Ollscoil na hÉireann
The National University of Ireland

Coláiste na hOllscoile, Corcaigh
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Fourth Science: Computer Science

CS4000 Software Engineering

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Attempt four questions (all questions carry equal marks)

Three hours

1.

(a) Describe two new work practices that would be introduced when a software development team changes from a traditional Waterfall-based approach to an Agile method, such as Extreme Programming. For each new work practice, describe one important benefit and one disadvantage that it may have. (9 marks)

A project is initiated to develop a software system to allocate, track and co-ordinate a city ambulance service. You are the software manager for this project. (In the following questions please ensure your answers are relevant to this particular project.)

(b) Describe what general software process you would use to develop the software, and give three reasons for its use on this particular project. (9 marks)

(c) Assuming you have an excellent technical team, generous finances and a supportive management team, describe what would be the two biggest risks that might lead to the project failing. (6 marks)

(d) Describe what you would do to reduce these two risks. (6 marks)

(e) State, and give reasons, your choice for the single most important method of verification that should be used on this project. (4 marks)

(f) Give your opinion on what software tools will be most important for this project and give detailed reasons for your choices? (6 marks)

2.

(a) What is a "use case" and why are use cases useful in a software development project. (6 marks)

A project is developing a software system for an online restaurant delivery service. The system will support various functions including making food orders, cancelling orders, paying, tracking orders. A software process using the UML (for example Larman's lightweight UML process) will be used in the development of this system.

(b) Give an overview of the main activities in the UML-based software development process, going from requirements through to implementation. Describe briefly each activity and describe any relationship between activities and their associated artifacts (i.e. text, code, UML diagrams etc.) (16 marks)

(c) Give one example of a diagram (or piece of text) that is produced in the UML-based software development of the online restaurant delivery service, for each of four of the stages of the software development for this application. (12 marks)

(d) Describe how Larman's Controller software design pattern might be used in this system, and describe the benefits of this pattern for this project. (6 marks)

3.

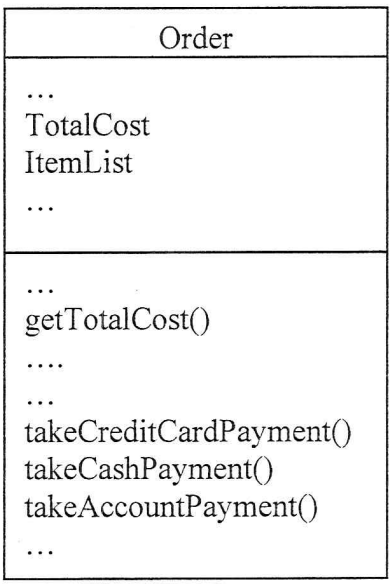
(a) In software engineering what is meant by object-oriented analysis? (4 marks)

(b) Describe two benefits and any limitations of object-oriented analysis. (6 marks)

(c) What is meant by Six Sigma as used in statistical models of quality? What rate of defects does it correspond to? (6 marks)

(d) How relevant are Six Sigma statistical measures to software quality? Give detailed reasons for your answer. (6 marks)

The following diagram illustrates a design of a class to represent an Order object in a purchasing system. Attributes of the class include all the items in the order and the total cost of items being purchased. Methods of the class include various get methods, and methods for the different ways of taking payment for the order.



(e) Evaluate the above design, stating any limitations it has. (6 marks)

(f) Improve the above design using a software design pattern (other than Factory). Name the software design pattern used, and describe two benefits of its use for this design. (8 marks)

(g) Discuss how, if at all, the above design could be improved by the Factory software design pattern. (4 marks)

4.

An alliance of international airlines is developing an information system to manage its fleet of planes. This system will keep track of the planes and their status. It will allow redeployment of planes within the alliance when required because of, for example, delays or faults. The system will be used by the ground managers at the airports to input status of planes and to access the status of planes

(a) Describe a suitable architecture for this distributed application, and provide detailed reasons for this choice. (6 marks)

(b) Describe an alternative architecture that might be considered and describe any limitations and benefits this might have. (4 marks)

(c) What are the three most important non-functional requirements for this system, and describe in detail what you would do when implementing the system to satisfy these requirements. (8 marks)

(d) Describe any trade-offs that might arise when trying to satisfy the non-functional requirements of this system (6 marks)

(e) What are the difficulties in testing the non-functional aspects of a system? (8 marks)

(f) A software system is being designed that has four modes: search; delete; add; modify. From historical data, the operational profile is known: the system is in search mode 50% of the time, delete mode 20% of the time, add mode 20% of the time, and modify mode 10% of the time. Historical data also indicates that the probability of selecting a failure-causing input is: 0.0001 for the search mode; 0.0001 for the delete mode; 0.0001 for the add mode; and 0.005 for the modify mode. Determine the number of random tests that must be run to have a 50% chance of detecting a fault in each mode. When building a new system for this application what influence (if any) should these results have on our software development? (8 marks)

5.

The following is a Hoare triple specifying a fragment of a program.

$$\{X=x \wedge Y=y\}\ R:=X;\ X:=Y;\ Y:=X\ \{X=y \wedge Y=x\}$$

(a) Explain clearly each part of the formula and what this formula means. (8 marks)

(b) If this formula is true, explain why; if it is not true explain why not and alter it to a true formula. (4 marks)

(c) In a software control system a simple lift controller is implemented as a class that has boolean attributes representing the state of the lift: stopped; going up; going down; door open; door closed. Write down a class invariant in standard mathematical logic for this class stating the most important invariant properties. The class includes two operations (methods): one to make the lift go up; one to open the lift doors. Specify each of these two operations using a contract expressed in a standard mathematical logic. (6 marks)

(d) A software controller for a CD player must respond to signals: load; play; pause; eject and stop. Develop a statechart that models precisely the controller system, adding any extra events, states and other information to the statechart as necessary. Include in the statechart at least four features not found in conventional state machines, and indicate clearly these particular features. (16 marks)

(e) Discuss (with the aid of a sketch if appropriate) how the software controller relates to the physical CD player. Describe one important benefit and any limitation that result from the relationship between the software object and the physical object. (6 marks)