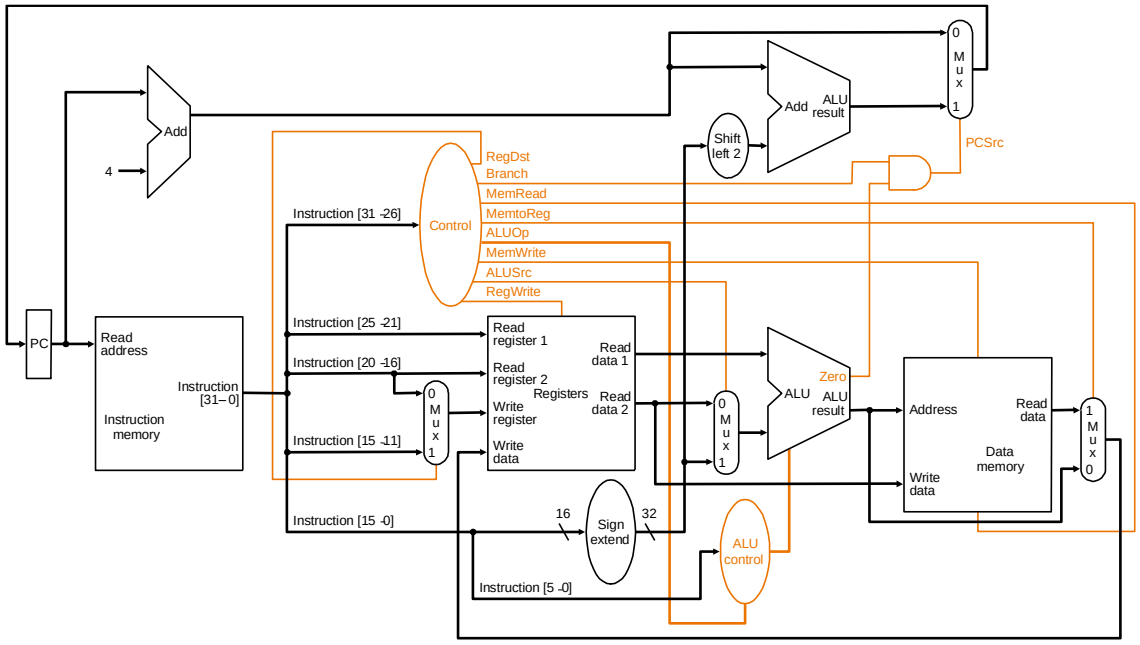
Core 1: `y = 5/(z + w);`
Core 2: `x = x + y/w + 1;`
Core 3: `z = w*(x – y);`

9. (7 points) . Consider a computer running a program that requires 750 s, with 70s spent executing FP instructions, 85 s executing L/S instructions, and 40 s spent executing branch instructions and the rest executing R Type instructions. By how much must we improve the CPI of R Type instructions if we want the program to run two times faster?

10. (15 points) Add a variant of the lw instruction which sums the contents of two registers to obtain the address of the data and which uses the R format to the single-cycle datapath shown in the figure below. Add any necessary datapaths and control signals and show the necessary additions to the table of control signals given.

```
lw   $9, $6, $22
```
$9 ← MEM[$6+$22]

36	6	22	9	0	32



Instruction	RegDst	ALUSrc	Memto-Reg	Reg Write	Mem Read	Mem Write	Branch	ALU Op1	ALU Op0	
R-format	1	0	0	1	0	0	0	1	0	
lw	0	1	1	1	1	0	0	0	0	
sw	d	1	d	0	0	1	0	0	0	
beq	d	0	d	0	0	0	1	0	1	

d – don't care

11. (12 points) The following data constitutes a stream of virtual addresses as seen on a system. Assume 8 KiB pages, a 4-entry fully associative TLB, and true LRU replacement. If pages must be brought in from disk, increment the next largest page number.

4669, 2227, 13916, 34587, 18885, 12608, 49225, 9226, 46390

TLB

Valid	Tag	Physical Page Number
1	0	5
1	7	4
1	3	6
0	4	9

Page table

Valid	Physical page or in disk
1	5
0	Disk
0	Disk
1	6
1	9
1	11
0	Disk
1	4
0	Disk
0	Disk
1	3
1	12

Given the address stream, and the shown initial state of the TLB and page table, show the final state of the system. Also list for each reference if it is a hit in the TLB, a hit in the page table, or a page fault.

12. (15 points) (a) Identify all of the data dependencies in the following code. (b) How is each data dependency either handled or not handled by forwarding? Draw a multiple clock cycle style diagram to support your answer.

```
a     add   $5, $5, $4
b     lw    $4, 28($2)
c     add   $2, $4, $5
d     sw    $4, 100($2)
e     add   $3, $2, $4
```

13. (8 points) Pseudoinstructions are not part of the MIPS instruction set but often appear in MIPS programs. For the pseudoinstruction listed, produce a minimal sequence of actual MIPS instructions to accomplish the same thing. You may need to use $at for some of the sequences. In the table, big refers to a specific number that requires 32 bits to represent and small to a number that can fit in 16 bits.

Pseudoinstruction	What it accomplishes
lw $t5, big($t2)	$t5 = Memory[$t2 + big]

14. (8 points) Consider a SEC code that protects 4 bit words with 3 parity bits. If we read the value 0x57, is there an error? If so, correct the error.