Name

Student ID

Signature

Department of Electrical and Computer Engineering, McGill University

ECSE 321 - Introduction to Software Engineering, Fall 2007

Final Examination

December 10, 2007, 14:00-17:00

Examination version I

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Associate Examiner: Prof. Warren Gross WjGross

INSTRUCTIONS

1. Write your name, McGill student ID number, and signature in the top of this page. If you require an answer booklet, write your name there too.
2. This examination consists of two sections:
   a. Section I consists of 13 multiple-choice questions.
   b. Section II consists of 5 open questions.
3. Section I is worth 39 marks in total; section II is worth 61 marks in total. The multiple-choice questions are equally weighted; wrong or omitted answers are worth 0 marks.
4. This examination booklet has 14 pages, including this page. Keep all pages together.
5. Please use only the space allocated in the booklet.
6. Multiple choice questions: circle the correct option in multiple choice questions. Any ambiguity in the final answer will be considered invalid. If you change your mind, you may write "Final: A" for making sure we understand you think that A is the correct answer.
7. Several questions require a written explanation. Be concise and precise. Don't use more space than allocated to you.
8. You may **not** use any written material.

Good luck!

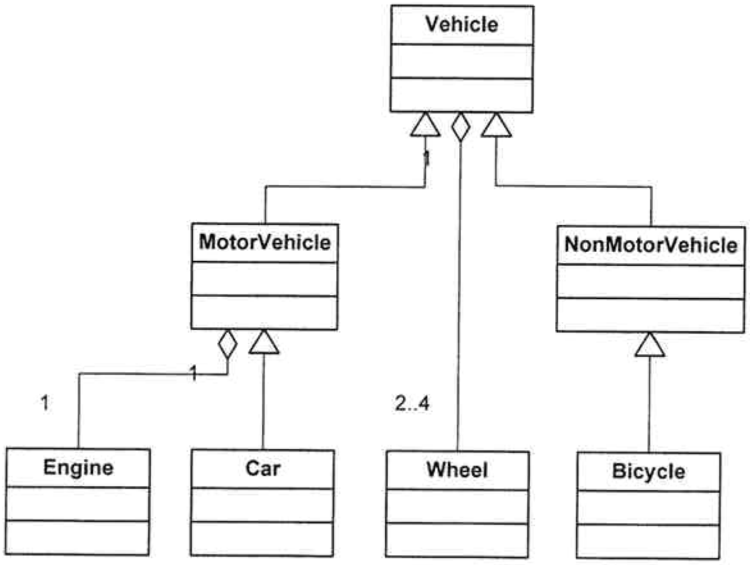
Section I: Multiple choice questions

(3 marks for each question, total of 39 marks)

1. The "Strategy" design pattern is best described as:
    a. Allowing algorithms to be swapped at runtime.
    b. Wrapping one general API around several more specific ones.
    c. Modifying the interface of one class to supply an interface that the client class expects.
    d. Restricting the instantiation of a class to one object.
    e. Minimizing the amount of memory an individual object uses by sharing its properties with other instances.

2. Suppose we are given a piece of code in the programming language we use for a project (say in Java). This code instantiates memory objects, draws them on the screen, and access the file system. We would like to include this code in our project, and occasionally use it during runtime. What would be the appropriate way to integrate it?
    a. Use the abstract factory pattern.
    b. Use the bridge design patters.
    c. Use a wrapper pattern.
    d. Use a Java interface around the code.
    e. Run the code in a different executable.

For questions 3-5 consider the diagram below and answer the following questions.



3. What is the relationship between Engine and MotorVehicle?
    a. Composition.
    b. Aggregation.
    c. Generalization.
    d. Dependency.
    e. Unrelated.

4. What is the relationship between Bicycle and Vehicle?
    a. Composition.
    b. Aggregation.
    c. Generalization.
    d. Dependency.
    e. Unrelated.

5. Which of the following is false?
    a. A bicycle is a non motor vehicle.
    b. A car is a vehicle.
    c. A car must have 4 wheels.
    d. A bicycle is a vehicle.

6. Suppose S is a subtype of T and T is a subtype of Q. Then according to the Liskov substitution principle (also known as strict substitution):
    a. S can be replaced by Q in any place in the program.
    b. Q can be replaced by S in any place in the program.
    c. S and T must have the same signatures for all methods.
    d. S and Q must have the same signatures for all methods.
    e. T, S, and Q must all be entity classes.

7. You are hired to design the newest booking software system for an airline. As your employer is listing the objectives of your system, you write these down as either Functional or Non-Functional requirements. Here are a few of them, which one is Functional?
    a. The system will provide feedback in less than 5 seconds.
    b. When creating a new booking, the booking agent will be presented with two options: First Class or Business Class.
    c. The System will work in all the airlines desks worldwide.
    d. The System will back up all bookings on a per hour basis to prevent data loss.
    e. The system will be implemented in C++.

8. Which of these SVN commands allows uploading your version of the files to the server.
    a. Commit
    b. Update
    c. Checkout
    d. Check In
    e. Add
    f. Resolve
    g. None of the above

9. A use case model is **not** intended to:
    a. capture all of the system requirements.
    b. capture functional requirements from the user's perspective.
    c. give a clear and consistent description of what system should do.
    d. be a basis for performing tests.
    e. provide the ability to trace functional requirements into actual classes and operations in the system.

10. Which of the following is true about testing?
    a. Extensive testing can verify that the system has no bugs
    b. Regression testing is done during integration of different subsystems.
    c. The main reason not to use bottom-up integration is the excessive number of test stubs.
    d. Black box tests and white box tests cannot be used to test the same code.
    e. Alpha and Beta tests are done at different locations.

11. Which of the following is a benefit of the repository architecture?
    a. It improves runtime efficiency.
    b. It provides abstraction.
    c. It distributes load over the system.
    d. It reduces coupling between the subsystems and the repository.
    e. It reduces coupling between the subsystems other than the repository.

12. When is it a better idea to use delegation instead of inheritance?
    a. When two objects are involved in handling a single request.
    b. Whenever we want to activate method in the parent class so that we can prevent the receiving object from misusing the delegate object.
    c. Never, because delegation can be done with a single class, while a class can inherit from multiple classes.
    d. Always because delegation is more efficient.
    e. Always because delegation allows for multiple inheritance.

13. Which of the following is true?
    a. The proxy design pattern facilitates easier testing because we do not have to instantiate complex objects.
    b. The composite design pattern can be used even if we don't know the depth and width of the object hierarchy in advance.
    c. The Façade pattern must not appear more than once in a system.
    d. The adapter pattern is used heavily for testing.
    e. The singleton pattern is used mostly in conjunction with the abstract factory pattern.

Section II

Question 1 – Analysis (class diagrams)

(8 marks)

Bank

Consider the following description:

A Bank has one central office and many branches. Each branch contains one or more tellers, zero or more ATMs, and one or more investment advisers.

A) Designing for maximum flexibility and reuse, draw the class diagram for a "Bank" object

B) A second type of Bank is being built, which will contain between zero and one drive-through tellers. Add this onto the class diagram from Part A, and circle it with a dashed line.

Question 2-5: A "real" case

The following description characterizes a system. Please read it as the following four questions relate to it.

QuickNCheap is a next generation supermarket – it is a large automatic supermarket that serves its shoppers 24 hours a day, 7 days a week with minimal staffing and maximal flexibility.

A shopper that arrives to QuickNCheap gets a special motorized cart for his (we will refer to a shopper as a "he" for convenience) shopping. Activating the cart is possible only after a credit card is inserted to a specially designed slot in the cart where it must be stored until the client leaves QuickNCheap. Taking the card out of the cart locks the engine of the cart making it unmovable. The cart is equipped with a small "shopping computer" that contains a touch-screen and a keyboard. Using this computer the cart serves as the personal cashier of the shopper: every item in QuickNCheap has a magnetic code that includes the item's price, name, and expiry date. A sensor in the cart can detect when an item is put in the cart and when it is taken out. When a shopper tries to put in the cart an item that expired 48 hours ago or more, the cart will sound a noise. Products such as fruits and vegetables (which are usually purchased in bulk) are only sold in packages that are weighted and priced in advance. The bill of the shopper is managed by the cart and during the purchase the shopper can view it on the cart screen. When the shopper leaves the supermarket (by passing through a magnetic gate) the credit card is billed for the purchase. When the credit card is billed, the shopper can ask for a receipt with or without a detailed list of all the products that were purchased.

Before the store's exit (but after the magnetic gate used for the billing) there is a delivery stand that includes: empty boxes on a moving platform, a touch-screen and delivery software. The shopper activates the delivery stand by inserting his credit card, filling the boxes, and sending them on the moving platform to the delivery warehouse by pressing the "SEND" button which is on the bottom right corner of the screen. Every box has a unique tag that allows associating it with the right client. When the boxes are filled the screen presents a form with the details of the delivery which the shopper fills out. A delivery is allowed only for clients that did their shopping in the store in the last two hours.

The shopping cart is also a "smart purchasing consultant" for the shopper by suggesting current specials, advertising items and controlling the purchase process (for example, if the store has a "two for the price of one" special for a certain item and the shopper only places one item in the cart it will advise him to put two items). The cart also helps the client by allowing him to manage his purchase list – he can enter a list of items manually or edit it at home and bring it on a USB key which he can connect to the cart. A shopper who is interested can purchase storage space on the store's server and upload his grocery list from home using the Internet. The cart has a WiFI card and when the shopper is identified, the most recent grocery list is uploaded.

The cart can assist the shopper in the supermarket in finding items. The screen is a touch screen and by choosing an item from the grocery list, or an item that was suggested on a special, the cart knows how to locate the desired item and navigate the shopper to the appropriate location using arrows on the cart's screen. The navigation can also be based on voice instructions for the visually impaired shoppers.

The items in the store arrive from the suppliers directly. The suppliers unpack the goods in an automatic warehouse in specially designed packages. A sophisticated robotic hauling system is in charge of moving items that are missing from the warehouse to the store and expired items from the store to the warehouse every day between 02:00 to 04:00. The system also takes inventory in the warehouse to identify items that require further replacing. Suppliers can determine the manner in which they interact with the warehouse. They can either supply on a regular basis – the supplier brings a particular quantity of items in a certain frequency (both are updated from time to time). Or the supplier can supply on demand – the supplier can wait for an email from the system that announces that the inventory in the warehouse is below a certain threshold (which the supplier determines). When replenishing the inventory, the supplier will collect the expired items that were taken off the shelves of the store.

The store has a security system to reduce the probability of thefts. Every attempt to take an item out of the store (through the magnetic gate) will result in a lockdown of the store. These doors will be opened only when the item has been returned to the store. There is a single security person patrolling the store at any given point – his role is to assist the customers to overcome any problems they may encounter.

The supermarket owners get monthly reports that include: sale charts for the different items, distribution of shoppers along the time of day and day of the week, the number of deliveries, etc.

Question 2

(14 marks)

Quoting from the text (precisely), please specify requirements that are:

1. Functional/operative requirement

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2. A content constraint (reminder: a content constraint is a restriction on the input/output of the developed software).

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3. A requirement which is incomplete or not well defined

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4. A requirement that contradicts another requirement.

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5. A requirement that should not be implemented in software

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6. A requirement whose cancellation would lead to canceling one or more other requirements

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7. A requirement that would be cancelled if the requirement given in the previous question was cancelled.

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Question 3:

(14 marks)

For each of the following requirement specify which UML model will allow the expression of the requirement and the way in which it will be expressed using the model Examples:

- The state transition from the state "in the store" to "out of the store" in the state diagram of "shopper."
- A Boolean function of the class "Item" with the input parameter "current date" that checks if the product expired.
- An exception of the main use-case "shopping"

Choose from the following UML models: UML models include: use cases, deployment diagrams, object diagrams, class diagrams, state-charts, sequence diagrams, etc.

1. When the shopper is identified by the CART the most recent grocery list is uploaded.

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2. Before the store's exit (but after the magnetic gate used for the billing) there is a delivery stand that includes: empty boxes on a moving platform, a touch-screen and delivery software.

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3. By choosing an item from the grocery list, or an item that was suggested on a special, the cart knows how to locate the desired item and navigate the shopper to the appropriate location using arrows on the cart's screen.

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4. The supplier brings a particular quantity of items in a certain frequency (both are updated from time to time).

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5. A delivery is allowed only for clients that did their shopping in the store in the last two hours.

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6. The supermarket owners get monthly reports.

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7. Taking the card out of the cart locks the engine of cart making it unmovable.

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Question 4: Design

(16 marks)

A. What architecture would you choose to implement the QuickNCheap system? (You may choose a combination of architectures) Explain. (Reminder: We covered the following architectures in class: client/server, peer to peer, 3 tier, 4 tier, pipe and filter, MVC, repository).

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B. List the subsystems for the QuickNCheap market. Explain the role of each subsystem briefly.

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C. Draw the subsystem diagram

Question 5: Life cycles

(9 marks)

Which is the life cycle (out of those presented in class) that makes the most sense for each of the following situations (the situations are independent). Please mention briefly which are the main stages in the life cycle in every situation. Explain your reasons.
Reminder: we discussed the following life cycles: Waterfall, build and fix, modified waterfall model (V model), saw tooth model, spiral model, extreme programming, rapid prototyping, etc…

1. The system is to be built based on an existing purchasing system which is available on the Internet. In the existing system the cart is virtual and essentially all the functionality exists. There is no need to implement the delivery system.

2. The shopping cart and the delivery stand can be purchased off-the-shelf. The initiative to build QuickNCheap is jointly of the owner of a software company and the owner of a supermarket. The system will be gradually developed and integrated with partial functionality added at any time. Any new functionality will be tested in the supermarket and its success will affect the direction of development.

3. The brilliant son of the supermarket owner keeps offering his father new ideas and "tricks" to make the supermarket more efficient. One day he comes up with the cart that he built in his basement and offers one of the shoppers to use it. After the shopper checks his bill he discovers that he was double billed for some items. The son says "Oops, sorry" and take the cart back to the basement to fix the bug.