

CSEE W3827

Fundamentals of Computer Systems Homework Assignment 3

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Due June 30, 2015 at 5:30 PM

Write your name **and UNI** on your solutions

Show your work for each problem; we are more interested in how you get the answer than whether you get the right answer.

1. (20 pts.) In MIPS assembly, implement the `strncat` function from the C standard library, i.e.,

```
char *strncat(char *dest, const char *src, size_t n)
```

This appends at most n characters from the `src` string to the end of the `dest` string, overwriting `dest`'s terminating 0 and returning `dest`. The returned string is always 0-terminated. Assume `src` and `dest` do not overlap. Assume `dest`, `src`, and `n` are each 32 bits.

Start from the `strncat.s` template on the class website.

Your function must obey MIPS calling conventions.

Implement your function in the SPIM simulator.

Turn in your solution on paper with evidence that it works. Add at least one test case.

On the supplied test harness, your code should print

```
Hello World!  
Hello World!
```

```
Hello Wo  
3827 sucks you in with wonderful ideas  
3827 sucks you in with wonderful ideas
```

```
3827 sucks you in
```

2. (30 pts.) In MIPS assembly, implement a function that returns the maximum sum of node values from the root of a tree. Each node is represented by the consecutive words in memory: the value of the node (unsigned), the address of the left child, and the address of the right child. At each node, consider the maximum sum returned from the left and the right child and return it plus the node's value. Start from the `maxpath.s` template on the class website.

Your function must obey MIPS calling conventions. Use the stack to implement the recursion.

Implement your function in the SPIM simulator.

Turn in your solution on paper with evidence that it produces the desired result. Add at least one test case.

On the supplied test harness, your code should print

```
(42 )
42
(39 (3 ) (2 ))
42
(31 (42 (23 ) (31 )) (57 (1 ) ))
104
(6 (5 (3 ) (4 (1 ) (2 ))) (4 (1 ) (2 )))
17
```


4. (10 pts.) Assuming the following dynamic instruction frequency for a program running on the single-cycle MIPS processor

add	25%
addi	25%
beq	10%
lw	25%
sw	15%

(a) (5 pts.) In what fraction of all cycles is the data memory accessed (either read or written)?

(b) (5 pts.) In what fraction of cycles is the sign extend circuit used?

5. (15 pts.) For each of the caches listed below, show how a 32-bit addresses breaks into *tag*, *set index*, and *byte offset* fields.

Cache A: 4096B, 4-way set-associative, 8B lines

000000000000000000000000000000000000

Cache B: 2048B, direct-mapped, 16B lines

000000000000000000000000000000000000