The University of New South Wales
School of Computer Science & Engineering

COMP 4001
Object Oriented Software Development
Final Examination
Session 1, 2012

Time permitted: 3 hours + 10 minutes reading time

Answer all questions.

Total Marks = 85

- Answer Part A on this exam paper.
- Parts B, C and D must be answered in one or more answer booklets.
- Label each booklet you use with your name and student ID.

This paper may not be retained by the candidate.

No examination materials are permitted.

Answers in booklets must be written in ink.
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**Part A. Multiple Choice Questions [25 marks]**

Select just one best choice. There is no penalty for wrong answers. Circle your choice. If you wish to change your choice, cross it out, and write your answer on the left side. Ambiguous answers will score 0.

1. Dynamic binding for method calls in OO languages is best described as:
   A. ...
   B. ...
   C. ...
   D. ...

2.5
Java & Scala Collections:
- Recognise use and implementation idioms for common Design Patterns
- (Adaptor, Decorator, Iterator, Factory Method)
Java & Scala generics
- Use of type parameters for methods and classes
- Type bounds
- Wild cards
- Type erasure and raw types

8..15
Concurrency control in Java
- Volatiles and atomic variables.
- Use of wait, notify, notifyAll. Nested monitors and deadlock
- Read-write locks. Reader or writer preference.
- Role of copy-on-write.

6,7,16 .. 25
Scala
- Functions as objects
- Class abstractions in Scala (trait, class, case class, object). Their different roles
- Use of companion objects
- Type members, abstract and concrete
- Pattern matching
- Operator expressions as method calls
- Immutability
- Covariance and contravariance
- For loop syntax. Type of for expressions using yield.

e.g. Which one of the following is false? For the following method definition in Scala
   ...
   A. the call ... yields a run-time error
   B. the result type of f is ...
   C. the call ... returns ...
   D. the argument type of f is ...
Part B. Scala programming [20 marks]
Start a NEW PAGE in your answer booklet. Label it B.

1. [15 marks] You are required to implement a simple interpreter for … in Scala, which you should do in the following steps.

   a. Write down a simple grammar (using extended BNF notation) for a language of … that include the following forms

   ... [More description of language here]

   b. Using the Scala parser combinators, and assuming that

      variable : Parser [String]
      number   : Parser [Double]

      are given, write a parser for recognizing expressions defined by your grammar above.

   c. Extend your recognizer to a parser for evaluating expressions

      exp : Parser [Double]

      [More description of language here]

2. [5 marks] Given Scala function declarations

   ...

   a. Define ... using a [form of recursive algorithm] so that it satisfies:

      [More description here]

   .

   b. Discuss how you could parallelize this … in Scala. You do not need to provide full code details, but do provide enough detail to make the key issues clear.
PART C. JAVA CONCURRENCY [20 marks]

Start a NEW PAGE in your answer booklet. Label it C.

A detailed description of a particular synchronization problem is given.

In this question, you are required to write Java code for a number of classes, making use of the code below.

...

Write Java code according to the following requirements. In (a) and (b), you only need to ensure the safety properties of the problem. In (c), you need to modify your code to prevent starvation, ensuring that deadlock will not occur.

You must not use any concurrency library utilities, other than from package java.util.concurrent.locks. You may use Java concurrency primitives, such as synchronized, wait and notifyAll.

(a) Write a Java class to model … which is thread-safe, allowing concurrent read operations.

(b) Synchronisation with conditional waiting.

(c) A more detailed requirement needing further concurrency control, with multiple locks and possibility of deadlock that must be avoided.

(d) A question based on Assignment 1. No detailed code required here.
Part D. Short answer questions [20 marks]
Start a NEW PAGE in your answer booklet. Label it D.

7 questions. 3 marks each except for one worth 2 marks.

Topics covering both Scala and Java, selected from:

- Thread control in Java, managing interrupts; executor framework concepts (conc.4)
- Use of ForkJoin framework; concept of work-stealing (conc.5)
- Static methods vs dynamic binding in Java and Scala; (oofp.1-2) conversion of Java interface/class into equivalent Scala definitions
- Single vs multiple inheritance in OO; mixins in Scala, linearization of mixins (oofp.2)
- Role of implicits in Scala (oofp.6)
- Underlying structure Scala Collections; use and role of implicit Builders in the framework (oofp.3,7)
- The Actor model of concurrency and its implementation in Scala (oofp.8) know the behaviour and use of key methods: ! for message send, receive and react message handling, actor factory; in particular the difference between receive and react
- Correct overriding for object equality (oofp.9)
- Composite/Interpreter and Visitor Design Patterns in Scala; the extensibility/expression problem (oofp.9)

END OF PAPER