Engr 5895 Software Design — Final Exam

T. S. Norvell (c) 2010

2010 April 14. 12:00 to 15:00.

Instructions: Answer all questions. Write your answers in the space provided. Request a yellow booklet if more space is required. This is an **closed** book test. Textbooks, notes, and electronic devices are not permitted. However, paper inter-language dictionaries are permitted. Cell phones that ring during the exam become property of the instructor.

Total points: 112

Name:

Student #:

Q0 [10] Draw a UML class diagram corresponding to the following description of entities in the real-world. Show attributes and operations. Show navagability and multiplicities.

T&J Video rents out videos in VHS, DVD, and Blu-ray format. Each video is either in the store, rented to some customer, or lost. Each video is associated with an acquisition number.

Each customer has a customer number, an address, a list of videos rented, and a list of outstanding charges. Customers may have one of two statuses plain or elite. After renting 100 movies a plain customer becomes elite.

If a video is rented to a customer, there is a due-date and lateness policy associated with the rental. A lateness policy specifies the late fee as a function of the due date and the date the video is actually returned. The applicable lateness policy depends on the format of the item and the status of the customer.

Student #: _____

Q1 [**15**] The Strategy pattern

(a) [**5**] Explain the circumstances when it is most appropriate to use the Strategy pattern. Given an example.

(b) [**5**] Use a class diagram to illustrate the Strategy pattern

(c) [**5**] Use a sequence diagram to illustrate the Strategy pattern

Student #: _____

Q2 [**10**] Open/Closed Principle

(a) [**5**] Explain what is meant by the Open/Closed Principle (OCP).

(b) [**5**] Give an example of a class that exhibits the Open/Closed principle.

Student #: _____

Q3 **[10]** Consider the following Java class, instances of which I intend to use to mediate communication between three threads. One thread puts in messages. The other two read messages. Each message must be received exactly once by each thread.

```
public class Messages {
    private String message = null ;
    private int count = 2;
    // invariant 0 <= count && count <= 2

    public synchronized void put( String message ) {
        while( count < 2 ) this.wait() ;
        this.message = message ;
        this.count = 0 ;
        this.notifyAll() ; }

    public synchronized String getMessage( ) {
        while( this.count == 2 ) this.wait() ;
        String result = this.message ;
        this.count += 1 ;
        this.notifyAll() ;
        return result ; }
}
```

(a) **[2]** Is there a race condition?

(b) **[4]** Explain why or why not.

(c) **[4]** If so, explain how to repair it. (Feel free to change the syntactic interface.)

Student #: _____

Q4 [**12**] Consider the following declarations

```
class A { void f() { ... } ... }
class B extends A { void g() { ... } ... }
... A a ; B b ;
```

Explain why the each of the following statements is legal code or not.

(a)[**2**] `a = b ;`

(b)[**2**] `b = a ;`

(c)[**2**] `a = new B() ;`

(d)[**2**] `b = new A() ;`

(e)[**2**] `b.f() ;`

(f)[**2**] `a.g() ;`

Q5 [**5**] Method documentation

Explain why and in what way the documentation of a method m in a class C must go beyond describing the behaviour of direct instances of C.

Student #: _____

Q6 [10]

```
class A {
    private B b = new B( ) ;
    void go() { b.start(this) ; }
    void halt() { b.stop() ; }
}
class B() {
    void start(A x) { ... x.halt() ; }
    void stop() { ... }
}
```

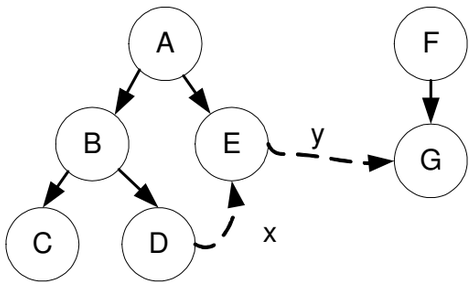
Give a sequence diagram for the following code.

```
A a = new A() ;
a.go() ;
```

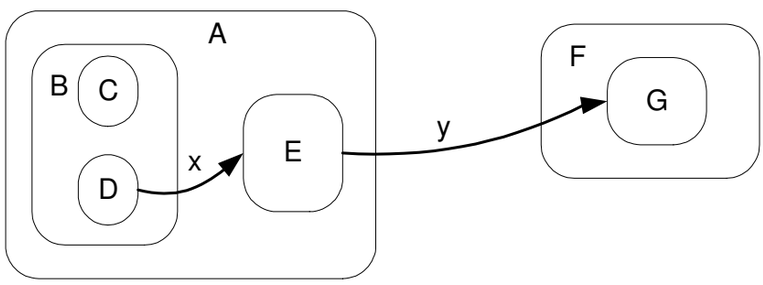
Be sure to indicate each invocation (execution) with a box.

Student #: _____

Q7 [30] A higraph is a mathematical structure that consists of a set of directed trees together with a set of edges between the nodes of the trees. Each node and edge may be associated with a (string) label. In the figure below, parents and children are shown connected by solid arrows, while dashed arrows represent edges between nodes.



You have been tasked with designing and implementing an editor for higraphs. For display and editing purposes, the higraph is presented to the user in the following format (known as a "blob diagram").



(However, in the next release, it is planned that the user will be able to view and edit the diagram in other formats as well.) Edit actions include creating new nodes and edges, deleting nodes and edges, moving nodes around in the tree, changing labels, et.c.

Using UML diagrams, English prose, Java code, and/or pseudo code, present a design for the interaction between, on the one hand, the model for the higraph and, on the other, the view of the higraph that displays to the user and which the user interacts with. Be as complete as possible in the space provided.

(There is more room on the next page.)

(Continue question 6 here.)

(There is more room on the next page.)

Student #: _____

(Continue question 6 here.)

(If you need more space, continue in a yellow book.)

Student #: _____

Q8 [10] Explain your use of design patterns and design principles (such as SRP, OCP, LSP, and DIP) in the design of your project for this course.

All the best in the rest of your exams. It's been a pleasure instructing this course.