

May 6, 2013

cs402 - Introduction to Advanced Studies II

Spring 2013

Final Exam

Open books / notes

Starts: **7:30 pm** Ends: **9:30 pm**

Name: _____ (print) ID: A _____

Problem	Max Points	Your Mark	Comments
1	15		10+5
2	5		
3	10		5+5
4	10		5+5
5	20		5+5+5+5
6	5		
7	5		
8	5		
9	5		
10	5		
11	5		
12	15		5+5+5
13	5		
14	5		
15	5		
	120		
	Extra credit		
	Total		Your Mark: ____ / 120 =

Do not write on the back of any page!

This exam will be retained until 5/31/2014 at which time it will be destroyed.

1. Consider the following fragment of C code:

```
int i = 99;
do {
    a[i] = b[i] & c;
    i = i - 2;
} while (i < 100);
```

Assume that *a* and *b* are arrays of *bytes* and that *c* is a *byte* too. The base address of *a* is in *\$a0*, the base address for *b* is in *\$a1* and *c* is in *\$s0*. You will use *\$t0* for *i*.

a) Write the code for MIPS using *native* instructions.

b) How many instructions are being executed when running the code?

2. Assume the following piece of MIPS assembly code, running on a big-endian machine:

```
.data
a: .word 0x9abcdef0
.text
main: la    $t0, a
      lb    $t1, 2($t0)
```

The value in register \$t1 (as a decimal number) is (circle one):

- (i) -34
- (ii) -68
- (iii) 188
- (iv) 205
- (v) 240

3. Assume the following piece of MIPS assembly code:

```
.data 0x10000000
var1: .word 0x8192a3b4
var2: .word 0

.text 0x400040
main: subu $sp, $sp, 4
      sw   $ra, 0($sp)
      jal  Mistery
      lw   $ra, 0($sp)
      addu $sp, $sp, 4
      jr   $ra

.text 0x400100
Mistery:
      lui  $t0, 4096
      lb   $t1, 3($t0)
      sw   $t1, 4($t0)
      jr   $ra
```

a) Show the sequence of addresses issued by the CPU to execute this code. You may assume that the initial value of the stack pointer is 0x7fffffff0.

Address (in hexadecimal)

Address (in hexadecimal)

d) What is the contents of the variable `var2` after the program executes? Assume a little-endian memory model.

4. Let's assume we want to add the memory indirect addressing mode to the MIPS instruction set. This will increase the clock cycle by 7% but will decrease somehow the instruction count because certain sequence of instructions will be replaced by just one instruction:

```
lw $t0, @($t1) # $t0 <- M[M[$t1]]
```

a) Which of the following sequence of instructions could be replaced by the instruction above? Circle one answer:

(i)

```
lw $t0, 0($t1)
sw $t0, 0($t0)
```

(ii)

```
lw $t1, 0($t0)
lw $t1, 0($t1)
```

(iii)

```
lw $t1, 0($t1)
lw $t0, 0($t1)
```

(iv)

```
lw $t0, 0($t1)
lw $t0, 0($t0)
```

(v)

```
lw $t0, 0($t0)
lw $t1, 0($t0)
```

b) Assume that the frequency of memory indirect addressing is 5% after the code changes and that the overall CPI doesn't change. Indicate whether the performance, after the introduction of this new addressing mode and code changes to utilize it is better and by how much, compared to the performance of the original code (select one):

(i) The new system is by 0.7% faster than the old one

(ii) The old system is by 1.9% faster than the new one

(iii) Performance doesn't change

(iv) The new system is by 1.83% faster than the old one

(v) The old system is by 0.9% faster than the new one

5. Your first job as a new employee with ACME Computing is to upgrade your CIO's computer with a new disk: the change will make every disk access three times faster. **With this enhancement in place** disk accesses account for 30% of the running time. The overall cost of the system increases by 21%.

a) What is the overall speed-up? Circle one answer:

- (i) $S_{\text{overall}} = 0.7$
- (ii) $S_{\text{overall}} = 1.15$
- (iii) $S_{\text{overall}} = 1.3$
- (iv) $S_{\text{overall}} = 1.5$
- (v) $S_{\text{overall}} = 1.6$

b) What was the fraction of the workload that could be enhance by the disk upgrade before the upgrade was done? Circle one answer:

- (i) $F = 0.37$
- (ii) $F = 0.46$
- (iii) $F = 0.56$
- (iv) $F = 0.66$
- (v) $F = 0.76$

c) Decide whether the new system is more cost effective than the old one. We say that one system is more cost effective than another if the ratio of performance by cost is higher. Circle one answer:

- (i) The upgrades system is not more cost effective than the old one
- (ii) The upgraded system is more cost effective than the old one
- (iii) The upgraded system has better performance, however its price is higher, therefore the upgraded system is equally cost effective with the old one

d) What is the overall speedup if you also improve the graphics system of your bosses' computer at the same time with the disk upgrade? The new graphics card will make all graphics 10 times faster and graphics represent 25% of the workload of the old machine (before the improvements are made).

6 ■ Which of the following statements are true? Select all correct answers:

- (i) A class can extend more than one class
- (ii) A class can implement more than one interface
- (iii) An interface can extend more than one interface
- (iv) An interface can implement more than one interface

7 ■ A book has one of more pages. Which of the following concepts characterize it best? Select one answer:

- (i) Inheritance
- (ii) Composition
- (iii) Association
- (iv) Specialization
- (v) Polymorphism

8 ■ Which of these fragments represents the HAS-A relationship between Bar and Foo? Circle all correct answers:

- (i) `class Foo extends Bar { ... }`
- (ii) `class Foo implements Bar { ... }`
- (iii) `class Foo { private Bar mybar; }`
- (iv) `abstract class Bar extends Foo { ... }`
- (v) None of the above

9 ■ Select, from the choices below, the class definition that correctly implements the following interface:

```
interface I { boolean plus(I x); }
```

- (i) `class A implements I { public boolean plus(Obj x) { return true; }}`
- (ii) `class A implements I { public boolean plus(I x) { return true; }}`
- (iii) `class A implements I { public boolean plus(A x) { return true; }}`
- (iv) `class A implements I { public boolean plus(I x) { return x; }}`

10.

 Consider the following system of classes:

```
package flipflop;

public class FlipFlop {
    private AFFState _state = new FlipState();
    public String toString() {
        return _state.toString(this);
    }
    void setState(AFFState state) {
        _state = state;
    }
}

abstract class AFFState {
    abstract String toString(FlipFlop context);
}

class FlipState extends AFFState {
    String toString(FlipFlop context) {
        context.setState(new FlopState());
        return "Flip";
    }
}

class FlopState extends AFFState {
    String toString(FlipFlop context) {
        context.setState(new FlipState());
        return "Flop";
    }
}
```

What output will the following code produce? Why? Be specific and complete.

Operations executed in the following order	Output and reasons for the output
<pre>flipflop.FlipFlop ff = new flipflop.FlipFlop();</pre>	

Operations executed in the following order	Output and reasons for the output
<code>System.out.println(ff.toString());</code>	
<code>System.out.println(ff.toString());</code>	
<code>System.out.println(ff.toString());</code>	

11

■ You are designing an OO program to help people plan an evening out. It is proposed that the following classes be used. Add inheritance (`extends` keyword) and instance variables to show the IS-A and HAS-A relationships between these classes. Do not introduce any additional classes or/and instance variables of any basic type. Note: By “Business”, we mean anything that would appear in the Yellow Pages.

```
class Address {

}

class Business {

}

class City {

}

class Restaurant {

}

class Theater {

}
```

12. Think of a train as a string of train cars. Each car has two couplings, one in front and one in the back, that allows train cars to be coupled to one another. Furthermore, consider all cars to be equipped with breaking lights (to indicate when the train driver hits the break). As a bystander, you can only see the breaking lights of the last car. In this question, you are asked to implement a communication mechanism that signals breaking from one car to the next.

```
abstract class Car {
    Car[] Coupling = {null, null};           // Coupling[0]: Car in front
                                              // Coupling[1]: Car in back
    boolean lightson = false;                // True if the breaking lights are on
    void couple (int i, Car c) {
        this.Coupling[i] = c;
        c.Coupling[1-i] = this;
    }
    void notify (boolean state) {
        // Implementation needed
    }
}

class EndOfTrain extends Car {
    void EndOfTrain() {}
}

class Locomotive extends Car {
    void pushBreak() {
        // Implementation needed
    }
    void releaseBreak() {
        // Implementation needed
    }
}

class PassengerCar extends Car { }
```

In this class hierarchy, for example,

```
Locomotive loc = new Locomotive();
loc.couple(0, new EndOfTrain());
PassengerCar c1 = new PassengerCar();
loc.couple(1, c1);
PassengerCar c2 = new PassengerCar();
c1.couple(1, c2);
c2.couple(1, new EndOfTrain());
```

will create a train that is lead by the locomotive `loc` followed by two passenger cars `c1` and `c2`.

a) Implement the `notify()` method.

b) Implement the `pushBreak()` method.

c) Implement the `releaseBreak()` method.

13. Given the classes below:

```
class PoorConditions extends Exception {}
class FlatTire extends Exception {}
class Vehicle {
    public void drive() throws PoorConditions {...}
}

class Car extends Vehicle {
    public void drive() throws PoorConditions, FlatTire {...}
}
```

If a Java compiler would compile this code without error -- which it doesn't, but let's assume it does -- what would be the problem? Explain with an example of a situation where this would be a problem.

14. What are the freedoms allowed by Free Software -- as described by the Free Software Foundation.

15. List three differences between Free Software and Open-Source software.

Scrap space

Scrap space continued