THE UNIVERSITY OF MELBOURNE
DEPARTMENT OF COMPUTING AND INFORMATION SYSTEMS

Examination – Semester 1, 2016
COMP90041Programming and Software Development

Reading Time: **15** minutes   **Total marks for this Exam: 60**
Writing Time: 2 hours
This exam has 12 pages.

Identical Examination Papers: None
Common Content Papers: None

Authorised materials:
Writing materials (e.g. pens, pencils) are allowed.
Books, calculators and dictionaries are *not* allowed.

Instructions to Invigilators:
Supply students with standard script book(s).

Instructions to Students:

- Attempt all questions.
- Answer all the questions in the provided answer booklet. Put your answer next to the corresponding question number for each question. Answer all the multiple choice questions on the first page of the answer booklet.
- Clearly number and write your answers. Any unreadable answer will be considered wrong.
- For multiple choice questions, choose the best answer.
- Use the marks as a guide to the level of details required in your answers while keeping your answers concise and relevant.

This paper may be held by Baillieu Library.

Multiple choice questions [choose only one answer for each question]: [1 mark each]

1. The following piece of Java code:

   ```
   System.out.println("Java programming is \"fun\"");
   ```

   a) produces the line of output: `Java#programming#is#\"fun\"`
   b) produces the line of output: `Java#programming#is#fun`
   c) produces the line of output: `Java#programming#is#"fun"`
   d) produces the line of output: `Java#programming#is#"fun""`
   e) will cause compilation errors.

   Note: The `#` character indicates a space character in the output.

2. Which of the following identifier is invalid in Java:
   a) `Player`
   b) `player1`
   c) `$player`
   d) `Player_1`
   e) None of the above

3. The following piece of code:

   ```
   int i = 3;
   while (i >= 0) {
     System.out.print(" " + i);
      i--;
   }
   System.out.println;
   ```

   produces which of the following lines of output in standard output?

   a) `#3#2#1#0`
   b) `3#2#1#0`
   c) `#3#2#1#0#-1`
   d) `#3#2#1`
   e) `#3#2#1#`

   Note : The character `#` indicates a space character in the output.

4. What is the output of the following piece of code:

```
String str = "banana";
System.out.print(str.compareTo("PIE"));
```

   a) `RuntimeException`
   b) `0`
   c) a negative umber
   d) a positive number
   e) `NULL`

5. After the execution of the following piece of code:

```
int[] u = new int[] { 1, 2, 3, 4, 5 };
int[] v = u;
v[4] = 6;
```

the array element `u[4]` will contain the value:

   a) `null`, because the assignment empties the array `u`.
   b) `5`, because the array `v` is a copy of the array `u` and changes on `v` will not affect `u`.
   c) `4`, because the array `v` is a copy of the array `u` and changes on `v` will not affect `u`.
   d) `6`, because `v` and `u` refer to the same array.
   e) `Integer(6)`, because arrays can contain only Java objects, not primitive data types.

6. Given the following piece of code, what is the result of execution:

```
class Ex1{
    static int x = 3;
    public static void main(String[] args) {
          for(int x=0;x<5;x++);
          System.out.print(x);
    }
}
```
   a) `01234`
   b) `3`
   c) Compilation fails
   d) `5`
   e) A runtime exception will be thrown

7. A UML association from class `A` to class `B` (that is, the arrow points to `B`) means
   a) Class `B` inherits from Class `A`
   b) Class `B` is defined within class `A`
   c) Class `B` has an attribute of type `A`
   d) Class `A` has an attribute of type `B`
   e) None of the above

8. Which of the following statements is true?
   a) "`X extends Y`" is correct if and only if `X` is a class and `Y` is an interface
   b) "`X extends Y`" is correct if and only if `X` is an interface and `Y` is a class
   c) "`X extends Y`" is correct if `X` and `Y` are either both classes or both interfaces
   d) "`X extends Y`" is correct for all combinations of `X` and `Y` being classes and/or interfaces.
   e) None of the above

9. Given following piece of code:

```
ArrayList<Double> marks = new ArrayList<Double>();
marks.add(3.0);
marks.add(2.5);
marks.add(4.7);
marks.add(3, 3.9);
marks.add(1, 1.5);
double a = marks.get(2);
double b = marks.get(4);
marks.remove(2);
marks.remove(1);
int c = marks.lastIndexOf(3.9);
boolean d = marks.contains(2.5);
int e = marks.indexOf(4.7);
```

Which statement is evaluated to be `true`:

   a) `a == 3.9`
   b) `b < a`
   c) `c == 2`
   d) `d == true`
   e) `e == 3`

10. Given the following class definition:

```
public class Base {
    protected int count;
    public Base () {
        count = 1;
    }
}

public class Inherited extends Base{
    public int addCount() {
        return count++;
    }
}
```

Which of the following claim is true after the following statements have been executed?

```
Inherited inheritedObject = new Inherited();
int i = inheritedObject.addCount();
```

   a) `i == 0`
   b) `i == 1`
   c) `i == 2`
   d) A `RuntimeException` will be thrown
   e) The code will not compile and hence cannot be executed

11. Which package is imported by default into Java programs?
   a) `java.lang`
   b) `java.util`
   c) `java.io`
   d) `java.util.ArrayList`
   e) None of the above

12. An object of which of the following types can have its length changed during the runtime of a program?
   a) Array
   b) `ArrayList`
   c) Type parameter
   d) `String`
   e) None of the above

13. Which of the following class can we use to read from a text file?
   a) `Scanner`
   b) `FileInputStream`
   c) `ObjectInputStream`
   d) Both (a) and (b)
   e) Both (b) and (c)

14. Which of the following interfaces should be used to implement a generalized sorting algorithm?
   a) `Collection`
   b) `Iterator`
   c) `Comparable`
   d) `Serializable`
   e) None of the above

15. Given the following class definition:

```
public class MyException extends Exception {
    private int errorCode;
    public MyException(int k) { errorCode = k; }
    public getErrorCode() { return errorCode; }
}
```

After executing the following code:

```
int i = 0;
try {
    i = 1;
    throw new MyException(i);
    i = 2;
} catch ( MyException e ) {
    i = e.getErrorCode();
} catch ( Exception e ) {
    i = 3;
}
```

The variable i will have the value:
   a) `0`, because the `try` block will never be executed.
   b) `1`, because the `MyException` object thrown matches the first catch clause.
   c) `2`, because after the `catch` clauses are executed, the control flow goes back to the statement after the throw statement.
   d) `3`, because the `MyException` object is also an `Exception` object, and therefore the second `catch` clause is also matched.
   e) None of the above

Short answer questions:

Answers for each of the following questions should **not exceed five** sentences.

16. **[2 marks]** What do constructors do? Why are they usually overloaded?

17. **[2 marks]** We can usually put an object as the argument of `System.out.println()` to print the contents of the object. We can do this due to that a certain method has been overridden. What is the name of the overridden method? Where is this method originally defined?

18. **[2 marks]** Based on the UML class diagram below, name all the classes that an object of the `Rectangle` class can be casted to.
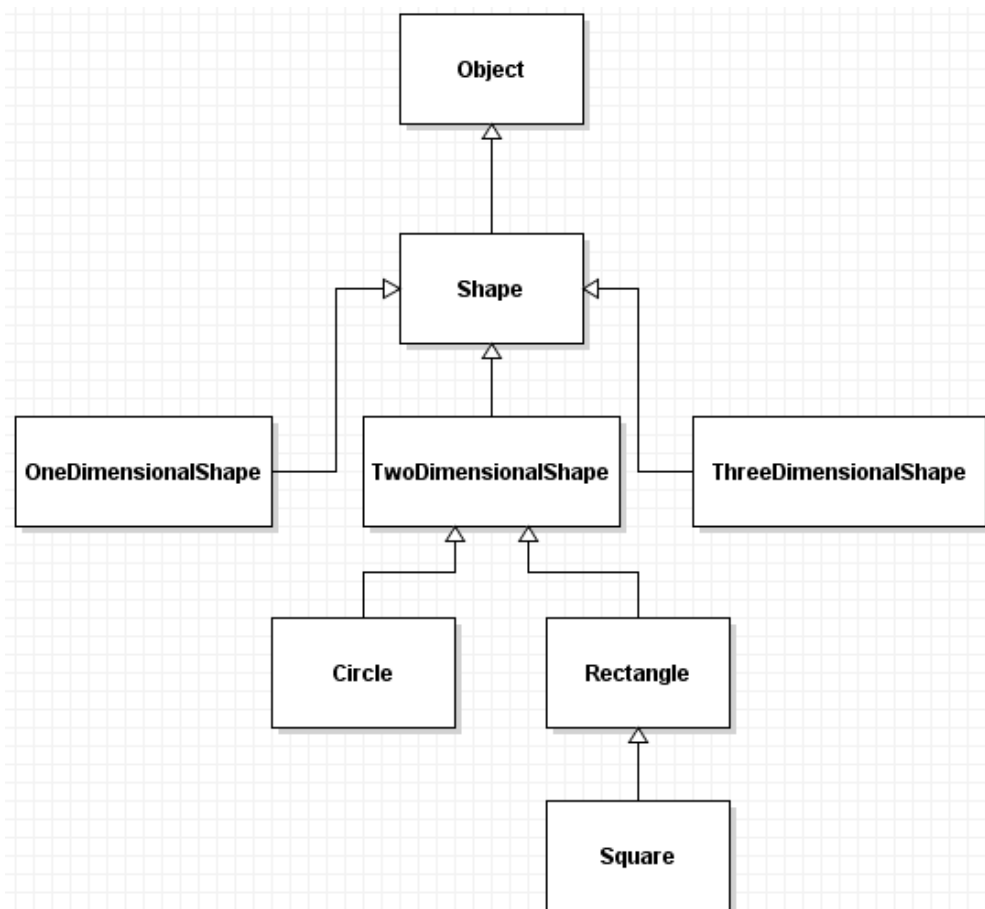
19. **[2 marks]** Consider the following Java class

```
public class Date {
    private int day, month, year;
}
```

If we want to use the generalised sorting algorithm to sort an array of `Date` type objects, list all the changes that should be made in the above code and give brief explanations. There is no need to either write the actual code or explain how to decide the order of two dates.

20. **[2 marks]** We are given the definitions of two classes:

```
public class ClassA {
    public int a;
}

public class ClassB {
    public static void ResetA1(ClassA obj){
        obj = new ClassA();
    }

    public static void ResetA2(ClassA obj){
        obj.a=0;
    }
}
```

After running the following program:

```
public class DemoProgram{
    public static void main(String[] args){
        ClassA myObj1 = new ClassA();
        ClassA myObj2 = new ClassA();
        myObj1.a=2;
        myObj2.a=2;

        ClassB.ResetA1(myObj1);
        ClassB.ResetA2(myObj2);
    }
}
```

What are the values of `myObj1.a` and `myObj2.a`, respectively?

Programming questions:

21. **[5 marks]** Write a `public` method called `reverseArray` that takes in an array of integers `intArray` as the input parameter, and reverses the order of the elements in the same array. The return type of the method is `void`.

    • For example, if `intArray = {1, 3, 8, 6, 2}` is given to the method, then after calling the method, `intArray` should become `{2, 6, 8, 3, 1}`.
    • You can assume that the input array is always valid and that it is always full of integers.
    • **You must NOT define any new arrays** in the `reverseArray` method (that is, you must operate on `intArray` itself only).

22. **[6 marks]** A string `str` is sorted alphabetically if it satisfies the following requirement: For any two integers `i` and `j`, if `0 <= i <= j < ` length of `str`, then `str[i] <= str[j]`.

    For example, `str = "ace"` is sorted alphabetically. Say, for `i = 0` and `j = 1`, we have `i <= j` and `str[0] <= str[1]` because `'a' < 'c'` in the ASCII table.

    You are given two strings `str1` and `str2` that are both sorted alphabetically. Write a method

    ```
    public String mergeString(String str1, String str2)
    ```

    that merges `str1` and `str2` into a new string, such that the new string contains all the contents from `str1` and `str2`, and it is also sorted alphabetically. The method should then return the new string. For example, if we call this method with `str1 = "ace"` and `str2 = "bbcf"`, then the method should produce `"abbccef"`.

23. **[5 marks]** (1) Write a class named `IllegalOperationException` that defines an exception. The class should have a constructor with a single parameter of type `String`. If an exception is thrown with this constructor, then `getMessage` returns the string that was used as the parameter to the constructor. (2) Write a `public` method inside which this exception is thrown (but not caught).

24. **[7 marks]** The **Insertion Sort** algorithm for sorting an array `intArray` of `n` elements into increasing order is described as follows:

  - If `n == 1`, the array is already sorted, and nothing needs to be done.
  - Otherwise, we do this for every element starting from `intArray[1]` up to `intArrray[n-1]`.
    - For an element `intArray[i]`, we move it to the left by performing swaps of adjacent elements, until `intArray[i]` arrives at a position where every element at its left is less than or equal to `intArray[i]`.

  Write a method

  ```
  public void insertionSort(int[] intArray, int n)
  ```

  that sorts an array `intArray` of `n` integers into increasing order using Insertion Sort. If you wish to make use of any auxiliary method, you must define them as part of your answer.

25. **[6 marks]** Add proper class and interface definitions to make the following code compile. Your design must satisfy the following constraints: (i) `Human` and `SuperHero` must be defined as classes; (ii) all other undefined types must **NOT** be defined as classes; (iii) the inheritance structure that you write must have at most 2 levels (the `Object` class is not counted as a level of the inheritance; you only need to consider the classes and interfaces used in this question). Note that the bodies of methods `fly`, `transform` and `fight` can be left empty and the return types are `void`. There should be **NO** statements inside the methods.

  ```
  public class Adventure {
      public static void demoFly(CanFly flyer) {
          flyer.fly();
      }
      public static void demoTransform(CanTransform
              transformer) {
          transformer.transform();
      }
      public static void demoFight(Human human) {
          human.fight();
      }
      public static void main(String args[]) {
          SuperHero ironman = new SuperHero();
          demoFly(ironman);
          demoTransform(ironman);
          demoFight(ironman);
      }
  }
  ```

26. **[6 marks]** You are given a Java source code file "`SampleClass.java`" which contains the definition of a class `SampleClass` and some comments. Both single line comments starting with "`//`" and multiline comments enclosed by "`/* */`" are included. An example of the file is as follows:

```
/* Comment: This is a sample class for testing comment
   removal.
   Jianzhong Qi, 01 May 2016
*/

import java.util.Scanner;

public class SampleClass{
    public static void main(String[] args) {
        // Print a message
        System.out.print("Hello students.");
    }
}
```

Your task is to complete the `main()` method in the following program:

```
public class CommentRemoval{
    public static void main(String[] args) {
        // Add your code here
    }
}
```

to read the file "`SampleClass.java`", remove all the comments in this file, and write the rest of the contents back to a new file "`SampleClass.`**`txt`**". The new file for the example code of "`SampleClass.java`" is as follows.

```
import java.util.Scanner;

public class SampleClass{
    public static void main(String[] args) {

        System.out.print("Hello students.");
    }
}
```

Note:
- You may assume that "`SampleClass.java`" is a valid java source code file and that it can compile and run successfully.
- You should only remove the comments but not any other contents of the original "`SampleClass.java`" file. That is, if we rename the file "`SampleClass.`**`txt`**" written back by your program to

"`SampleClass.java`", then this renamed file must be able to compile and run as the original file.

- You may assume that all the packages required by your program are already imported. That is, you do **NOT** need to write code to import any packages.

End of exam