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EXAMINATIONS – 2014 TRIMESTER 1

SWEN221

Software Development

Time Allowed: THREE HOURS

Instructions: Closed Book.

There are 180 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.

No calculators permitted.

Non-electronic Foreign language dictionaries are allowed.

No reference material is allowed.

Question	Topic	Marks
1.	Debugging and Code Comprehension	30
2.	Java Masterclass	30
3.	Interfaces & Cloning	30
4.	Exceptions	30
5.	Testing	30
6.	Generics	30
	Total	180

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Question 1. Debugging and Code Comprehension

[30 marks]

Consider the following classes, which compile without error:

```
1 // A square on the board
2 abstract class Square {
     public abstract void attack();
4 }
6 // A blank square on the board
7 public class Blank extends Square {
     public void attack() {}
  // A monster on the board
  public class Monster extends Square {
      private int hitPoints;
      public Monster(int hitPoints) { this.hitPoints = hitPoints; }
15
      public void attack() { hitPoints --; }
17
      public boolean isDestroyed() { return hitPoints == 0; }
20
21
  // The board
  public class Board {
24
      // A width * height grid of squares. Each square
      private Square[][] squares;
26
27
      public Board(int width, int height) {
          squares = new Square[width][height];
29
      }
30
      public void place(Monster m, int x, int y, int width) {
           for (int i=x;i!=width;++i) {
33
             squares[i][y] = m;
34
           }
35
      }
36
      public void attack(int x, int y) { squares[x][y].attack(); }
 }
39
```

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(a) Based on the code given on page 2, state the output you would expect for each of the following code snippets:

(i) [2 marks]

```
Board board = new Board(10,10);
Monster m = new Monster(5);
board.place(m,0,0,3);
board.attack(0,0);
System.out.println(m.isDestroyed());
```

(**ii**) [2 marks]

```
Board board = new Board(10,10);
Monster m = new Monster(2);
board.place(m,0,0,3);
board.attack(1,0);
board.attack(2,0);
System.out.println(m.isDestroyed());
```

(iii) [2 marks]

```
Board board = new Board(10,10);
Monster m = new Monster(2);
board.place(m,0,0,3);
board.place(m,0,5,3);
board.attack(1,0);
board.attack(2,5);
System.out.println(m.isDestroyed());
```

(**iv**) [2 marks]

```
Board board = new Board(10,10);
Monster m = new Monster(5);
board.place(m,0,0,3);
board.attack(1,5);
System.out.println(m.isDestroyed());
```

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(b) [5 marks] Rewrite the Board constructor so that it initialises every square in square to a Blank square.	35
	_
(c) [3 marks] Consider the method Monster.attack(). Does this overload or overrice the method Square.attack()? Justify your answer.	de
(d) [3 marks] The class Square is declared as abstract. Briefly, discuss what the means.	nis

e) Two square	es on the board may refer to the same Monster.
(i) [2 marks]	Briefly, explain the meaning of this in terms of <i>objects</i> and <i>references</i> .
(ii) [5 marks	Briefly, discuss what effect this has on how the program works.
	Two squares on the board may refer to the same Blank square. Brinis does not affect how the program works.

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Question 2. Java Masterclass

[30 marks]

As for the self assessment tool, for each of the following questions, provide in the answer box the code that should replace [???].

```
(a) [4 marks]

1    //The answer must have balanced parentesis
2    public class Exercise{
3        public static void main(String [] arg) {
4            int foo=10;
5            assert (10==[???]);
6            assert (11==[???]);
7            assert (12==[???]);
8            assert (13==[???]);
9            }
10      }
```

(b) [4 marks]

```
//The answer must have balanced parenthesis,
class Avatar{
   Avatar(String name) {this.name=name;}
   String name;
}
class NintendoAvatar extends Avatar{[???]}

public class Exercise{
   public static void main(String [] arg) {
      assert (new NintendoAvatar().name.equals("Mario"));
      assert (new NintendoAvatar("Luigi").name.equals("Luigi"));
}
```

SWEN221 Page 6 of 26 continued...

```
(c) [4 marks]

//The answer must have balanced parenthesis

class Base1{ int m(){return 1;}}

class Base2{ int m(){return 2;}}

class C1 extends Base1{ int m(){[???]}}

class C2 extends Base2{ int m(){[???]}}

public class Exercise{

public static void main(String [] arg){

assert new C1().m()==10;

assert new C2().m()==20;

}

(d) [4 marks]

//The answer must have balanced parentesis

import java.util.HashSet;
```

//The answer must have balanced parentesis
import java.util.HashSet;
class Elem { [???] }
public class Exercise{
public static void main(String [] arg) {
 HashSet<Elem> es=new HashSet<Elem>();
es.add(new Elem());

es.add(new Elem());
es.add(new Elem());
es.add(new Elem());
es.add(new Elem());
assert es.size()==1;

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(e) [4 marks]

```
//The answer must have balanced parenthesis
class A{
  int m() {return 1; }

public class Exercise{
  public static void main(String [] arg) {
    A a=[???];
  assert a.m() == 2;
}
```

(f) [10 marks]

```
//The answer must have balanced parenthesis
import java.util.ArrayList;
interface A{int m();}

public class Test {
   public static void main(String[] arg){
        ArrayList<A> a=new ArrayList<A>();
        for(int i=0;i<10;i++){add(a);}

        assert a.get(0).m()==0;
        assert a.get(1).m()==1;
        assert a.get(7).m()==7;
        assert a.get(9).m()==9;
}
[???]</pre>
```

Hint: since add () is called from main () but is not declared, you may want to declare it.



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Question 3. Interfaces & Cloning

[30 marks]

(a) Consider the following classes and interfaces:

```
interface Shape {
      boolean contains(int x, int y);
      Shape clone();
  }
  public class Rectangle implements Shape {
    private int x1;
    private int y1;
    private int x2;
    private int y2;
11
    public Rectangle(int x1, int y1, int x2, int y2) {
      this.x1 = x1; this.y1 = y1;
      this.x2 = x2; this.y2 = y2;
14
15
    public bool contains(int x, int y) {
16
      // Check x,y is contained within this rectangle
17
      return x >= Math.min(x1, x2) &&
              x \le Math.max(x1, x2) &&
              y >= Math.min(y1, y2) &&
20
              y \le Math.max(y1,y2);
21
    public Shape clone() { [???] }
23
 }
24
```

(i) [3 marks] Give an appropriate implementation of clone() for the Rectangle class.



(ii) [5 marks] Briefly, discuss why there is no difference between a *deep clone* and a *shallow clone* for the Rectangle class.

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(b) Consider the following implementation of shape:

```
class ShapeUnion implements Shape {
    private Shape[] shapes;

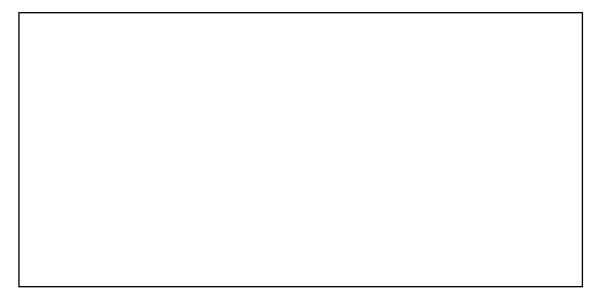
public ShapeUnion(Shape[] ss) {
    this.shapes = ss;
}

public boolean contains(int x, int y) {
    for(Shape s : shapes) {
        if(s.contains(x,y)) { return true; }
    }

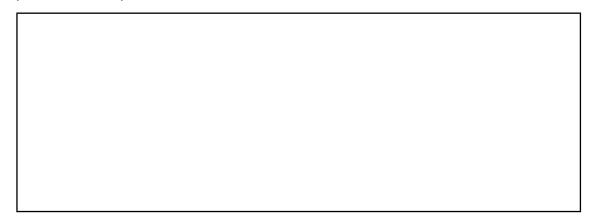
return false;
}

public Shape clone() { [???] }
}
```

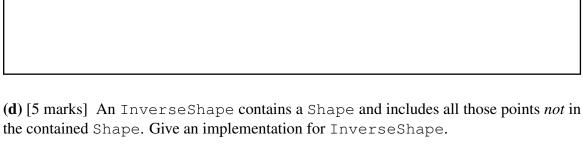
(i) [7 marks] Give an implementation of clone () for the ShapeUnion class which implements a *deep clone*. You may assume that a Shape cannot contain itself.

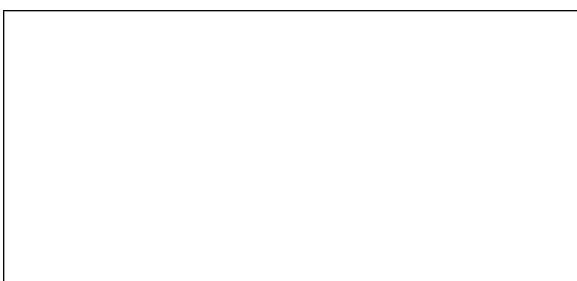


(ii) [5 marks] Suppose that a Shape was permitted to contain itself. Briefly, discuss how you would alter your clone () method to handle this.



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(c) [5 m	narks] Consider again the constructor for ShapeUnion:
1	<pre>public ShapeUnion(Shape[] ss) {</pre>
2	<pre>this.shapes = ss;</pre>
3	}
	onstructor assigns the ss parameter directly to the shapes field. Briefly, discuss r you think this is a good or bad idea and what (if anything) you would do differently.





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Question 4. Exceptions

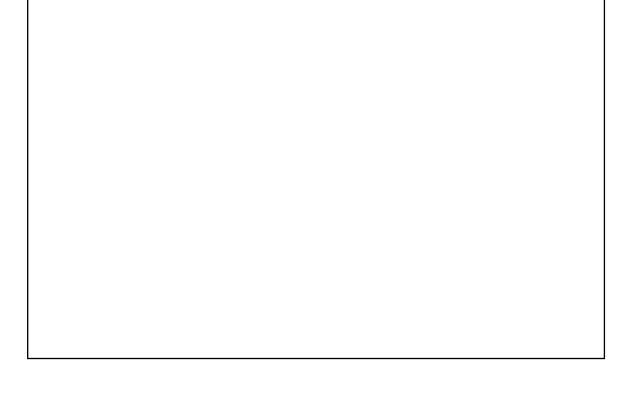
[30 marks]

A New Zealand supermarket chain has a data management system which is able to recover employers data. This is their getData() method

```
public Employer getData(int id) {
   Employer result=null;
   DBConnection db=new DBConnection("...");
   Result r=db.query("select_..."+id+"...");
   // if a result comes back, just return it
   if(r.size()==1) {result=new Employer(r);}
   // otherwise, must have been an invalid id.
   return result;
   }
}

(a) [2 marks] How does the current implementation handle the case of an invalid employer ID?
```

(b) [5 marks] How would you modify this method in order to provide a better behaviour in the case of an invalid employer ID? Write down the new code for method getData().



lefine for you	Write down t r answer to (b				
	Class DBCor	ection. Ho	ethod clos w would yo		
	latabase conn	osed?			
		osed?			

(I) [2 marks]	Is Throwable checked or unchecked?
	Explain why it must be checked / unchecked and why it could not but are encouraged to use a code example.
(***) [6 mandra	The Exception class has the following constructor:
	(String message, Throwable cause)
Exception	(String message, Throwable cause) meaning of both parameters. In particular, when is the second paramet
Exception Describe the	

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Question 5. Testing

[30 marks]

(a) Consider the following classes which compile without error:

```
public class Rectangle {
    private int x1;
    private int y1;
    private int x2;
    private int y2;
    public Rectangle(int x1, int y1, int x2, int y2) {
       this.x1 = x1; this.y1 = y1;
       this.x2 = x2; this.y2 = y2;
10
    }
11
    public boolean contains(int x, int y) {
       int minX;
       int maxX;
14
       int minY;
15
       int maxY;
16
       // Determine minimum and maximum bounds
       if (x1 < x2) \{ minX = x1; maxX = x2; \}
       else {
         minX = x2; maxX = x1;
20
21
       if (y1 < y2) \{ minY = y1; maxY = y2; \}
22
       else {
23
         minY = y2; maxY = y1;
       // Check whether point x,y is contained
       if(minX > x) { return false; }
       if(maxX < x) { return false; }</pre>
       if(minY > y) { return false; }
       if(maxY < y) { return false; }</pre>
       return true;
  } }
  public class RectangleTests {
    @Test void testContains_1()
35
       assertTrue (new Rectangle (0, 0, 5, 5) .contains (1, 1));
36
37
    @Test void testContains_2() {
       assertTrue (new Rectangle (5, 5, 0, 0) .contains (1, 1));
40
    @Test void testContains_3() {
41
       assertFalse (new Rectangle (0, 0, 5, 5) .contains (-1, 1));
42
43
    @Test void testContains_4() {
44
       assertFalse (new Rectangle (0,0,5,5) .contains (6,1));
  } }
```

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(iii) [2 marks] Give the total statement coverage of class Rectangle tests in RectangleTests. (iv) [2 marks] What is branch coverage? (v) [2 marks] Give the total branch coverage of class Rectangle tests in RectangleTests.	obtained from t
(iv) [2 marks] What is branch coverage? (v) [2 marks] Give the total branch coverage of class Rectangle	obtained from t
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(v) [2 marks] Give the total <i>branch coverage</i> of class Rectangle	
	obtained from t
The <i>path coverage</i> criterion counts the proportion of all possible exece tested.	
(i) [3 marks] Give the total number of possible execution paths the Rectangle.contains().	ution paths whi

(ii) [2 marks] Give the total path coverage of class Rectangle obtained from the tests in RectangleTests.
(iii) [4 marks] Give two additional test cases which increase the path coverage obtained for Rectangle.
(iv) [2 marks] Briefly, describe what an <i>infeasible path</i> is.
(v) [3 marks] Why is path coverage impossible to measure in general?

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Question 6. Generics

[30 marks]

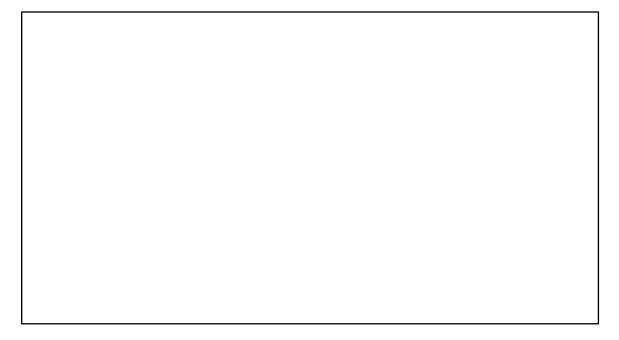
Consider the following code

```
import java.util.ArrayList;

class Point{
  int x; int y;
  Point(int x, int y) { this.x=x; this.y=y; }

class ColoredPoint extends Point{
  int color;
  ColoredPoint(int x, int y,int color) {
    super(x, y); this.color=color;
}
```

(a) [5 marks] There are many possible representations for colours. The class ColoredPoint uses an **int**. Write instead a generic class GenericPoint<T> that uses any kind of type as a representation of a colour.



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(b) Consider the following code

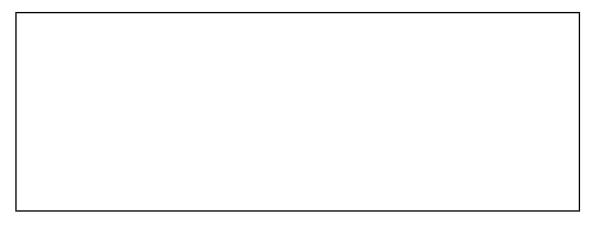
```
public class GenericTest {
    static void m(ArrayList<Point> p) {
     [???]//you will be asked to fill the hole here
    }
    public static void main(String[] args) {
      ArrayList<ColoredPoint> cps=new ArrayList<ColoredPoint>();
      try{
        m((ArrayList<Point>)(Object)cps);
      }
10
      catch(Throwable t) { }
11
      for (ColoredPoint p:cps) {
        System.out.println(p.color);
    }
15
```

Initially, Bob the programmer tried to pass variable cps directly to the method m(), but this caused a compilation error; he could not understand the reason for such an error, thus he decided to trick the type system and cast the error away (line 9).

(i) [5 marks] Explain the effect of the two casts in line 9, i.e. what happens when

m((ArrayList <point>)(Object)cps); is executed.</point>											

(ii) [7 marks] Inserting such casts is unsafe! Provide an example implementation of the method m(), (replacing the [???] sign) that forces the method main() to throw an exception.



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