VERSION 5 COMPSCI 230

THE UNIVERSITY OF AUCKLAND

FIRST SEMESTER, 2015

Computer Science

TEST (with sample answers, v2 of 4 May 2015)
(with corrected sample answer to Q28, v2.1 of 29 May 2015)

Software Construction

(Time Allowed: 60 minutes)

Note:

- This is a closed-book test. The use of calculators is NOT permitted.
- Before opening this booklet:
    - **Compare** the test version number on the Teleform sheet supplied with the version number above. If they do not match, ask the supervisor for a new sheet.
    - **Enter** your name and student ID on the Teleform sheet. Your name should be entered left aligned. If your name is longer than the number of boxes provided, truncate it.
    - **Write** your name, student ID, and UPI at the bottom of this page.
    - **Read** the notes on this page.
- When the signal is given to "open the test booklet", you should
    - **Read** through the entire test.
    - **Plan** your time, so that you will be able to review your Teleform answers for accuracy and completeness *before* the signal is given to "stop writing".
- Answer Sections A-E on the **Teleform answer sheet** provided.
    - **Use** a dark pencil to mark your answers clearly.
    - **Erase** carefully and completely, if you change your mind. (Only one answer per question!)
    - **Check** that the question number on the sheet corresponds to the question number in this question/answer book.
    - If you spoil your sheet, **ask** the supervisor for a replacement.
    - There are a total of 90 marks in these defined-response sections: 14 multiple-choice questions worth 3 marks each, and 24 true-false questions worth 2 marks each.
- Answer Section F in the space provided in this booklet.
    - **Write** your ID number at the top of each answer page.
    - **Write** your answers in the space provided in the short answer section.
    - The space provided is intended to be **more** than sufficient to answer each question: you can gain full marks even if you don't fill every text box.
- There are overflow pages at the end of this booklet.
    - You may use an overflow page to **explain** any reasonable assumption you made, when answering one of the questions in Sections A-E. Note that your marker will *not* look at anything you write on Sections A-E.
    - You may use an overflow page to **revise or extend** any answer you made in Section F.
    - Take care to **number your answers** if you write on an overflow page.

Surname:	
First Name(s):	
Student ID:	
Login Name(UPI):	

Section A

1. **[3 marks]** The JavaDoc comment for a method should be

○ (a) Just after the method body.
○ (b) Just before the method body.
○ (c) In the body of the method.
● (d) Just before the method declaration.

If choice d is selected set score to 3.

2. **[3 marks]** The first line of a JavaDoc comment for a method should be

○ (a) A description of the most recent defect-repair on this method.
○ (b) A list of the method's parameters.
● (c) A brief description of the method.
○ (d) The author's name.

If choice c is selected set score to 3.

3. **[3 marks]** If you write an application in which a Java method invokes itself, then

● (a) Your application may deliver useful results.
○ (b) Your application will not compile.
○ (c) Your application will compile but it will not run.
○ (d) Your application will compile and run, but it will throw a runtime exception when the method calls itself for the first time.

If choice a is selected set score to 3.

4. **[3 marks]** Creating a new method by extracting some lines of code from an existing method is called

○ (a) Redesigning.
○ (b) Reworking.
● (c) Refactoring.
○ (d) Remodelling.

If choice c is selected set score to 3.

5. **[3 marks]** What will happen when the following Java expression is evaluated?

```
String.format("%.1f", 12.345)
```

● (a) The value `"12.3"` is returned by the `format()` method, and there is no console output.
○ (b) The value `"12.3"` is returned by the `format()` method, and the value `"12.3"` is printed to the console.
○ (c) The value `"12.3"` is printed to the console.

If choice a is selected set score to 3.

6. **[3 marks]** Backwards compatibility of Java source code means that

○ (a) A Java program which was compiled in an old version of Java is likely to run without errors on a recent Java Runtime Environment (JRE).
○ (b) A Java program which was developed in an old version of Java should be executed on a version of the Java Runtime Environment (JRE) which is at least as old as the program.
● (c) A Java program which was developed in an old version of Java is likely to recompile and run without errors on a recent Java Runtime Environment (JRE).

o (d) Any previous version of the Java Development Kit (JDK) can be used to develop a Java program for the current Java Runtime Environment.

If choice c is selected set score to 3.

7. **[3 marks]** What value is assigned to a reference variable when it refers to no object?

o (a) `void`
o (b) `0`
• (c) `null`
o (d) `""`

If choice c is selected set score to 3.

Section C

8. **[2 marks]** An import statement may use the asterisk (*) wildcard character, to indicate that multiple packages should be imported.

o (a) True
• (b) False

If choice b is selected set score to 2.

9. **[2 marks]** A static import statement can be used to import `enum` types.

• (a) True
o (b) False

If choice a is selected set score to 2.

10. **[2 marks]** A class declaration may be the first line of a Java source file.

• (a) True
o (b) False

If choice a is selected set score to 2.

11. **[2 marks]** A package statement may be the first line of a Java source file.

• (a) True
o (b) False

If choice a is selected set score to 2.

12. **[2 marks]** An import statement may use the asterisk (*) wildcard character, to indicate that all classes and interfaces of a package should be imported.

• (a) True
o (b) False

If choice a is selected set score to 2.

13. **[2 marks]** If a package is not imported, then its types cannot be referenced and its methods cannot be invoked.

o (a) True

- (b) False

If choice b is selected set score to 2.

14. **[2 marks]** A method declaration may be the first line of a Java source file.

o (a) True
- (b) False

If choice b is selected set score to 2.

15. **[2 marks]** We say a constructor is overloaded if the runtime system is unable to allocate sufficient memory to create a new object of that type.

o (a) True
- (b) False

If choice b is selected set score to 2.

16. **[2 marks]** `this()` will invoke the default constructor, if it is executed in the body of a constructor with at least one parameter in its signature.

- (a) True

o (b) False

If choice a is selected set score to 2.

*If choice b is selected, adjust marks by +2, because this is "technically" the correct answer even though it was not taught in this offering of CompSci 230. As I learned (by referring to the Java SE8 Language Specification, after a student's query), the default constructor is provided, by the Java compiler, **only** for classes which lack an explicit constructor. So: it is never possible to invoke a default constructor for a class within an explicit constructor, and this question is unambiguously false – but for a reason that was not covered in this offering of COMPSCI 230!*

My original intent, when designing this question, was to test your understanding of overloaded methods – and their appropriate use in constructors. I had discussed this during lecture, with a demonstration involving Eclipse; but regrettably my implementation of this design became defective after I had "simplified" it to involve just a single explicit constructor.

Section B

Recall the Swing application you developed in Assignment 1, then answer the following True/False questions.

17. **[2 marks]** A Swing application may have no customised event handlers or painters.

● (a) True
○ (b) False

If choice a is selected set score to 2.

18. **[2 marks]** Every Swing application must explicitly register at least one customised event handler, by defining a class which implements the `ActionListener` interface.

○ (a) True
● (b) False

If choice b is selected set score to 2.

19. **[2 marks]** Every Swing application must explicitly instantiate at least one customised event handler, using the `new` keyword.

○ (a) True
● (b) False

Section C

The True/False questions in this section refer to the Java application listed below. This is a valid Java application, *i.e.* it will compile and run without any errors.

```
public class HuckleBuckle {
    public static String VERSION = "1.5";
    public static void main(String[] args) {
         System.out.println("Version = " + VERSION);
    }
}
```

20. **[2 marks]** If `args` is typed as an `Integer[]`, then this class would still compile but it would not be a Java application.

• (a) True
o (b) False

If choice a is selected set score to 2.

21. **[2 marks]** The `out` object must be of type `System` or some subtype of `System`.

o (a) True
• (b) False

If choice b is selected set score to 2.

22. **[2 marks]** `main()` must be defined as a `void` method, otherwise this is not a valid Java application.

• (a) True
o (b) False

If choice a is selected set score to 2.

23. **[2 marks]** `main()` must be defined as a `static` method, otherwise this is not a valid Java application.

• (a) True
o (b) False

If choice a is selected set score to 2.

24. **[2 marks]** If some other method in this application modifies the value of `VERSION`, the new value of `VERSION` must be either a `String` or a subtype of `String`.

• (a) True
o (b) False

If choice a is selected set score to 2.

25. **[2 marks]** The developer of this code has capitalised `VERSION` appropriately.

o (a) True
• (b) False

If choice b is selected set score to 2.

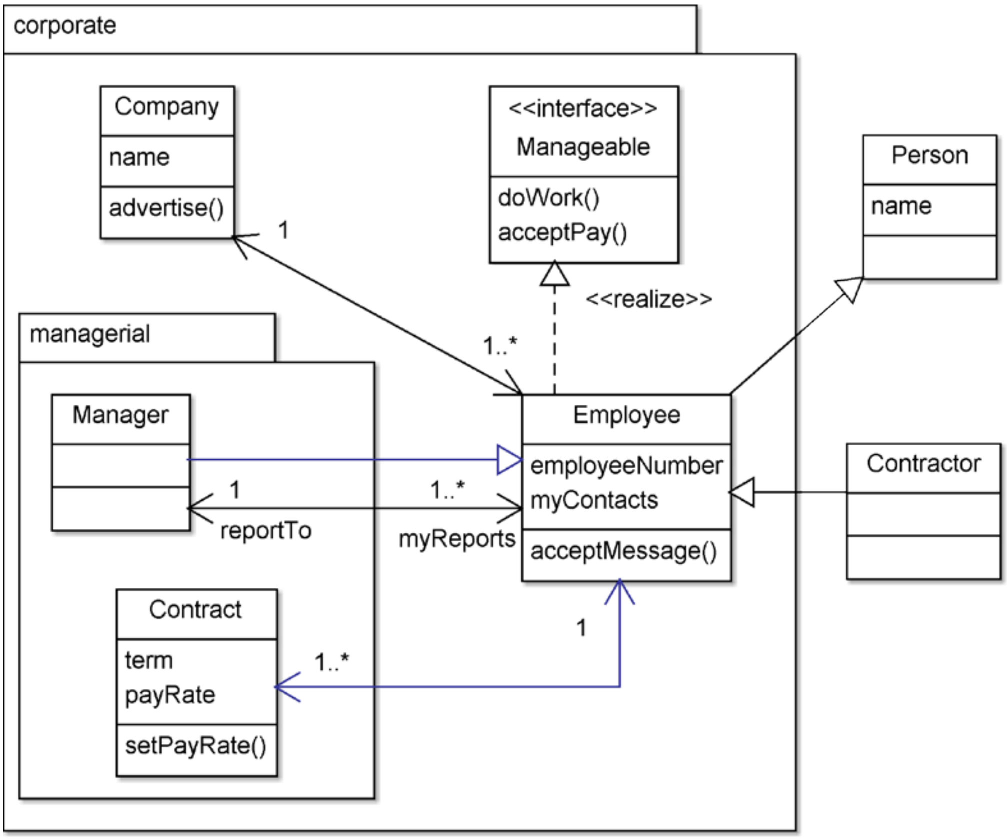
26. **[2 marks]** The `println()` method is invoked with two parameters of type `String`.

- o (a) True
- ● (b) False

If choice b is selected set score to 2.

Section D

The questions in this section refer to the following class diagram.



27. **[3 marks]** Which of the following options would be the most appropriate signature for a `doWork()` method which instructs an employee to lead a team?

○ (a) `String doWork(String task, List<Manageable> team);`
○ (b) `String doWork(String task, List<Person> team);`
● (c) `String doWork(String task, Collection<Manageable> team);`
○ (d) `String doWork(String task, Collection<Person> team);`

If choice c is selected set score to 3.

28. **[3 marks]** If the `acceptMessage()` method has default visibility, would a contractor be able to invoke the `acceptMessage()` method of another contractor?

● (a) No, this invocation will not compile.
○ (b) Yes.
○ (c) No, this invocation will throw a runtime exception.

If choice a is selected set score to 3. Note: this question was originally mismarked; students who answered "b" were incorrectly awarded marks, and students who answered correctly were not awarded marks. There will be a compilation error if a `Contractor` method (attempts to) refer to the `acceptMessage()` method of any employee – because this method is not visible outside its package. Furthermore a contractor doesn't even have an `acceptMessage()` method – methods with default visibility aren't inherited by any subclass declared in a different package – and there will be a compilation error if a programmer attempts to reference a non-existent method.

I apologise for the confusion caused by my mis-keying of the correct answer to this question, and for the delay in correcting your test scores. The correction will amount to about +/-4 marks after scaling, so it is unlikely to affect your final grade – but it is important that these sample answers be correct, and that your tests are accurately marked.

29. **[2 marks]** The source file for the `Manager` class must include an implementation of the `doWork()` and `acceptPay()` methods.

o (a) True

• (b) False

If choice b is selected set score to 2.

30. **[2 marks]** A competent developer would define and implement some methods which are not named in this class diagram.

• (a) True

o (b) False

If choice a is selected set score to 2.

31. **[2 marks]** Every employee has exactly one contract.

o (a) True

• (b) False

If choice b is selected set score to 2.

32. **[2 marks]** One of the navigabilities in this OO design could be implemented with a class variable, of type `Collection<Employee>`, in the `Manager` class.

o (a) True

• (b) False

If choice b is selected set score to 2.

33. **[2 marks]** A contractor might not have a contract.

o (a) True

• (b) False

If choice b is selected set score to 2.

34. **[3 marks]** Which of the following options is the most appropriate visibility for the `setPayRate()` method, if managers (but not other employees) should be invoking this method?

o (a) The `setPayRate()` option should be `private`.

• (b) The `setPayRate()` option should have default visibility.

o (c) The `setPayRate()` option should be `public`.

o (d) None of the above.

If choice b is selected set score to 3.

35. **[3 marks]** What visibility should the `advertise()` method have, if a company may engage a contractor to supply the text for its advertisements?

o (a) The `advertise` method should be `private`.

o (b) The `advertise` method should be `protected`.

• (c) The `advertise` method should be `public`.

o (d) The OO design should be modified, so that the `Contractor` class is defined in the `corporate` package.

o (e) The `advertise` method should have default visibility.

If choice c is selected set score to 3.

36. **[3 marks]** If the `doWork()` method has `protected` visibility, would a contractor be able to invoke the `doWork()` method of a manager?

• (a) No, because all methods of an interface must be `public`.
o (b) Yes.
o (c) No, because this access is not allowed for a `protected` method.

If choice a is selected set score to 3.

37. **[3 marks]** Assume the `acceptMessage()` method of `Employee` has signature `void acceptMessage(String msg, Manageable sender)`. Also assume the `myContacts` field of `Employee` is of type `Set<Person>`. Would invoking `myContacts.add(sender)` in the body of the `acceptMessage()` method be a reliable way to update an employee's set of contacts?

• (a) No, there would be a compilation error.
o (b) Yes, the employee's set of contacts would be updated to include the sender.
o (c) No, there would be a runtime error.

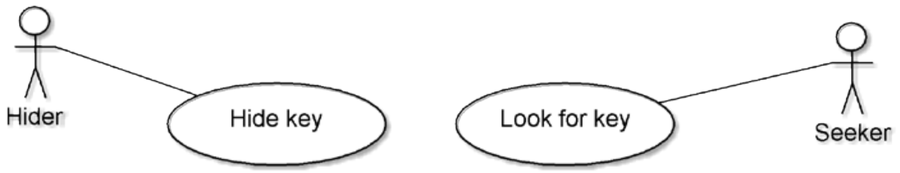
If choice a is selected set score to 3.

Section E

This section of the test refers to the following description of a children's game.

> Huckle Buckle Beanstalk, also called Hide the Object or Hide the Key, is a childhood game which involves the hiding and seeking of an object. It is a variation of a traditional parlour game which can be played with two or more players, one being the hider, or the person who is "it," and the other person or persons being seekers. …
>
> The seekers must cover their eyes and ears or leave the designated game area while the hider hides a small, pre-selected object. When the hider says to come and find it, or after the seekers have counted to a specific number, usually sixty or one-hundred, the seekers come out and attempt to be the first to find the object. When a seeker has the object in hand, he can alert the other players of his success by yelling "huckle buckle beanstalk!".
>
> [http://en.wikipedia.org/wiki/Huckle_buckle_beanstalk, 23 March 2015 at 14:28]

38. **[3 marks]** Does the following use-case diagram have any major defects?



o (a) Yes, the semantics of this diagram are inaccurate.
o (b) Yes, this diagram should show more semantic detail.
o (c) Yes, this diagram has a syntax error.
• (d) No, this diagram has no major defects.
o (e) Yes, this diagram should show less semantic detail.

If choice d is selected set score to 3.

ID ………………….

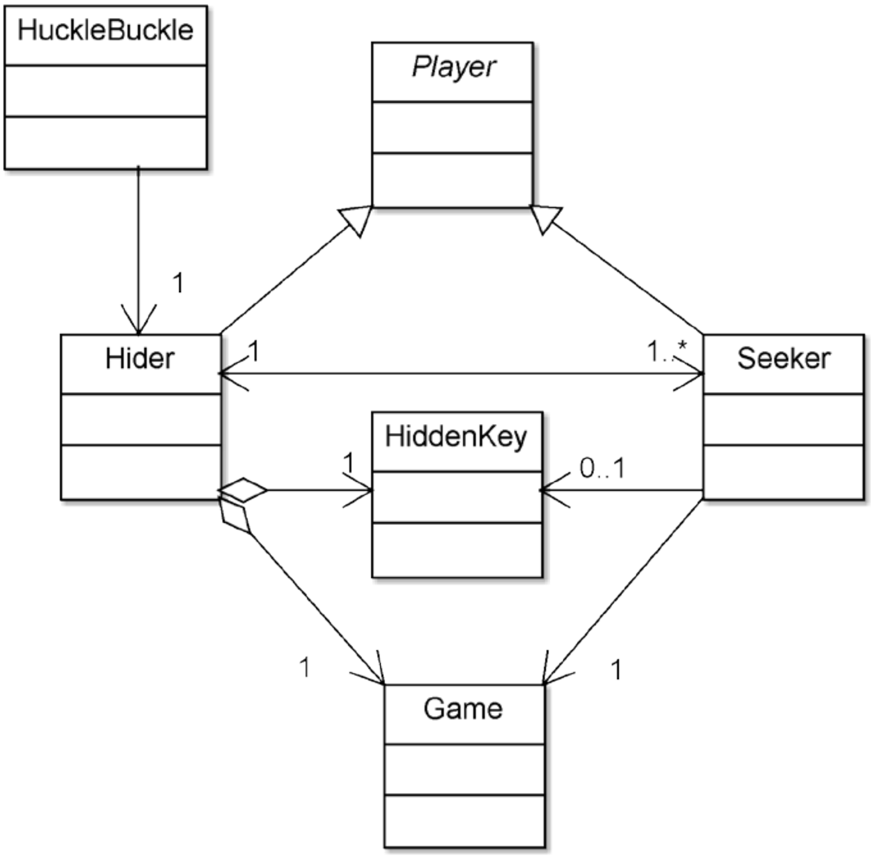
Section F

39) **[4 marks]** Add a class called `HiddenKey` to the following class diagram, so that it describes an OO design which ***accurately represents*** the Huckle Buckle Beanstalk game described in Section E.

You should not name any variables or methods. You should not add any interfaces. You should add no classes other than `HiddenKey`.

To receive full marks, your class diagram must show the ***multiplicity*** and ***navigability*** of all important associations in your OO design.

Sample answer:



Marking notes:

- *2 marks for a design with syntactically correct (and plausible) navigabilities; in particular HiddenKey must be reachable (perhaps indirectly) from Seeker.*
- *2 marks for a design with syntactically correct (and plausible) multiplicities on all associations involving HiddenKey.*
- *If the design doesn't have a HiddenKey class, I awarded 0 marks.*
- *If HiddenKey inherits from some other class, I tentatively awarded 0 marks because it is apparently a "randomly-generated" class diagram rather than a plausible OO design; however I read through the student's explanation of their design in question 40, before finalising these marks.*
- *The multiplicity of an unnavigable end should not be shown in a UML class diagram, however I did not deduct marks if a student did this -- because it's rather a fine point of UML syntax.*

ID ………………….

40) **[6 marks]** Briefly ***explain*** the major design decision(s) you made when answering the previous question.

I made the HiddenKey an aggregate part of the Hider because the hidden key initially belongs to the hider, and I reckon the key still belongs to the hider after a seeker finds it. The hider has exactly one key. Because each seeker may find the hidden key, but because she initially has no reference to any hidden key, I introduced a 0..1 association from the Seeker class to the HiddenKey class. As in hbbv1.0, the seeker must ask the Hider for her temperature. In my version, the hider would provide a reference to the hidden key if the seeker invokes a didIfindIt() method while they are at the FOUNDIT temperature.

Marking notes:

- *2 marks for an understandable explanation of why the HiddenKey is associated with either the Hider or the Game (depending on the student's design); this explanation must cover the multiplicity and navigability issues.*
- *2 marks for an understandable discussion of a (possibly indirect) navigation to the HiddenKey from the seeker. (If we add a HiddenKey method with signature* `isItHere(p:Point):Boolean`*, then the Seeker could be 1-1 associated with a HiddenKey and we'd have a very accurate representation of a seeker who recognises a hidden key when she is very near to it – rather than, as in hbbv1.0 and in my sample answer, modelling a seeker who is effectively blind because she must rely on the hider to tell her if she's in the same square as the hidden object.)*
- *2 marks for the overall effectiveness/elegance of the design, for example, if a student adds all possible associations then the design is certainly feasible but would be unnecessarily difficult to implement. However if a student associates the HiddenKey with the Game, and explains that this allows a Seeker to discover the key without asking questions of the hider, then I'd award full marks for elegance -- because this design decision will significantly increase the accuracy of the representation of Huckle Buckle Beanstalk.*

Note: the game being played in Assignments 1 and 2 would be more accurately named Hot or Cold.

ID ………………….

Overflow pages – please number answers carefully

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