


EXAMINATIONS – 2015
TRIMESTER 1

SWEN221

Software Development

Time Allowed: TWO HOURS

CLOSED BOOK

Permitted materials: No calculators permitted.
 Non-electronic Foreign language to English dictionaries are allowed.

Instructions: Answer all questions
 All questions are of equal value

Answer all questions in the boxes provided.
 Every box requires an answer.
 If additional space is required you may use a separate answer booklet.

Question	Topic	Marks
1.	Code Comprehension	30
2.	Testing	30
3.	Java Masterclass	30
4.	Exceptions and Assertions	30
Total		120

Question 1. Code Comprehension

[30 marks]

Consider the following classes and interfaces, which compile without error:

```
1 // A variable holding a logic (i.e. boolean) value
2 class LogicVar {
3     private boolean value;
4
5     public LogicVar(boolean value) { this.value = value; }
6
7     public boolean get() { return value; }
8
9     public void set(boolean value) { this.value = value; }
10 }
11
12 // A logic gate reads two inputs and writes one output
13 abstract class LogicGate {
14     private LogicVar[] variables = new LogicVar[3];
15
16     public LogicGate(LogicVar in1, LogicVar in2, LogicVar out) {
17         variables[0] = in1;
18         variables[1] = in2;
19         variables[2] = out;
20     }
21     public void evaluate() {
22         boolean in1 = variables[0].get();
23         boolean in2 = variables[1].get();
24         variables[2].set(evaluate(in1,in2));
25     }
26     public abstract boolean evaluate(boolean in1, boolean in2);
27 }
28
29 // If both inputs true, out is true; otherwise, out is false.
30 class AndGate extends LogicGate {
31     public AndGate(LogicVar v1, LogicVar v2, LogicVar v3) {
32         super(v1,v2,v3);
33     }
34     public boolean evaluate(boolean in1, boolean in2) {
35         return in1 && in2;
36     } }
37
38 // If either input is true, out is true; otherwise, out is false.
39 class OrGate extends LogicGate {
40     public OrGate(LogicVar v1, LogicVar v2, LogicVar v3) {
41         super(v1,v2,v3);
42     }
43     public boolean evaluate(boolean in1, boolean in2) {
44         return in1 || in2;
45     } }
```

(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]

```
1 LogicVar v1 = new LogicVar(true);
2 System.out.println(v1.get());
```

(ii) [2 marks]

```
1 LogicVar v1 = new LogicVar(false);
2 LogicVar v2 = new LogicVar(true);
3 LogicVar v3 = new LogicVar(true);
4 LogicGate gate = new AndGate(v1,v2,v3);
5 gate.evaluate();
6 System.out.println(v1.get() + "_" + v2.get() + "_" + v3.get());
```

(iii) [2 marks]

```
1 LogicVar v1 = new LogicVar(true);
2 LogicVar v2 = new LogicVar(false);
3 LogicGate gate = new OrGate(v1,v2,v2);
4 gate.evaluate();
5 System.out.println(v1.get() + "_" + v2.get());
```

(iv) [2 marks]

```
1 LogicVar v1 = new LogicVar(true);
2 LogicVar v2 = new LogicVar(false);
3 LogicVar v3 = new LogicVar(false);
4 LogicGate gate1 = new OrGate(v1,v2,v3);
5 LogicGate gate2 = new AndGate(v3,v2,v1);
6 gate1.evaluate();
7 gate2.evaluate();
8 System.out.println(v1.get() + "_" + v2.get() + "_" + v3.get());
```

(b) [5 marks] Provide an implementation for a class `XorGate`. This sets the `out` field to **true** if exactly one input is **true** (i.e. not both); otherwise, it sets it to **false**.

(c) [3 marks] Consider the method `LogicGate.evaluate()`. Does it *overload* or *override* the method `LogicGate.evaluate(boolean, boolean)`? Justify your answer.

(d) Suppose the following method were added to class LogicGate:

```
1 public boolean equals(Object o) {
2     if(o instanceof LogicGate) {
3         LogicGate lg = (LogicGate) o;
4         for(int i=0;i!=variables.length;++i) {
5             if(variables[i] != lg.variables[i]) { return false; }
6         }
7         return true;
8     }
9     return false;
10 }
```

(i) [6 marks] This method means an AndGate can equal an OrGate. Briefly, illustrate how you would fix this problem.

(e) Consider the following snippet of code:

```
1 LogicGate gate = new AndGate(v1,v2,v3);
```

(i) [4 marks] The *static type* of variable `gate` is `LogicGate`. Briefly, discuss what this means and how it affects what values variable `gate` may hold.

(ii) [4 marks] The *dynamic type* of variable `gate` is `AndGate`. Briefly, discuss what this means and how it affects the execution of method `LogicGate.evaluate()`

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Cross out rough working that you do not want marked.
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Question 2. Testing

[30 marks]

(a) [5 marks] Briefly, discuss the difference between *black-box* and *white-box* testing.

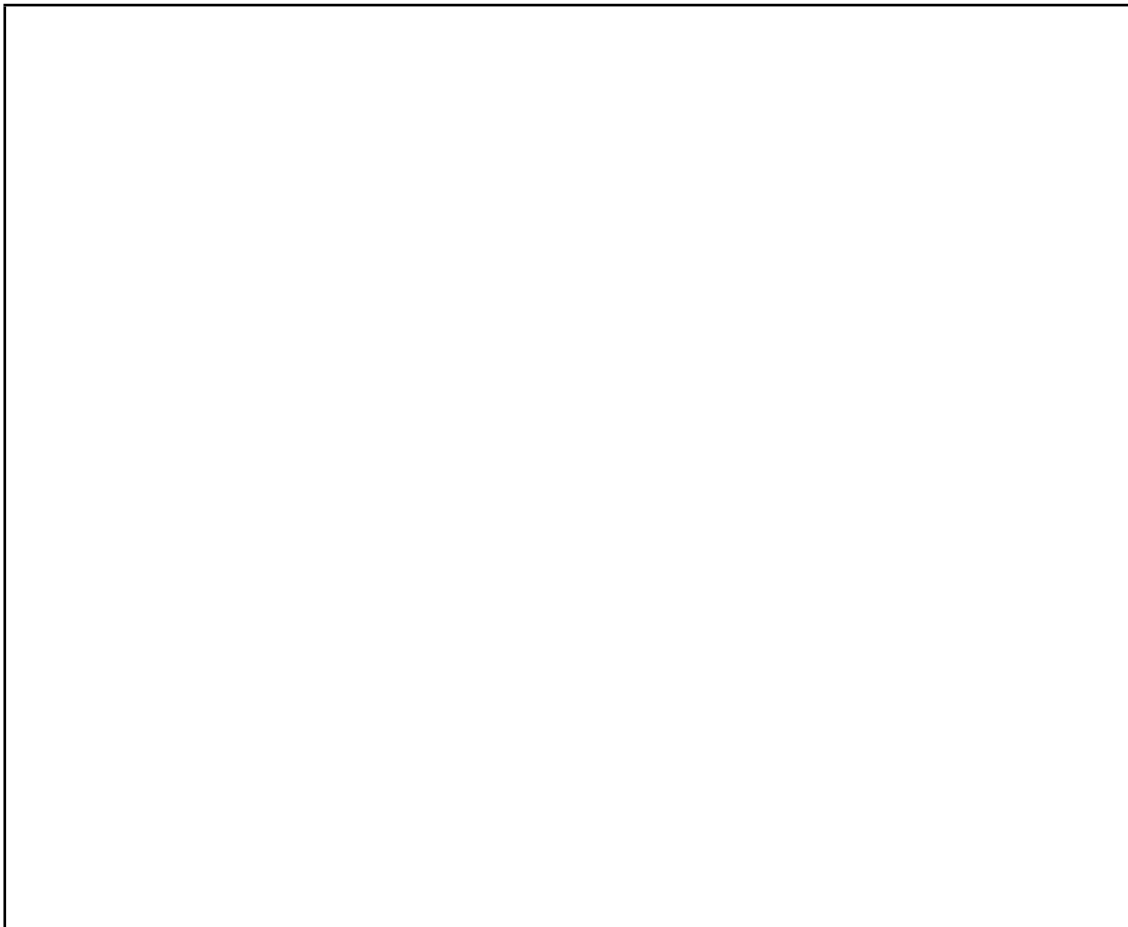
(b) [2 marks] What is *branch coverage*?

(c) [2 marks] What is *simple path coverage*?

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

```
1  class List {
2      private int[] items;
3
4      public List(int[] items) {
5          this.items = items;
6      }
7
8      public boolean hasBetween(int min, int max) {
9          int i = 0;
10         while(i < items.length) {
11             if(min <= items[i]) {
12                 if(items[i] <= max) {
13                     return true;
14                 }
15             }
16             i = i + 1;
17         }
18         return false;
19     } }
```

(i) [8 marks] Draw the *control-flow graph* for the `List.hasBetween(int, int)` method:



Consider the following test cases for the class `List`:

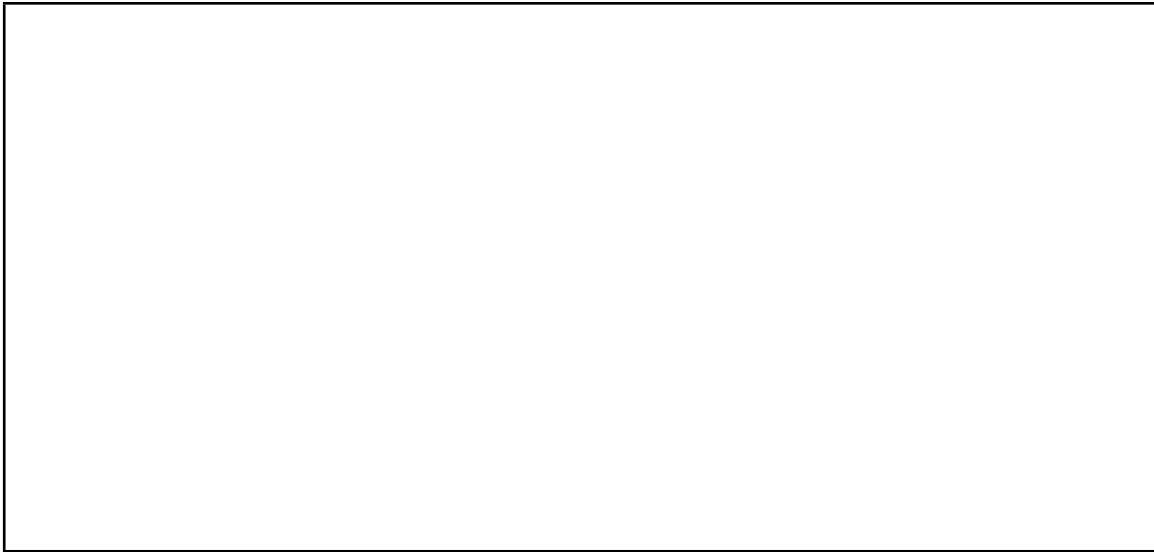
```
1 public class ListTests {
2     public static final int[] ITEMS = {-1,0,1};
3
4     @Test public void testHasBetween_1() {
5         assertFalse(new List(ITEMS).hasBetween(5,10));
6     }
7     @Test public void testHasBetween_2() {
8         assertFalse(new List(ITEMS).hasBetween(-10,-5));
9     } }
```

(ii) [2 marks] Give the total *branch coverage* obtained for class `List` from the tests provided in `ListTests`.

(iii) [2 marks] Give the total *simple path coverage* obtained for class `List` from the tests provided in `ListTests`.

(iv) [4 marks] Give two additional test cases which increase the simple path coverage obtained for `List` to 100%.

(e) [5 marks] Briefly, discuss why *polymorphism* in Java can result in an infinite number of execution paths for a given method.



Question 3. 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) [5 marks]

```
1 //The answer must have balanced parenthesis
2 interface Joke{
3     int laughingTime();
4 }
5 class FunnyJoke implements Joke{
6     public int laughingTime(){return 5;}
7 }
8 class BadJoke implements Joke{
9     public int laughingTime(){return 0;}
10 }
11 class SoBadItsGoodJoke extends BadJoke{
12     public int laughingTime(){return 10;}
13 }
14 public class Exercise{
15
16     static int time=0;
17
18     static void joke(Joke j){time+=j.laughingTime();}
19
20     public static void main(String[] arg){
21         joke(new FunnyJoke());
22         joke(new SoBadItsGoodJoke());
23         joke(new BadJoke());
24         assert time==[???];
25     }
26 }
```

(b) [4 marks]

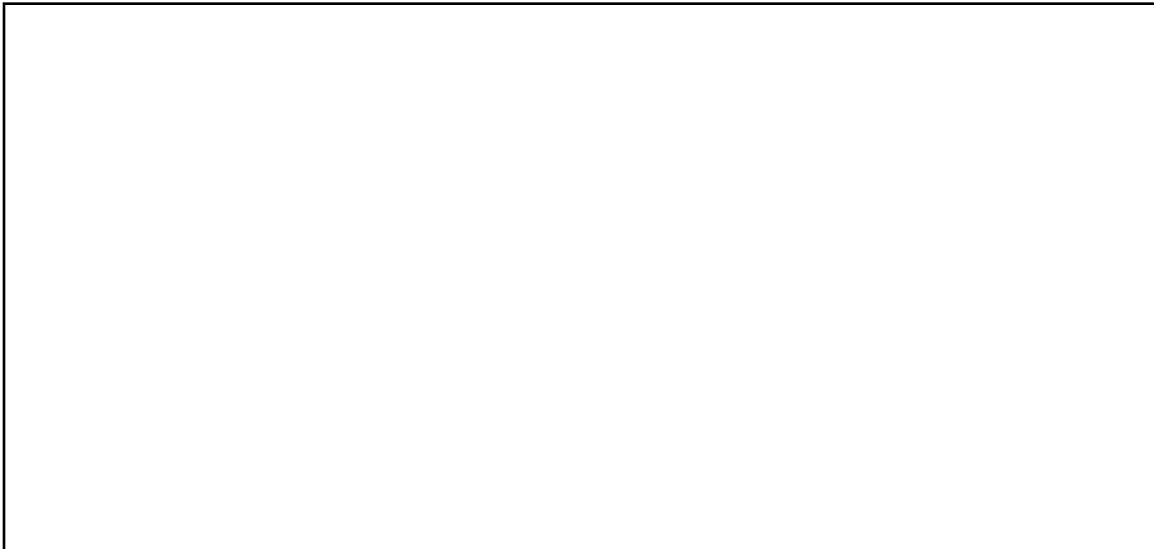
```
1 //The answer must have balanced parenthesis
2 class Hero{ int strength(){return 10;} }
3 class [???]{ int strength(){return 100;} }
4 public class Exercise{
5     public static void main(String [] arg){
6         Hero h=new Hercules();
7         assert h.strength()==100;
8     }
9 }
```

(c) [5 marks]

```
1 //The answer must have balanced parenthesis
2 class ThorHammer{[???]}
3
4 public class Exercise{
5     public static void main(String [] arg){
6         ThorHammer h1=ThorHammer.getInstance();
7         ThorHammer h2=ThorHammer.getInstance();
8         assert h1!=null;
9         assert h1==h2;
10 } }
```

(d) [6 marks]

```
1 //The answer must have balanced parenthesis
2 class Hammer{
3     private int weight;
4     public Hammer(int weight){this.weight=weight;}
5     public int getWeight(){return weight;}
6     public int hashCode() {return this.weight;}
7 }
8 class ThorHammer extends Hammer{[???]}
9
10 public class Exercise{
11     public static void main(String[] arg){
12         assert new ThorHammer().getWeight()==42;
13         assert new Hammer(0).hashCode()==new ThorHammer().hashCode();
14     } }
```



(e) [5 marks]

```
1 //The answer must have balanced parenthesis
2 class A{ int m(){return 1;}}
3
4 public class Exercise{
5     public static void main(String[] arg){
6         A a=[???];
7         assert a.m()==2;
8     }
9 }
```



(f) [5 marks]

```
1 // The answer must have balanced parenthesis
2 import java.util.Arrays;
3 import java.util.List;
4
5 class Point{
6     int x;
7     int y;
8     Point(int x, int y) { this.x=x;this.y=y; }
9 }
10 class ColPoint extends Point {
11     int colour;
12     ColPoint(int x, int y, int colour) {
13         super(x,y);
14         this.colour=colour;
15     }
16 }
17
18 public class Exercise{// make this code compile
19     static void printAll([??]){
20         for(Point p:ps){
21             System.out.println(""+p.x+"_"+p.y);
22         }
23     }
24     public static void main(String[]arg){
25         List<Point> l1=Arrays.asList(new Point(1,2));
26         List<ColPoint> l2=Arrays.asList(new ColPoint(1,2,0));
27         printAll(l1);
28         printAll(l2);
29     }
30 }
```


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Question 4. Exceptions and Assertions

[30 marks]

(a) [2 marks] Are Assertions in Java enabled or disabled by default?

(b) [2 marks] Explain how to enable/disable assertions either from the command line or from eclipse.

(c) [4 marks] Insert sensible assertions with appropriate error messages into the following code to ensure that the parameter cannot be null and that the result will be positive.

```
public static int distanceFromOrigin(Point p) {  
  
    int x=p.x*p.x;  
  
    int y=p.y*p.y;  
  
    int result=x+y  
  
    return result;  
  
}
```

(d) [6 marks] One of your colleagues has written a method `dbQuery`. This method connects to a database, executes a query and returns a list of all the data produced. If there is an error working with the database, `dbQuery` simply propagates a checked exception.

You are using `dbQuery` to write a function to load employers data from a database.

```
1 class LoadData{
2     private static
3     List<Data> dbQuery(String id) throws DBException {
4         /*omitted*/
5     }
6     public static Data load(String id){
7         try{
8             List<Data> data=dbQuery("select_..." +id);
9             if(data.size() !=1){
10                throw new UncheckedDBException(
11                    "Data_size_is_" +data.size());
12            }
13            return data.get(0);
14        }
15        [???]
16    }
17 }
```

As for the self assessment tool, provide in the answer box the code that should replace `[???]` to make the code compile. At this stage, you can assume a class `UncheckedDBException` is declared elsewhere.

(e) [5 marks] Identify an alternative solution for question (d) and discuss its pros and cons.

(f) [4 marks] Provide code for the class `UncheckedDBException`, so that the code before could compile.

(g) “Finally” is an important feature of Java exception handling.

(i) [4 marks] Briefly, discuss what **finally** means in Java.

(ii) [3 marks] Briefly, describe a situation where using **finally** would be sensible.

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