Australian National University

Sample Examination

Software Construction

(COMP2200/COMP2500/COMP6442)

Writing Period: 3 hour duration
Study Period: 15 minutes duration
Permitted Materials: One A4 page with notes on both sides.
Note also the standard lab tools are available including: Java, eclipse, gedit, git, umbrello, dia, gcc, man, the calculator on the computer, ...

NO calculator permitted (physical electronic device).

Please Read The Following Instructions Carefully.

This exam will be marked out of 100 and consists of 4 questions. Questions are of unequal value. The value of each question is shown in square brackets. Questions that are partitioned into parts show the number of marks given to each part within square brackets.

Students should attempt all questions. Answers must be saved into the question's directory (Q1, Q2, Q3, Q4) using the file(s) described in the question statement. Marks may be lost for giving information that is irrelevant.

Network traffic may be monitored for inappropriate communications between students, or attempts to gain access to the Internet.

The marking scheme will put a high value on clarity so, as a general guide, it is better to give fewer answers in a clear manner than to outline a greater number of less clear answers.

Question 1 [40 marks]

Highest marks are gained by providing clear, concise, and short answers. Save your answers in the text file 'Q1answers.txt' in the directory Q1 (note this file is already created with places to add your answers, so just open up 'Q1answers.txt' and save your answers directly into it). This file can be edited using 'gedit'. Please make certain that this file is saved both as you progress through the exam and before the exam ends.

i. [4 marks] What is the relationship between “ssh” and “rsh/rlogin”? When a client connects with a server using “ssh” a secret session key is agreed on by both parties. What approach is used to enable both the client and the server to have the same session key without passing it between the client and server? Suppose you wish to log into a server with “ssh” using public key authentication. What do you need to set up on the client and on the server for a Linux system (you may assume the client software is installed and the server is running)?
ii. [4 marks] Why are revision control systems, such as git, useful for developing software? What is the difference between a client-server revision control systems, such as svn, and distributed systems such as git or mercurial? Suppose you have a git repo set up in a local directory with a gitlab server set up as the remote fetch/push repo. What commands would you use to get a change in a single file propagated to the gitlab server?
iii. [4 marks] Explain the difference between coupling and cohesion in terms of software design. Why is it advantageous to have low coupling and high cohesion in a design?
iv. [4 marks] Below is the text of “makefile”. Explain how it works by adding a short annotation to each line.

```
Hello.class : Hello.java
   javac Hello.java
run : Hello.class
   java Hello
```

v. [4 marks] In Swing what is the relationship between a JFrame, a JComponent, and a LayoutManager?
vi. [4 marks] Describe the XML format. Illustrate your description with an XML document that could be used for storing a person's name and shoe size.
vii. [4 marks] What are the similarities and differences between using inheritance and the decorator design pattern to add extra features to a class?
viii. [4 marks] What are the addition requirements for a binary tree to be a binary search tree? What is the maximum height of a binary tree that has 32 nodes? What is the minimum height of a tree with 32 nodes?
ix. [4 marks] What is the advantage of using a factory design pattern (such as the factory method or abstract factory) over just using “new” in the code using the products of this factory?
x. [4 marks] “bash” has many language features such as: variables, if-else statements, loops, functions, that languages such as Java, c, and c++ have. However, generally people would not implement large or complex programs in “bash”. Why is this the case? What are some key differences between “bash” and languages such as Java, c, and c++?

Question 2 [30 marks]

The aim of this question is to complete a mini software development project. This involves developing a simple GUI application along with producing some documentation, testing your implementation, and demonstrating your use of some software engineering tools. The code and all other associated documentation you create must be included in the Q2 directory.

A mechanical tally counter provides a simple way of counting the number of occurrences of a particular event (number of laps someone has done on the running field, number of students who turn up to a lecture, etc..). Develop a GUI application that provides the functionality of a mechanical tally counter. Your application must display the current count value, have an "Inc" button that increments the counting, and a "Reset" button that sets the count value to 0.

Tally Counter, Wesha, wikipedia, CC BY-SA 3.0

In-addition to implementing an application that fulfils the requirements[10 marks] you should:

- set up and use git within the Q2 directory for version control (do at least 3 commits) [2 marks],
- complete a UML diagram (export this as a png in a file called UML.png in the Q2 directory) [4 marks], and
- undertake JUnit testing (at least 2 unit tests and 1 integration test) [4 marks].

You will also be evaluated on the overall quality of your submission [10 marks], this includes aspects such as: design, testing coverage, code formatting, variable/field/method/class naming, documentation clarity and conciseness, code commenting, UML diagram formatting, git commit comments, etc ...

To get you started you have been provided with the "HelloWorld" gui application. In the Q2 directory.

Question 3 [20 marks]

In the Q3 directory is a program that enables you to change the colour of a rectangle via “twisting” 3 dials. The dial value is changed via dragging the mouse left or right across the dial's icon. There is a red dial, a green dial, and a blue dial, these set the RGB values of the rectangle's colour. The implementation of this application is made up of 4 classes: DialGUI (with the main GUI code), DialR (the code for the red dial), DialG (the code for the green dial), and DialB (the code for the blue dial).

Although the application works fine the design could be improved. Firstly, there is considerable duplication in code. Secondly, DialR (along with DialG and DialB) are dependent on the DialGUI code so they could not be used in different applications without modification. Redesign and modify this implementation to address these 2 issues. Use the observer design pattern to address the second of the issues. Remove unused classes form the directory. Note the changed application should work exactly the same.

Question 4 [10 marks]

The Q4 directory contains code for an implementation of a binary search tree. This tree is used to represent a set of integers. The implementation uses an immutable approach such that the fields of a node of a tree are never changed after they are constructed. Thus to alter a set that these trees represent one needs to create a new set and move the reference you have onto the new set. The code for this is almost complete except the “remove” methods that removes elements from a set. Complete this implementation by implementing the “remove” methods. Note this should also use an immutable approach. Do not alter methods other than the “remove” methods as they may be used for testing purposes.