UNIVERSITY OF EDINBURGH

FACULTY OF SCIENCE AND ENGINEERING

M.Sc./DIPLOMA IN ARTIFICIAL INTELLIGENCE
M.Sc./DIPLOMA IN COGNITIVE SCIENCE
M.Sc./DIPLOMA IN COMPUTER SCIENCE
M.Sc./DIPLOMA IN INFORMATICS

PROGRAMMING IN JAVA

Monday 22 April 2002

09:30 to 11:00

Examiners:
N. Chater (External)
N. Jennings (External)
E. Hancock (External)
K. Hawick (External)
R.N. Ibbett (Convener)
J. Oberlander (Co-Convener)

INSTRUCTIONS TO CANDIDATES

Answer any TWO questions.

All questions carry equal weight.

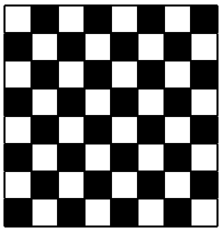
1. (a) Java applets are prevented from inflicting damage on the system onto which they are downloaded by *sandboxing*. Explain the restrictions which sandboxing places on an executing applet and discuss the safety or security issues which are relevant for each of these restrictions. [*4 marks*]

(b) Which component of the Java run-time system is responsible for enforcing the sandboxing policy? How does this component ensure that it can control access to security-sensitive operations? [*3 marks*]

(c) Describe the event-driven programming model which underlies the Java 1.1 Abstract Windowing Toolkit (AWT) as used in Java applets. Identify the Java language constructs which are used to implement the defining concepts of the Java 1.1 AWT event model. [*6 marks*]

(d) What are the security concerns which are raised by Java's AWT? How are these concerns alleviated in practice? [*3 marks*]

(e) You are to implement the graphical interface of a Java program to play chess. Your interface is to draw a chessboard as shown below, made up of alternating black and white squares.



The frame in which the chessboard is to be drawn is 800 $\times$ 800 pixels, so each of the black and white squares above measures 100 $\times$ 100 pixels. Provide the implementation of the `paint()` method for this class. Recall that a graphics context *`Graphics`* `g` provides the following methods:

```
public void setColor (Color c)
public void fillRect (int x, int y, int width, int height)
```

and that the `Color` class defines constants `Color.white` and `Color.black`.

[*6 marks*]

(f) The program needs to register mouse clicks in the frame in order to identify the squares on the chessboard by their row and column position. These positions are used to index into a two-dimensional array of *`ChessPiece`* objects and so their values are to range between 0 and 7. Implement the method

```
public void mousePressed(MouseEvent e)
```

for the *`MouseAdapter`* class listening for these mouse clicks. Recall that the `MouseEvent` class provides methods `getX()` and `getY()`. Update the *`int`* variables `row` and `column` accordingly. [*3 marks*]

2. (a) Users of Java's *Thread* class might find that the use of threads in their program slows its execution relative to a purely sequential version. Why does this happen? [*5 marks*]

(b) What are the two ways of creating threads in Java programs? Which would be used to make a subclass of `MyClass` into a thread? [*5 marks*]

(c) Each Java object contains a *lock* (also called a *monitor*). What role does this play in multi-threaded programming? [*3 marks*]

(d) What are *daemon* threads? [*2 marks*]

(e) The thread methods `stop()` and `suspend()` have been deprecated. What are the reasons for this? [*5 marks*]

(f) The *Fibonacci* numbers are defined thus:

$$
\begin{aligned}
fib(0) &= 0 \\
fib(1) &= 1 \\
fib(n) &= fib(n-2) + fib(n-1) \qquad (n > 1)
\end{aligned}
$$

Write a Java class, `Fib`, which uses threads to compute Fibonacci numbers. Your class should implement the following interface.

```
interface Fibonacci {
    public void setInput(int n);
    public int getResult();
}
```

[*5 marks*]

3. (a) What role does a *just-in-time* (JIT) compiler play in a Java Virtual Machine (JVM)? What are the advantages and disadvantages of the use of JIT compilers? What are the alternatives to deploying a JIT compiler in a JVM? [*6 marks*]

(b) The design of the Java language requires that the JVM provides automatic *garbage collection* for the language. Outline the operation of the garbage collector in a JVM. [*5 marks*]

(c) How do Java compilers implement *nested classes*? Why is this unusual compilation scheme chosen? [*2 marks*]

(d) The Java Virtual Machine submits compiled Java class files to *byte-code verification*. What properties are checked in this process? [*6 marks*]

(e) The Jalapeño Virtual Machine is a virtual machine for Java servers which is itself written in the Java language.

i. How does the Jalapeño Virtual Machine implement the run-time services of the virtual machine? [*2 marks*]

ii. With regard to the other processes of the virtual machine, what special care must be taken by the Jalapeño Virtual Machine while executing these run-time service methods? [*2 marks*]

iii. What special requirements are placed on a Java virtual machine for a Java server over and above those for a Java virtual machine which is to run on a typical workstation? [*2 marks*]