

EXAMINATIONS — 2011

MID-YEAR

SWEN221
Software Development

Time Allowed: 2 Hours

Instructions: There are 120 possible marks on the exam.
 Answer all questions in the boxes provided.
 Every box requires an answer.
 If additional space is required you may use a separate answer booklet.
 Non-electronic Foreign language dictionaries are allowed.
 Calculators ARE NOT ALLOWED.
 No reference material is allowed.

Question	Topic	Marks
1.	Style, Debugging and Exceptions	20
2.	Inheritance and Polymorphism	20
3.	Encapsulation and Object Contracts	20
4.	Java Generics	20
5.	Testing	20
6.	Threading, Garbage Collection and Reflection	20
Total		120

Question 1. Style, Debugging and Exceptions

[20 marks]

(a) [5 marks] For each of the following groups of statements, clearly indicate the one statement that is true:

(i) Generally, good code ...

1. does not need any comments.
2. will need some comments.
3. needs comments on every statement.

(ii) Following Java conventions as discussed in this course, constructors should be named ...

1. CapsWithWholeWordsCaps.
2. firstLowercaseThenCaps.
3. UPPERCASE_WITH_UNDERSCORE.

(iii) Debugging is the process of ...

1. reporting bugs.
2. checking there are no bugs.
3. finding and eliminating bugs.

(iv) Reproducing bugs ...

1. should be avoided during the debugging process.
2. is an important and straightforward step in the debugging process.
3. is an important and sometimes difficult step in the debugging process.

(v)

1. Every defect causes a failure.
2. Every failure causes a defect.
3. Every failure is caused by a defect.

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Cross out rough working that you do not want marked.

Specify the question number for work that you do want marked.

```

1 public class PalindromeCheck {
2
3     public static void main(String[] args) {
4         try {
5             String word = null;
6             boolean caseSensitive = true;
7             for (int i = 0; i != args.length; i++) {
8                 word = args[i];
9                 if (word.startsWith("-")) {
10                    String arg = args[i];
11                    if (arg.equals("-ci")) {
12                        caseSensitive = false;
13                    }
14                    if (arg.equals("-help")) {
15                        System.out.println("Palindrome_check");
16                        return;
17                    } else {
18                        throw new RuntimeException("Unknown_option");
19                    }
20                }
21            }
22            if (! caseSensitive) {
23                word = word.toUpperCase();
24            }
25            System.out.println("Result:_ " + palindromeCheck(word));
26        }
27        catch (Exception e) {
28            System.out.println("Sorry");
29        }
30        finally {
31            System.out.println("Bye");
32        }
33    }
34
35    /**
36     * Returns true if and only if the given word is a palindrome,
37     * that is, is the same when read forwards as when read backwards.
38     * For example, the word "otto" is a palindrome
39     * but the word "palindrome" is not.
40     */
41    public static boolean palindromeCheck(String word) {
42        ...
43    }
44 }

```

(b) For each of the following program calls, state what the program prints. You may assume that method `palindromeCheck(String word)` behaves as described.

(i) [2 marks] `java PalindromeCheck -help`

The input to main will be the array { `"-help"` }

(ii) [2 marks] `java PalindromeCheck -verbose otto`

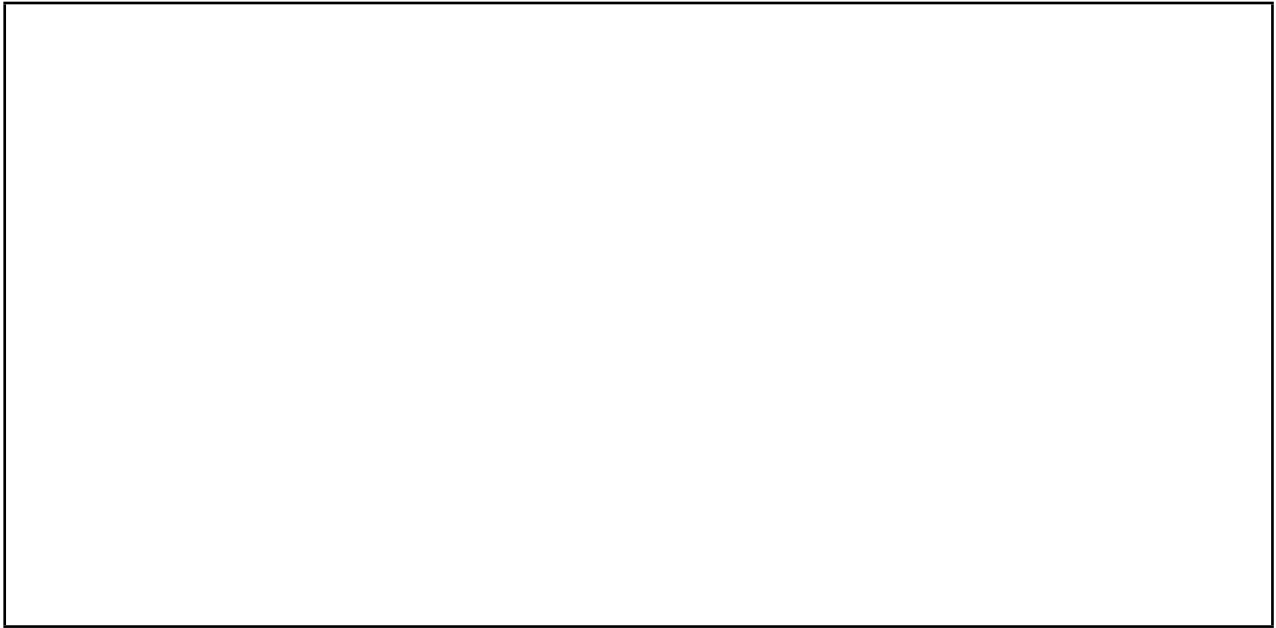
The input to main will be the array { `"-verbose"`, `"otto"` }

(iii) [2 marks] `java PalindromeCheck otto palindrome`

The input to main will be the array { `"otto"`, `"palindrome"` }

(iv) [4 marks] The program has a bug that prevents the case-insensitive case from working properly. Provide an input that exposes the bug, explain what the problem is, and how you would fix it.

(c) [5 marks] Using a *recursive* method, implement `palindromeCheck(String word)` so that it behaves as described.



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Question 2. Inheritance and Polymorphism

[20 marks]

Consider the following Java classes and interfaces.

```

1 interface Endangered {}
2
3 interface Named { String getName(); }
4
5 class Animal { public boolean chases(Animal a) { return false; } }
6
7 class Kiwi extends Animal implements Endangered {}
8
9 class Cat extends Animal implements Named {
10     public boolean chases(Animal a) { return true; }
11     public String getName() { return "Kitty"; }
12 }
13
14 class Dog extends Animal implements Named {
15     public boolean chases(Cat c) { return true; }
16     public String getName() { return "Fluffy"; }
17 }

```

(a) Given the above declarations, state whether the following classes compile without error. For any which do not compile, briefly describe the problem.

(i) [2 marks]

```

1 class Sheep extends Animal implements Named { }

```

(ii) [2 marks]

```

1 abstract class Tuatara extends Animal implements Endangered, Named {
2     public abstract String getName();
3 }

```


(iii) [2 marks]

```
1 class SuperKiwi extends Kiwi {
2     public boolean chases(Animal a) {
3         if (a instanceof Cat) {
4             Named kitty = (Cat) a;
5             return kitty.getName() == "Kitty";
6         }
7         return false;
8     }
9 }
```

(b) Given the above declarations, state either the output of the following code snippets or explain why the code does not compile.

(i) [2 marks]

```
1 Animal puss = new Cat();
2 puss.getName();
```

(ii) [2 marks]

```
1 Cat puss = new Cat();
2 Kiwi kiwi = new Kiwi();
3 System.out.println(puss.chases(kiwi));
```

(iii) [2 marks]

```
1   Animal puss = new Cat();
2   Kiwi kiwi = new Kiwi();
3   System.out.println(puss.chases(kiwi));
```

(iv) [2 marks]

```
1   Animal puss = new Cat();
2   Dog fluffy = new Dog();
3   System.out.println(fluffy.chases(puss));
```

(c) [6 marks] Discuss the similarities and differences between an abstract class and an interface.

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Question 3. Encapsulation and Object Contracts

[20 marks]

(a) Consider the following Java code. It compiles without error, but is of poor quality.

```
1 class IntArray implements Cloneable {
2     public int[] data;
3     public int size;
4
5     public boolean equals(IntArray other) {
6         if (this == other) return true;
7         if (size != other.size) return false;
8         for (int i = 0; i < size; i++) {
9             if (this.data[i] != other.data[i]) {
10                return false;
11            }
12        }
13        return true;
14    }
15
16    public int hashCode() {
17        // Returns a hash code based on the contents of the array data
18        return java.util.Arrays.hashCode(data);
19    }
20
21    public Object clone() {
22        IntArray cloned = new IntArray();
23        cloned.data = this.data;
24        cloned.size = this.size;
25        return cloned;
26    }
27 }
```

(i) [2 marks] Is IntArray properly encapsulated? Justify your answer.

(ii) [2 marks] Briefly, discuss one advantage of proper encapsulation.

(iii) [6 marks] Identify and explain 3 problems with the `equals` and `hashCode` methods given above.

1)

2)

3)

(iv) [6 marks] There are two standard ways of implementing the `clone` method. Discuss these two approaches, and identify which is used by `IntArray`.

(v) [4 marks] Rewrite the `clone` method given for `IntArray` so that it uses the other type of `clone`.

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Question 4. Java Generics

[20 marks]

(a) The `Tree` class, shown below, implements a *binary tree*.

(i) [6 marks] By writing neatly on the box below turn `Tree` into a generic version, `Tree<T>`, where `T` specifies the type of data held in the tree.

```

1 public class Tree {
2     private Tree left;
3     private Tree right;
4     private Object data;
5
6     public Tree(Tree left, Tree right, Object data) {
7         this.left = left;
8         this.right = right;
9         this.data = data;
10    }
11
12    public Tree left() {
13        return left;
14    }
15
16    public Tree right() {
17        return right;
18    }
19
20    public Object data() {
21        return data;
22    }
23
24    public static void flatten(Tree tree, List list) {
25        if(tree.left != null) { flatten(tree.left, list); }
26        list.add(tree.data);
27        if(tree.right != null) { flatten(tree.right, list); }
28    }

```

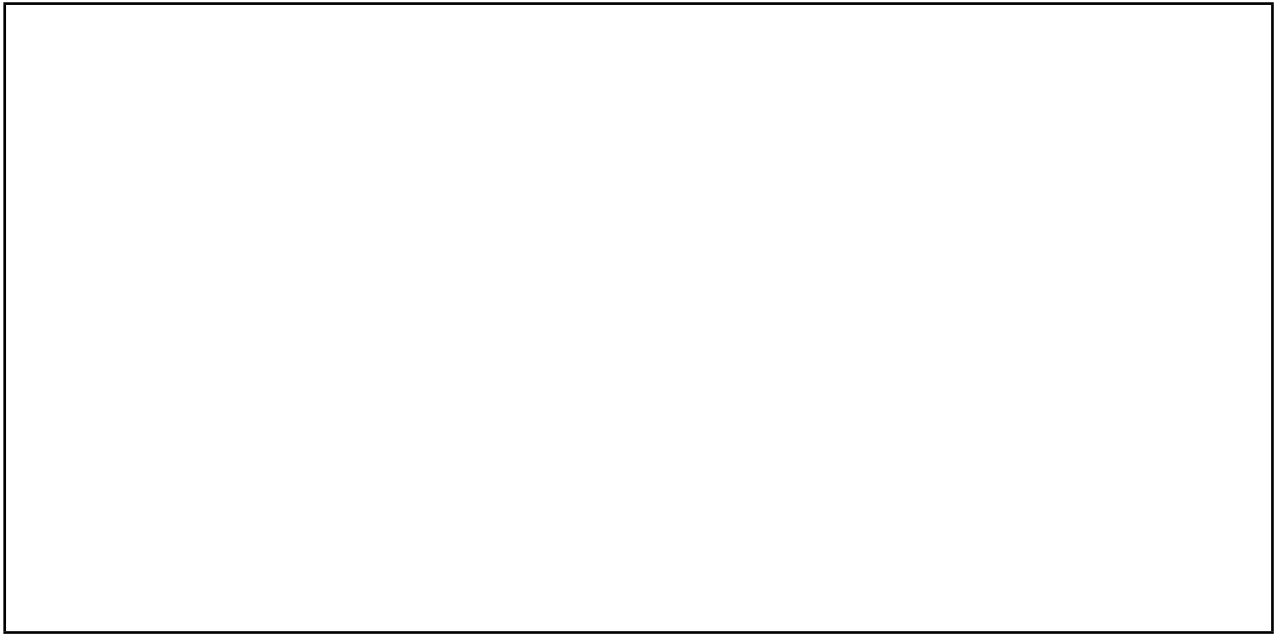
(ii) [4 marks] In the box below, provide code which creates an instance of a generic `Tree` which holds `Strings`. Your tree should contain at least three nodes.

(iii) [2 marks] Briefly, discuss why the generic `Tree<T>` is preferable to the non-generic version.

(iv) [2 marks] Suppose you wanted a generic version of `Tree` which ensured every data object had a `compareTo()` method. Briefly, discuss how you would do this.

(b) [6 marks] In Java, `List<String>` is **not** a subtype of `List<Object>`. Discuss why this is not permitted, using example code to illustrate.

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Question 5. Testing

[20 marks]

(a) [3 marks]

Discuss the similarities and differences between white-box and black-box testing.

(b) [3 marks]

What benefit does simple path coverage provide in managing test coverage?

Simple path coverage provides a better indicator of test coverage than either statement or branch coverage do. This is because statement and/or branch coverage can report 100% coverage, even though certain execution paths which can arise in practice have not been tested.

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(c) On the following page there is code for the InsuranceCalculator class.

```
1 public class InsuranceCalculator {
2
3     public InsuranceCalculator() {}
4
5     // Returns -1 if age is either less than 18 or greater than 64,
6     // or if the number of previous claims is either negative or greater
7     // than 5. Otherwise returns a positive value representing the
8     // insurance premium for insuring this person.
9     public int calculatePremium(int age, int numPrevClaims) {
10        if ((age < 18) || (age > 64)) {
11            return -1;
12        }
13        if ((numPrevClaims < 0) || (numPrevClaims > 5)) {
14            return -1;
15        }
16        int premium = 100;
17        if ((age / 10) > numPrevClaims) {
18            for (int loop = 0; loop < numPrevClaims; loop++) {
19                premium = premium * 1.1;
20            }
21            if (premium > (age * 5)) {
22                premium = age * 5;
23            }
24        } else {
25            premium += 100;
26            for (int loop = 0; loop < numPrevClaims - 1; loop++) {
27                premium = premium * 1.1;
28            }
29            if (premium < (age * 10))
30                premium = age * 10;
31        }
32        return premium;
33    }
34 }
35 }
```

(i) [8 marks]

Write five JUnit test cases for the `calculatePremium` method. Your test cases should cover the boundary conditions identified in the method's comment.

```
@Test void test1() {
    InsuranceCalculator ic = new InsuranceCalculator();
    assertTrue(300 == ic.calculatePremium(30,0));
}

@Test void test2() {
    InsuranceCalculator ic = new InsuranceCalculator();
    assertTrue(-1 == ic.calculatePremium(17,0));
}

@Test void test3() {
    InsuranceCalculator ic = new InsuranceCalculator();
    assertTrue(-1 == ic.calculatePremium(65,0));
}

@Test void test4() {
    InsuranceCalculator ic = new InsuranceCalculator();
    assertTrue(-1 == ic.calculatePremium(30,-1));
}

@Test void test5() {
    InsuranceCalculator ic = new InsuranceCalculator();
    assertTrue(-1 == ic.calculatePremium(30,6));
}
```

(ii) [6 marks]

Will the five black box test cases you have written also give you 100% statement coverage? Justify your answer by identifying (for each test case) what statements are covered.

No, it won't. Lines covered by tests are:

- `test1()` — covers lines 10, 13, 16, 17, 25, 26, 29, 30, 31 and 32.
- `test2()` — covers lines 10-12.
- `test3()` — covers lines 10-12.
- `test4()` — covers lines 10, 13-15.
- `test5()` — covers lines 10, 13-15.

As we can see from this, lines 18–23 are not covered by any test. Likewise, line 27 is not covered either. Therefore, we clearly have not achieved 100% coverage.

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Question 6. Threading, Garbage Collection & Reflection

[20 marks]

Consider the SimplePrint class below:

```

1 public class SimplePrint extends Thread {
2
3     public SimplePrint() {}
4
5     public void run() { System.out.println("run_called"); }
6
7     public static void main(String[] args) {
8         new SimplePrint().run();
9         new SimplePrint().start();
10    }
11 }

```

(a) [2 marks]

There are two statements in the main method. What are the consequences of each of these statements?

(b)

The SimpleCounter class on the following page describes a very simple multi-threaded program.

(i) [4 marks]

Assume the program runs to completion and the `System.out.println()` method is properly synchronized. Will the output always be that shown below? If so, why? If not, why not?

```

count=100000
count=100000

```

No, it will not always return those values. The reason for this is that the two Threads may not be at the same position through the loop when `swap` is called. This means the process of incrementing `count` may not go in a strictly sequential order.

(ii) [3 marks]

Sometimes the program doesn't complete, and seemingly freezes forever. Why?

This is because a dead-lock can occur if (by chance) both Threads enter their `swap()` method at the same time. Then, each will be waiting for the other to release its lock and, hence, they will wait forever.

```

1 public class SimpleCounter extends Thread {
2
3     private int count;
4     public SimpleCounter otherCounter;
5
6     SimpleCounter() { count = 0; }
7
8     public synchronized void setCount(int val) { count = val; }
9
10    public synchronized int getCount() { return count; }
11
12    public synchronized void swap() {
13        int value = count;
14        count = otherCounter.getCount();
15        otherCounter.setCount(value);
16        return;
17    }
18
19    public void run() {
20        for (int loop = 0; loop < 100000; loop++) {
21            setCount(getCount() + 1);
22            swap();
23        }
24        System.out.println("count=" + getCount());
25    }
26
27    public static void main(String[] args) {
28        SimpleCounter c1 = new SimpleCounter();
29        SimpleCounter c2 = new SimpleCounter();
30        c1.otherCounter = c2;
31        c2.otherCounter = c1;
32        c1.start();
33        c2.start();
34    }
35
36 }

```

(c) [3 marks]

Clearly indicate which one (or more) of the following three statements are true.

1. Non-static inner classes can access fields/methods of the enclosing class.
2. Inner classes automatically extend the enclosing class.
3. An instance of a private inner class cannot be returned from a method of the enclosing class to a method of an outside class.

(d) In the context of garbage collection, an object can be destroyed when it is no longer *reachable*.

(i) [2 marks]

Describe what is meant by the term *reachable*.

An object o_1 is *reachable* from another object o_2 if o_2 holds a reference to o_1 .

(ii) [3 marks]

Discuss the validity of the following statement: “An object is destroyed immediately when it becomes unreachable.”

(e) [3 marks] In Java, you cannot normally access **private** fields outside of their declared class. Briefly, discuss how *reflection* can be used to do this.

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