CS 250 Midterm Exam 1

There are 8 questions, with the point values as shown below. You have 75 minutes with a total of 75 points. Pace yourself accordingly.

This exam must be individual work. You may not collaborate with your fellow students. You may use 1 sheet of notes you created, but no other external resources.

I certify that the work shown on this exam is my own work, and that I have neither given nor received improper assistance of any form in the completion of this work.

Signature:

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Question 1: Numbers [10 pts]

1. Convert the decimal number -103 to 8-bit, signed 2’s complement binary:

2. Convert the 8-bit signed 2’s complement hex number 0x5A to decimal:

3. Convert the 16-bit signed 2’s complement binary number 1001 0001 1111 1010 to hex:
4. Convert 42.375 to its hexadecimal representation in IEEE floating point format:

5. Convert the hexadecimal IEEE format floating point number 0xC18E0000 to decimal:
Question 2: Binary Math [5 pts]

1. Add the 8-bit 2’s complement numbers 0110 0011 + 1110 1011. State the result of the addition (as a binary value), as well as whether overflow occurred if the number were treated as signed, and whether overflow occurred if the numbers were treated as unsigned. Show your work.

\[
\begin{array}{cccccccc}
1 & 1 & 1 & 0 & 1 & 0 & 0 & 1 \\
1 & 1 & 0 & 0 & 0 & 0 & 1 & 0 \\
\hline
1 & 1 & 1 & 0 & 0 & 0 & 1 & 0 \\
\end{array}
\]

Sum:

Signed Overflow:

Unsigned Overflow:
2. Add the 8-bit 2’s complement numbers 1111 1111 + 1110 1000. State the result of the addition (as a binary value), as well as whether overflow occurred if the number were treated as signed, and whether overflow occurred if the numbers were treated as unsigned. Show your work.

\[
\begin{array}{cccccccc}
0 & 1 & 1 & 1 & 0 & 1 & 1 & 1 \\
0 & 1 & 1 & 0 & 1 & 0 & 1 & 0 \\
\end{array}
\]

Sum:

Signed Overflow:

Unsigned Overflow:

3. Fill in the blank so that this is a true statement: 1100 0011 ^ ____ ____ = 1010 1010.

4. What does \( x << n \) compute algebraically (that is, what “normal” math operation(s) does it perform)?
Question 3: UNIX Commands [5 pts]

Match each of the following tasks with the UNIX program most suited to that task:

1. Copy a file

2. Create a new directory (aka folder)

3. Show what files are in the current directory

4. Debug a program

5. Delete a file

A. allfiles
B. cp
C. edit
D. emacs
E. gcc
F. gdb
G. less
H. ls
I. mkdir
J. nethack
K. newfldr
L. rm
M. scp
N. ssh
O. svn
P. textwzrd
Question 4: C Programming [15 pts]
Given the following linked list node definition:

```c
struct ll_node {
    int data;
    struct ll_node * next;
};
typedef struct ll_node node;
```

Fill in the function below which removes every other element from the list, starting with the 2nd. For example, if the list passed in contained (1,2,3,4,5), then the list returned should contain (1,3,5).

```c
node * removeEveryOther(node * head) {
```
Question 5: C Tracing [9 pts]
What is the output when the following C program is run?

```c
#include <stdio.h>

void f (int x, int * p) {
    *p = x+1;
    x = 33;
}

int main(void) {
    int a = 1;
    int b = 17;
    int * p = &a;
    int ** q = &p;
    *q = & b;
    *p = 3;
    printf("1: a = %d, b=%d\n", a, b);
    f(a,*q);
    printf("2: a = %d, b=%d\n", a, b);
    p = &a;
    **q = 99;
    printf("3: a = %d, b=%d\n", a, b);
    return 0;
}
```
Question 6: ISA Concepts [6 pts]

Briefly answer each of the following:

1. Name and (briefly!) describe three stages of the Von Neumann model.
   
   i
   
   ii
   
   iii

2. Give three features of RISC ISAs which distinguish them from CISC ISAs, and state what CISC ISAs have instead (You can write three sentences of the form “RISC ISAs have __________, whereas CISC ISAs have __________
   
   i
   
   ii
   
   iii
**Question 7: Asm Tracing [5 pts]**

Trace (execute by hand) the following fragment of assembly. The starting register and memory state is given to you in the table below. Write the final register and memory state in the blank row of the table.

```
li $t0, 4
mul $t0, $t1, $t0
add $t0, $t0, $sp
lw $t0, 4($sp)
beqz $t0, .L_xyz
sw $t0, 0($sp)
.L_xyz:
lw $v0, -8($fp)
```

<table>
<thead>
<tr>
<th>Registers</th>
<th>Memory</th>
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<tr>
<td><strong>t0</strong></td>
<td>0x1D0</td>
</tr>
<tr>
<td><strong>t1</strong></td>
<td>0x1D4</td>
</tr>
<tr>
<td><strong>sp</strong></td>
<td>0x1DC</td>
</tr>
<tr>
<td><strong>fp</strong></td>
<td>0x1D8</td>
</tr>
<tr>
<td><strong>v0</strong></td>
<td>0x1DC</td>
</tr>
</tbody>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial</strong></td>
<td>0x00</td>
<td>0x01</td>
<td>0x1D0</td>
<td>0x1DC</td>
<td>0x99</td>
<td>0x11</td>
</tr>
<tr>
<td><strong>Final</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x22</td>
</tr>
</tbody>
</table>
Question 8: Asm Programming [20 pts]
Write MIPS assembly for the following C function.

```c
int arrayUpdate(int * ptr, int n) {
    int i = 0;
    int sum = 0;
    while (i < n) {
        int x = ptr[i];
        if (x < 42) {
            x = f(x);
        } else {
            x = g(x);
        }
        sum += x;
        ptr[i] = x;
        i++;
    }
    return sum;
}
```

Answer on next page
.globl arrayUpdate
.ent arrayUpdate
.text
arrayUpdate:

.end arrayUpdate
Question 9: Extra Credit [?? pts]
The following questions are extra credit. I recommend completing the normal questions on your exam before attempting them. The number of points that each extra credit question will count will be inversely proportional to the number of students answering it correctly.

- Suppose x and y represent two 8-bit unsigned binary numbers. How many distinct values of x and y are there which make the following a true statement: \((1100\ 0011 \mid x) \& y = 0001\ 1001\).

- Assuming that q should end up in register $t0$, that x (which is an int), y (which is an int *), and z (which is a char**) are in registers $s0$, $s1$, and $s2$ (respectively), and that f (which returns an int), g (which returns an int *), and h (which returns an int*) are functions, write assembly for the following C code:

\[
q = f(*g(3), h(x, *y, **z)) + 42;
\]

You may use any of the registers you need, and may assume that all $s$ registers are properly saved and restored elsewhere in the function.