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## SEPTEMBER 2002 EXAMINATIONS

Bachelor of Arts : Year 2  
Bachelor of Arts : Year 3  
Bachelor of Engineering : Year 2  
Bachelor of Science : Year 1  
Bachelor of Science : Year 2  
Bachelor of Science : Year 3

### SOFTWARE ENGINEERING

TIME ALLOWED : Two Hours

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#### INSTRUCTIONS TO CANDIDATES

Answer *SIX* questions in Section A  
Answer *TWO* question from Section B

If you attempt to answer more than the required number of questions (in any section), the marks awarded for the excess questions will be discarded (starting with your lowest mark).



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SECTION A

(Answer six questions from this section)

- A1(a). Outline the symptoms of the so-called 'software crisis' that led to the emergence of software engineering as a discipline and illustrate by referring to the American Airlines seat reservation system of the mid-1960s, i.e. the SABRE system. **(5 marks)**
- (b). Outline the problems that occurred with the software for the emergency call handling system of the London Ambulance Service that was operational for a short while in the early 1990s, and discuss one of the simple lessons that can be learnt from such attempts to build large, novel software systems, even now, thirty years after the advent of software engineering. **(5 marks)** ■
- A2(a). With the help of a diagram, describe the classic 'waterfall' model of software development and list its merits and drawbacks. **(7 marks)**
- (b). List the advantages and disadvantages of building a prototype early in the software development process, and suggest what aspects of software might be most appropriate for the construction of such a prototype. **(3 marks)** ■
- A3(a). What do the requirements analysis stage and the software specification stage of software development have in common and what is the distinction between them? **(2 marks)**
- (b). Outline the problems facing the analyst when eliciting requirements from the stakeholders of some proposed new software system. **(4 marks)**
- (c). Identify and explain any occurrences of the so-called 'seven sins' in the following natural language fragment from a requirements document. **(4 marks)**

*The software system for monitoring the industrial plant should be capable of generating both status messages and warning messages, each of which should have an associated severity level indicating the seriousness of the situation. The severity level should range from 0 to 7 and, as a consequence, will require just three bits of the entire message structure.*

■



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A4(a). List the possible types of module cohesion giving a brief description of each and show how they form a qualitative cohesion spectrum. **(8 marks)**

(b). State the type of cohesion which best fits the following module description. **(2 marks)**

```
PRINT-RENEWAL( in VEHICLE-REGISTRATION-NUMBER )
```

*Given a vehicle registration number as input, this module retrieves from the database the name and address of the legal owner and then prints as output the appropriate vehicle licence renewal notice for sending to the legal owner.*

A5(a). Draw Nassi-Shneiderman charts (NS charts) for the primitive structures of sequence, selection and repetition. **(4 marks)**

(b). Give one possible role of NS charts in the software development process. **(1 mark)**

(c). Draw an NS chart corresponding to the following pseudo-code program. **(5 marks)**

```
INITIALISE tables and counters;
OPEN files;
WHILE there are more text records
LOOP
    READ next text record;
    WHILE there are more words in text record
    LOOP
        EXTRACT next word;
        SEARCH word table for extracted word;
        IF extracted word is found
        THEN
            INCREMENT extracted word's occurrence count
        ELSE
            INSERT extracted word in word table
        ENDIF;
        INCREMENT words processed counter;
    ENDLOOP;
ENDLOOP;
PRINT word table and words processed counter;
CLOSE files;
```



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A6(a). Briefly describe the following concepts and their notation as used in sequence diagrams of the Unified Modeling Language (UML).

- (i). a lifeline; (2 marks)  
(ii). an activation. (2 marks)

(b). Consider the following.

*A user who holds an account on a password-protected remote website  $W$ , has a web browser active and decides to fetch the login page of the website  $W$ . When the transfer of the login page to the user's browser is complete, the user fills in the login form with a userid and password, both of which get sent to the remote site  $W$  when the user clicks the OK button. The remote site  $W$  then sends a message to an account object to validate the login information. Once the information is checked and found to be valid, this fact is relayed to  $W$  which in turn sends the required protected information to the user's browser.*

Draw a UML sequence diagram corresponding to this situation. Note that you need not be concerned with the circumstance when the userid and password are invalid.

(6 marks) ■

A7(a). Briefly describe the following concepts and their notation as used in state diagrams of the Unified Modeling Language (UML).

- (i). a state; (2 marks)  
(ii). a transition. (2 marks)

(b). Consider the following.

*The lights in a lecture theatre are controlled by a main 'on'/'off' switch and a separate push button labelled 'dim'. The 'on' setting switches the lights to full brightness. The 'dim' push button behaves as a simple toggle, i.e. pressing it when the lights are on full, dims the lights and pressing it when the lights are already dim, returns the lights to full brightness. Pressing the 'dim' button when the lights are off has no effect. Setting the main switch to 'off' turns the lights off completely, regardless of whether the lights are on full or dim.*

Draw a UML state diagram modelling the behaviour of this lighting system.

(6 marks) ■



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- A8(a). What is meant by a 'test frame' in the category-partition method of testing? **(3 marks)**
- (b). During an application of the category-partition method of testing, three categories A, B, C are selected with choices a1, a2, a3 in category A, choices b1, b2, b3 in category B, and choices c1, c2, c3, c4 in category C. In the absence of any further constraints how many test frames would be generated? **(1 mark)**
- (c). Suppose now that constraints are added to the test specification, as represented by the annotations given in square brackets below:

```
Category A:
  a1      [single]
  a2
  a3      [property X]
Category B:
  b1
  b2      [property Y]
  b3      [if X] [property Y]
Category C:
  c1
  c2      [if X]
  c3      [if Y]
  c4      [if X and Y]
```

By itemising the valid test frames, determine how many would be generated in the presence of these constraints. **(6 marks)**





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SECTION B

(Answer two questions from this section)

- B1(a). In the context of data flow diagrams (DFDs), explain the meaning and significance of:
- (i). layering; (2 marks)
  - (ii). a context diagram; (2 marks)
  - (iii). continuity of information flow. (2 marks)
- (b). Consider the following description concerning a system for an employment agency.

*An employment agency system is to be developed which aims to help clients find an appropriate job. Each client provides the system with personal details (e.g. name, address, date of birth, etc.) together with a list of qualifications. Prospective employers provide the system with lists of job vacancies and details of jobs previously vacant, but now filled. On payment of a fee by the client, agency staff can initiate a search request and provide the client with a list of selected job vacancies.*

*Internally the system maintains a stored list of clients containing their personal details and qualifications and this is updated when a new client registers with the agency. The system also maintains a stored list of job vacancies which is updated whenever employers provide information about new vacancies or the filling of previously vacant jobs. When the client pays the fee this is duly processed and this information is stored as a field of the client's record. When agency staff initiate a search request, the client's payment status is checked and their qualifications are used to construct appropriate search criteria. The search criteria are used together with the list of vacant jobs to produce a list of selected jobs for the client.*

Using the DFD notation, represent the system as described above by drawing:

- (i). a context diagram; and (4 marks)
- (ii). a first-level decomposition diagram. (10 marks)





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B2(a). In the context of the algebraic approach to software specification, exemplified by the OBJ notation, explain what is meant by:

- (i). a constructor operator; (1 mark)
- (ii). an evaluator operator; (2 marks)
- (iii). term-rewriting. (4 marks)

(b). The following is an OBJ specification of a very simplified system which records the movements of a particular item of stock at a warehouse. The operator `nil` creates a new empty stock record. Operator `receive` enables a given quantity (specified as a natural number) of the item to be added to the existing stock. Operator `issue` enables a given quantity of the item to be taken from the stock. Operator `total` returns the current quantity of the item in stock, taking into account the sequence of stock movements.

```
StockControl
OBJ StockMovement
SORTS stock
OPS
  nil      :          -> stock *** empty stock ***
  receive : stock nat -> stock *** incoming stock ***
  issue   : stock nat -> stock *** outgoing stock ***
  total   : stock    -> nat   *** current total  ***
VARS
  q : nat
  s : stock
EQNS
  ( total( nil ) = 0 )
  ( total( receive( s, q ) ) = total( s ) + q )
  ( total( issue( s, q ) ) = total( s ) - q
    IF total(s) >= q )
  ( total( issue( s, q ) ) = 0 IF total(s) < q )
JBO.
```

- (i). Explain in words the effect of the last two given equations. (4 marks)
- (ii). Illustrate the 'term-rewriting' process by giving the steps in the evaluation of the following expression: (4 marks)

`total( receive( issue( receive( nil, 5 ), 3 ), 2 ) )`

- (iii). The OBJ specification is to be enhanced by the addition of one further operator:

`numissues : stock -> nat`

which delivers the number of transactions in the record of stock movements which are 'issue' transactions. Give appropriate equations for this operator.

(5 marks)



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B3(a). Briefly describe the following concepts and their notation as used in the Unified Modeling Language (UML).

- (i). an actor in a use case diagram; **(2 marks)**
- (ii). generalisation in use case and class diagrams; **(2 marks)**
- (iii). composition in a class diagram. **(2 marks)**

(b). Consider the following.

*A diagram drawing tool for a PC enables a user to create a new diagram by opening a drawing window where the current diagram can be modified as required. The user can store the current diagram in a diagram folder and may open a previously stored diagram so that it becomes the current diagram and hence can be modified. Stored diagrams in the diagram folder can be deleted only by a special administrative user who, in every other respect, has the same facilities as an ordinary user.*

Draw a UML use case diagram to represent this situation. **(6 marks)**

(c). Consider the following.

*Diagrams consist of one or more primitive items and when a diagram is copied or deleted, its component primitive items are copied or deleted with it. The possible types of primitive item are: rectangle, ellipse, line and text. Each has a control position associated with its central point. All primitive items may be moved or rotated, but only items of type rectangle, ellipse and line may be resized. Text items consist of a string of characters which may be edited.*

Draw a UML class diagram to represent this situation. **(8 marks)**

