## The University of Alabama in Huntsville Electrical and Computer Engineering Department CPE 221 01 Final Exam April 27, 2016

This test is closed book, closed notes. You may use a calculator. You should have the reference packet that includes Figure 2.10 and Appendix B. You must show your work to receive full credit.

- 1. (1 point).C ++ is an example of a \_\_\_\_\_ language.
- 2. (1 point) \_\_\_\_\_ (True or False) Pipelining is a technique for improving the throughput of instruction execution.
- 3. (1 point) \_\_\_\_\_ (True or False) Static RAM requires refreshing.
- 4. (1 point) \_\_\_\_\_ (True or False) Most instructions take fewer cycles to execute on a 2-bus SRC than they do on a 1-bus SRC.
- 5. (1 point) \_\_\_\_\_\_ numbers may have either positive or negative values.
- 6. (4 points) In an SRC computer, r2 contains a value of --3621 in decimal. What is the binary value of r1 after this instruction is executed?

not r1, r2

7. (4 points) In an SRC computer, r2 contains a value of 1698 in decimal. What is the binary value of r1 after this instruction is executed?

neg r1, r2

8. (2 points) In an SRC computer, r2 contains a value of -3621 in decimal while r3 contains a value of 1698 in decimal. What is the binary value of r1 after this instruction is executed?

and r1, r2, r3

9. (2 points) Using the SRC, if we want to examine the last bit of a binary number to see whether it was 0 or 1, we use a mask with a value of 1 and take the logical operation and of the two operands; mask and number. What mask value would we use if we wanted to examine bit 19?

10. (10 points) Encode 001\_0100\_1101 using the Hamming code and odd parity. What is the final Hamming code?

11. (8 points) What are the values of the following registers when the program executes "brnz r30, r2" for the third time? Answer in decimal.

(b) (4 points) r3:\_\_\_\_\_ (a) (4points) r2: \_\_\_\_\_ 200 data: .org num1: .dc 8 num2: 9 .dc result: .dw 1 1000 code: .org la r30, again r29, done la r1, num1 ld ld r2, num2 sub r3, r3, r3 brzr r29, r1 brzr r29, r2 add r3, r3, r1 again: addi r2, r2, -1 brnz r30, r2 r3, result done: st stop

- 12. (2 points) The fields ra, rb, and rc in the SRC instruction format are 5 bits long. If the register file were enlarged to contain 256 registers, how many bits are required for each of these fields?
- 13. (6 points) For the following pair of instructions, indicate how many bubbles must be placed between them in (a) (2 points) the absence of data forwarding, (b) (2 points) the presence of 3 to 3 forwarding only, and (c) (2 points) the presence of 4 to 3 forwarding only to resolve any dependence.

ld	r2,	(r4)
st	r6,	0(r2)

14. (15 points) Write concrete RTN steps for the SRC instruction st using the 1-bus SRC microarchitecture shown.





Т0	$MA \leftarrow PC : C \leftarrow PC + 4$
T1	$MD \leftarrow M[MA] : PC \leftarrow C$
T2	$IR \leftarrow MD$
Т3	
T4	
T5	
T6	
T7	

15. (10 points) A certain memory system has a 1024 MB main memory and a 64 MB cache. Blocks are 32 bytes in size. Show the fields in a memory address if the cache is 16-way set associative.

16. (6 points) If you want to build a 2<sup>48</sup> word, 64-bits-per-word memory and the only parts you have available to you are static RAM chips that contain 2<sup>40</sup> 8 bit words each. (a) (2 points) How many rows are required? (b) (2 points) How many columns are required? (c) (2 points) How many chips in all?

17. (6 points) Encode the lar r31, loop statement from the SRC program shown below in *hexadecimal.* 

```
.org 0
       .dc 1
seq:
       .dw cnt
ans:
       .org 1000
              r31, loop
       lar
        la
              r0, 8
              r1, seq
        la
              r2, 0(r1)
loop:
        ld
        ld
              r3, 4(r1)
        add
              r2, r2, r3
        st
              r2, 8(r1)
             r1, r1, 4
        addi
        addi r0, r0, -1
        brnz r31, r0
```

Instruction	ор	ra	rb	rc	c1	c2	c3
lar r31, loop							

18. (20 points) Complete the SRC assembly language program below so that it implements the following C++ statements. You must store the calculated tax rate in the memory location pointed to by the label tax.

```
This program calculates a tax rate based on the value of income as
;
       follows.
;
       if (income < level1)</pre>
;
         tax = 0;
;
       else
;
         if (income < level2)</pre>
;
;
           tax = 5;
;
         else
;
           tax = 10;
;
        .org 200
income: .dc 25000
level1: .dc 15000
level2: .dc 25000
tax: .dw 1
orig: .org 1000
```

ld	r7,	income
ld	r8,	level1
ld	r9,	level2

stop