

University of Swaziland
Department of Computer Science
Final Examination
May 2011

Title of paper : Software Engineering II

Course number : CS452

Time Allowed : Three(3) hours

Instructions :

- *Each question is worth 25 marks.*
- *Answer question 1.*
- *Answer any three (3) questions from questions 2 to 6*

This paper may not be opened until permission has been granted by the invigilator

Question 1 and 2 are based on the following Case study

LOMPALA CONSTRUCTION (LC) PAYROLL APPLICATION

As a software architect at LOMPALA CONSTRUCTION (PTY) LTD, you are tasked with building a new payroll system to replace the existing system that is hopelessly out of date. LC needs a new system to allow employees to record time card information electronically and automatically generate paychecks based on the number of hours worked and total amount of sales (for commissioned employees). As can be expected, this is just one of many software applications within LOMPALA CONSTRUCTION. Part of the mandate in designing and developing this application is ensuring that you are inline with the decisions and direction that have been made by management and the architecture team.

The new system will provide a web-based interface to allow employees to enter timecard information, enter purchase orders, change employee preferences (such as payment method), and create various reports. The system will be accessed by individual employee desktops and laptops throughout the entire company. For reasons of security and auditing, employees can only access and edit their own time cards and purchase orders.

The system will retain information on all employees in the company (LOMPALA CONSTRUCTION currently has around 5,000 employees world-wide). The system must pay each employee the correct amount, on time, by the method that they specify (see possible payment methods described later).

LOMPALA CONSTRUCTION, for cost reasons, does not want to replace one of their legacy databases, the Project Management Database, which contains all information regarding projects and charge numbers. The new system must work with the existing Project Management Database, which is a DB2 database running on an IBM mainframe. The Payroll System will access but not update information stored in the Project Management Database. A number of web services will provide access to the Project Management Database and are expected to be reused by other applications in the organization.

Some employees work by the hour and they are paid an hourly rate. They submit timecards that record the date and number of hours worked for a particular charge number. If someone works for more than 8 hours, LOMPALA CONSTRUCTION pays the employee 1.5 times his or her normal rate for those extra hours. Hourly workers are paid every Friday.

Some employees are paid a flat salary. Even though they are paid a flat salary, they submit timecards that record the date and hours worked. This is so the system can keep track of the hours worked against particular charge numbers. They are paid on the last working day of the month.

Some of the salaried employees also receive a commission based on their sales. They submit purchase orders that reflect the date and amount of the sale. The commission rate is determined for each employee, and is one of 10%, 15%, 25%, or 35%. It is expected that LOMPALA CONSTRUCTION will start to allow partner organizations sell LOMPALA CONSTRUCTION products and will therefore need the ability to work with the purchase order aspect of the system. To meet this future need this functionality must be exposed as a set of web services.

One of the most requested features of the new system is employee reporting. Employees will be able to query the system for number of hours worked, totals of all hours billed to a project (i.e., charge number), total pay received year-to-date, remaining vacation time, etc.

A number of other applications anticipate needing access to the employee reporting information. To meet that need, the payroll application is expected to expose access to this information via web services.

Employees can choose their method of payment. They can have their paychecks mailed to the postal address of their choice, or they can request direct deposit and have their paycheck deposited into a bank account of their choosing. Rather than deal with a number of banks to fulfill the processing of the payments, LOMPALA CONSTRUCTION has contracted with one bank that will then either mail out checks or process the direct deposit requests and route to the payment to the appropriate bank and account. To simplify integration with the bank, a number of web services have been exposed by the bank for client usage.

The payroll application will run payroll automatically every Friday and on the last working day of the month. The system will pay the appropriate employees on those days. The system will be told by the Administrator what date the employees are to be paid, so it will generate payments for records from the last time the employee was paid to the specified date. The new system is being designed so that the payroll will always be generated automatically, and there will be no need for any manual intervention.

The Payroll Administrator maintains employee information. The Payroll Administrator is responsible for adding new employees, deleting employees and changing all employee information such as name, address, and payment classification (hourly, salaried, commissioned), as well as running administrative reports. In the new IT architecture, it has been recognized that a number of applications will need to manage employee information. To facilitate this usage you've been instructed to expose a set of web services to other internal applications for accessing employee information.

Question 1 – 25 Marks

(Compulsory)

- (a) Using UML notation, draw a USE CASE diagram for LOMPALA CONSTRUCTION.

15 marks

- (b) Draw a sequence diagram that shows what happens when the payroll application automatically executed, as explained in paragraph 11: “

“The payroll application will run payroll automatically every Friday and on the last working day of the month. The system will pay the appropriate employees on those days. The system will be told by the Administrator what date the employees are to be paid, so it will generate payments for records from the last time the employee was paid to the specified date. The new system is being designed so that the payroll will always be generated automatically, and there will be no need for any manual intervention”

10 marks

Question 2 – 25 Marks

Using UML notation, draw an object-oriented (OOA) model for LOMPALA CONSTRUCTION. Show suitable classes, structures, attributes, services, instance and message connections.

Question 3 - 25 Marks

- (a) “*Software Design is a wicked problem*”. Briefly discuss the general characteristics of wicked problems and clearly how they are manifested in software design process. Explain a general approach to solving wicked problems. 15 marks

- (b) Consider the following routine.

```

Procedure Shiftdown (var A:Array of integer;
k,n:integer);
Var parent, child, insert, Ak : integer;
begin
    Parent := k; child := k+k;
    Ak := A[k]; insert := Ak;
loop
    if child > n then exit end;
    if child < n then
        if A[child] > A[child+1] then child := child+1
    end
    end;
    if Insert <= A[child]
        then exit
        else A[parent] := A[child];
            Parent := child; child := child+child
        end
    end;
    A[parent] := Ak
end;

```

- (i) Draw a control graph of the routine as described above. 5 marks
- (ii) Compute the cyclomatic number for the graph obtained above. 2 marks
- (iii) Write a possible set of linearly independent paths for this graph and explain how that could be used as a basis for testing. 3 marks

Question 4 – 25 Marks

An alarm clock application is needed that will allow the user to set the date and time at which an alarm will be sounded. Furthermore, it will allow the user to select from a number of preset alarm modes.

- (a) Draw a sketch, clearly labeled diagram of the possible windows based implementation of the alarm clock application described above. Show and label all components that would be required for such an application. *7 marks.*
- (b) Using Delphi notation (components) design a suitable problem domain component (PDC) class diagram for the Alarm application described above. *8 marks.*
- (c) Using Delphi notation (components) design a suitable human interaction component (HIC) class diagram for the Alarm application described above. Show the inter-relationship between the HIC and PDC. *10 marks.*

Question 5 – 25 Marks

- a) Discuss the main advantages of Object-Oriented software development methods versus traditional structured methods. *5 marks*
- b) Explain/describe how the following design principles are enforced in object-oriented modeling
 - (i) Information Hiding *2 marks*
 - (ii) Loose Coupling *3 marks*
- c) Discuss the contribution of Object-Oriented software development in the following aspects of software development.
 - (i) Implementing Rapid Application Development strategies. *5 marks*
 - (ii) Incremental development. *5 marks*
 - (iii) Improving the quality of the final software system. *5 marks*

Question 6 – 25 Marks

- (a) Describe the following categories of test techniques
- (i) Coverage-based testing *3 marks*
 - (ii) Fault-based testing *3 marks*
 - (iii) Error-based testing. *3 marks*
- (b) What is the difference between black box testing and white box testing?
2 marks
- (c) What is a test adequacy criterion? *2 marks*
- (d) What is a test objective? Briefly explain the three categories of test objectives.
3 marks
- (e) Briefly explain each of the following test techniques and state the test objective that it satisfies.
- (i) Mutation Testing *3 marks*
 - (ii) Fault Seeding *3 marks*
 - (iii) Stepwise abstraction *3 marks*