

NAME _____

STUDENT NUMBER _____

COMP ENG 3DR4 Midterm Test

Feb. 12, 2007

INSTRUCTIONS:

- This is a closed-book, closed-note exam.
- Total time allowed is 120 minutes.
- There are 5 questions. Budget your time accordingly
- Write your name and student number on every page.
- Total mark available is 30.
- No wireless devices of any kind (e.g., cell phone, PDA, wireless internet access of any kind) are allowed.

Question	Mark
1	
2	
3	
4	
5	
Total	

1. (6 points) A string is palindrome if it reads the same backwards and forwards. Examples of palindromes include the strings: "x", "madam", "wow" and "avid diva". Write a procedure, *palindrome* in MIPS assembly language that checks if a string is a palindrome. The procedure should take a single argument that is a pointer to a null-terminated string in register \$a0. The *palindrome* procedure should return a one in \$v0 if the string is palindrome and 0 in \$v0 otherwise. Comment your code. Assume that the string has at least one character. Do NOT use pseudo-instructions.

2. (6 points) In the embedded market, where cost is crucial, processors sometimes implement floating point only in software. We are interested in two implementations of a computer, one with and one without special floating-point hardware. Consider a program, P, with the following mix of operations:

Floating-point multiply	10%
Floating-point add	15%
Floating-point divide	5%
Integer instructions	70%

Computer MFP (computer with floating point) has floating-point hardware and can therefore implement the floating-point operations directly. It requires the following number of clock cycles for each instruction class:

Floating-point multiply	6
Floating-point add	4
Floating-point divide	20
Integer instructions	2

Computer MNFP (computer with no floating point) has no floating-point hardware and so must emulate the floating-point operations using integer instructions. The integer instructions all take 2 clock cycles. The number of integer instructions needed to implement each of the floating-point operations is as follows:

Floating-point multiply	30
Floating-point add	20
Floating-point divide	50

- Both computers have a clock rate of 1000 MHz. Find the mega instruction per second ratings for both computers.
- If the computer MFP needs 300 million instructions for this program, how many integer instructions does the computer MNFP require for the same program?
- What is the execution time (in seconds) for the program P to run on MFP and MNFP?

5. (6 points) In combinatorial mathematics, the Catalan numbers form a sequence of natural numbers that occur in various counting problems. They are named for the Belgian mathematician Eugène Charles Catalan (1814–1894). The definition of Catalan number is:

$Cat(1)=1$

Otherwise;

$$Cat(n) = \frac{2(2n-1)}{n+1} Cat(n-1)$$

The C code for $Cat(n)$ would be:

```
int Cat(n){
    if (n==1) {
        return 1;
    }else{
        return 2*(2*n-1)/(n+1)Cat(n-1)
    }
}
```

Write a recursive MIPS procedure to calculate $Cat(n)$. Assume that n is in $\$a0$ and your result should be placed in $\$v0$.