

**Answer sheet for Section A and Answer sheet for question 32(b) attached****Two and a half hours**UNIVERSITY OF MANCHESTER  
INSTITUTE OF SCIENCE AND TECHNOLOGY**CT203 Software Analysis and Design**

For candidates taking:

BSc IN COMPUTATION  
SECOND YEAR SESSIONALBSc IN COMPUTING SCIENCE  
SECOND YEAR SESSIONALBSc IN INFORMATION SYSTEMS ENGINEERING  
SECOND YEAR SESSIONALBSc IN COMPUTING AND GEOGRAPHY  
SECOND YEAR SESSIONALBSc IN MANAGEMENT AND INFORMATION TECHNOLOGY  
SECOND YEAR SESSIONALBSc IN ARTIFICIAL INTELLIGENCE  
SECOND YEAR SESSIONALBSc IN MATHEMATICS AND SOFTWARE ENGINEERING  
SECOND YEAR SESSIONALBSc IN BIOLOGICAL AND COMPUTING SCIENCE  
SECOND YEAR SESSIONALMEng, BEng IN SOFTWARE ENGINEERING  
SECOND YEAR SESSIONALMEng, BEng IN COMPUTER SYSTEMS ENGINEERING  
SECOND YEAR SESSIONALMSc IN COMPUTATION  
FINAL EXAMINATION

Wednesday 16 January 2002

9.30-12.00

Answer **all the multiple choice** questions in **Section A**  
and **one** question from **Section B****The answer sheet for section A appears on the back of this question paper and the ENTIRE PAPER MUST BE RETURNED with your answer book. Failure to return the FULL paper will result in ZERO marks for section A.****The use of electronic calculators is NOT permitted****Note: Do not answer more than the required number of questions. Clearly cross out anything you do not wish to be marked.**

PTO

**SECTION A: Answer all questions, marking your answer on the special answer sheet at the back of this paper.**

Section A comprises 60% of the total marks for this paper. Each question indicates the number of marks (out of a total of 60) which can be earned for a correct answer and the number of marks deducted for an incorrect answer. If you do not answer a question in section A, you will not gain any additional marks, nor will you lose any marks.

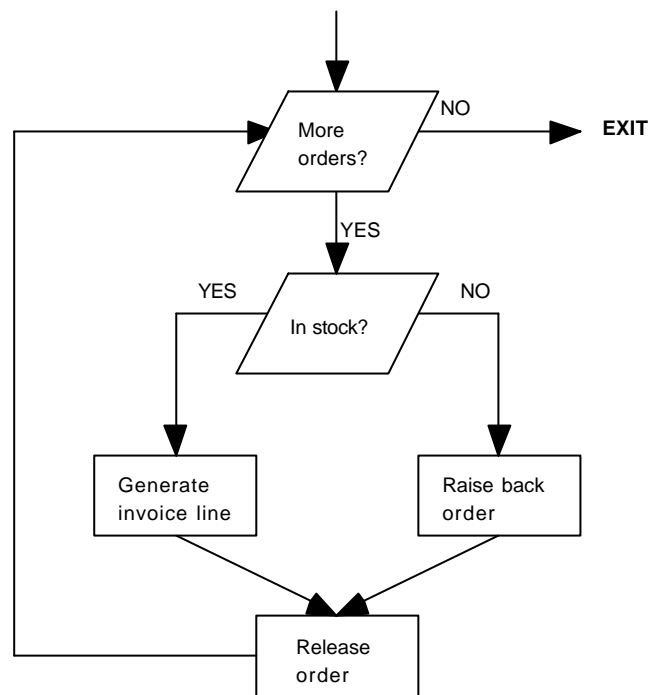
**The answer sheet for section A appears on the back of this question paper and the ENTIRE PAPER MUST BE RETURNED with your answer book. Failure to return the FULL paper will result in ZERO marks for section A.**

- 1) For an organisation seeking to produce reusable software components, there are a number of possible organisational structures which can be adopted. One structure is the 'Nested Producer Model'. Which of the following statements best describes the 'Nested Producer Model'.
- a) Development teams each produce their own applications, but whilst doing so, identify reusable components which can be made available to other teams, normally with the assistance of a central 'reuse manager'.
  - b) Two types of development team are formed. One type of team concentrates on producing reusable components, whilst the other type of team concentrates on using the reusable components, and others they produce themselves, to create applications.
  - c) Each application project has two sub-teams, one who produce reusable components and the other who assemble the reusable components and other components they produce themselves to create the application.
  - d) A separate, independent developer produces reusable components and makes them available for optional use by application development projects.
  - e) Every developer produces both reusable components and application-specific components.

(2 marks for a correct answer, -1/2 for an incorrect answer)

(3)

2) What is the measure of cyclomatic complexity of the following flowchart:



- a) 1
- b) 2
- c) 3
- d) 5
- e) 7

(2 marks for a correct answer, -1/2 for an incorrect answer)

3) The review of a software product or document should be based on which principle:

- a) to find the faults and errors, and to produce the solution to them
- b) to find the faults and errors, but not to produce the solution to them
- c) to ensure that the person who has caused a fault or error in the product is identified
- d) to ensure that the person who has caused a fault or error in the product is transferred to another project
- e) to review all products and documents in one go

(1 mark for a correct answer, -1/4 for an incorrect answer)

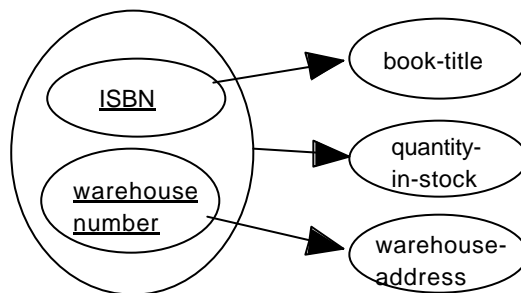
(4)

4) In trying to determine the priority of a set of requirements amongst a group of stakeholders, which method of prioritisation is likely to be best.

- a) *nominal group voting* is better than *weighted multivoting* because it is simple
- b) *nominal group voting* is better than *weighted multivoting* because it produces a ranked order of requirements
- c) there is no difference between the effectiveness of *nominal group voting* and *weighted multivoting*
- d) *weighted multivoting* is better than *nominal group voting* because it is simple
- e) *weighted multivoting* is better than *nominal group voting* because it includes measures of the strength of opinion of each stakeholder

(2 marks for a correct answer, -1/2 for an incorrect answer)

5) The following *functional dependency* diagram shows the relationship between attributes used to describe books stored in a number of different warehouses. Which statement is NOT true:



- a) given an ISBN number, you can uniquely determine the total number of copies of a book you have in stock
- b) given an ISBN number, you can uniquely determine a book title
- c) given a book title you can not necessarily uniquely determine its ISBN number
- d) given a quantity in stock you can not determine which book the quantity relates to
- e) you only need a warehouse number to determine the corresponding warehouse address.

(2 marks for a correct answer, -1/2 for an incorrect answer)

(5)

- 6) Consider the following case study and identify which class model best describes the text.

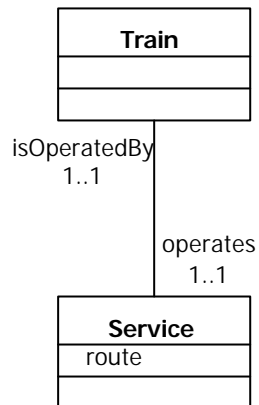
A railway company operates trains. At the start of each day, in the train depot, a vehicle set is created from a number of carriages. The maximum number of carriages permitted is 10, although less carriages may form a vehicle set. When a vehicle set has been created, it is assigned to an engine. The depot manager must be careful as some engines have lower power than others, which means they can pull fewer carriages. Finally, the depot manager will create a service schedule for each train (engine, plus carriage set) which identifies the route that the specific train will operate that day. The service will be unique for the train and can only be created once the depot manager knows the specific engine and number of carriages forming the train, as some routes have short station platforms and cannot accommodate long trains, whilst other routes have steep hills and require trains with a minimum power.

(4 marks for a correct answer, -1 for an incorrect answer)

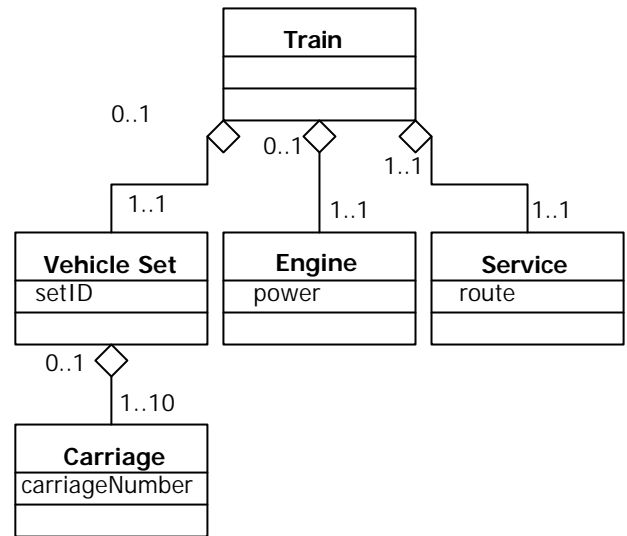
***QUESTION 6) CONTINUED ON NEXT PAGE***

(6)

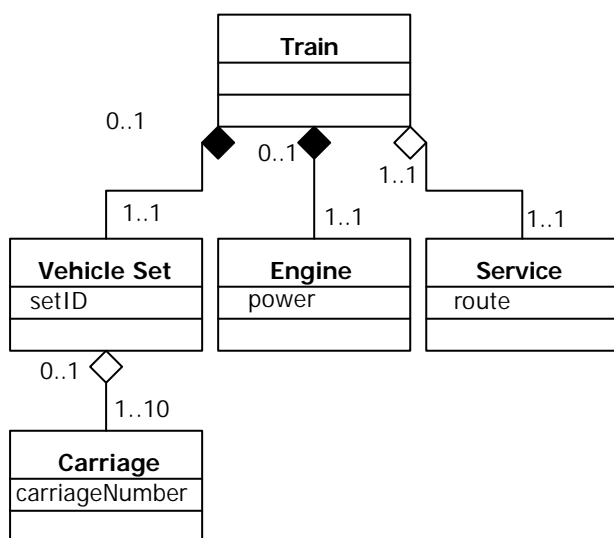
**QUESTION 6) CONTINUED**



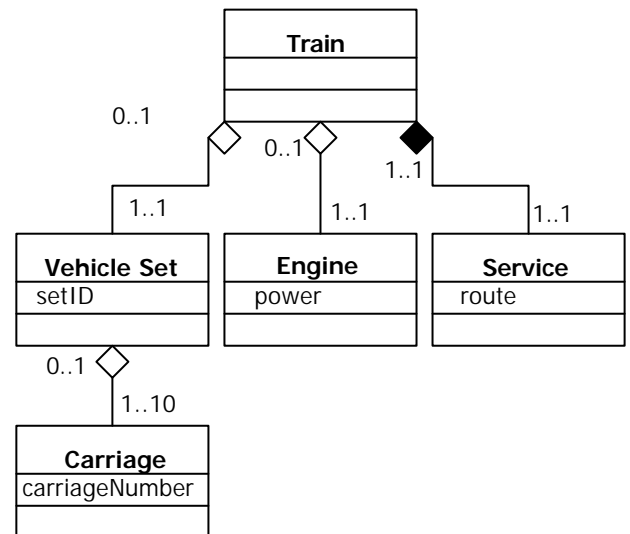
**model a**



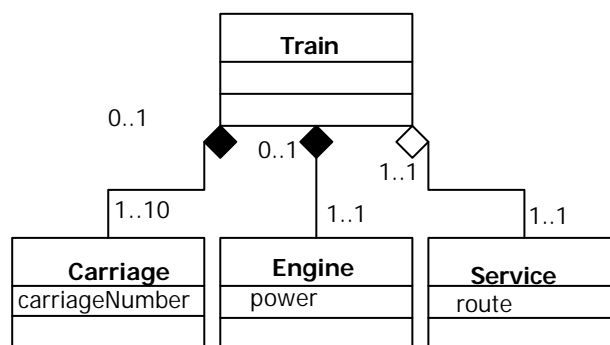
**model b**



**model c**



**model d**



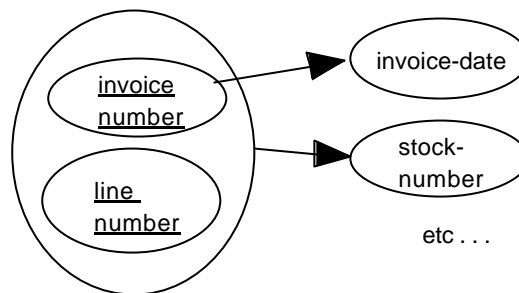
**model e**

(7)

- 7) Consider the following entity definition for an INVOICE LINE ITEM, that is a line which appears on an invoice:

INVOICE LINE ITEM (invoice-number, line-number, stock-number, invoice-date,  
ISBN, book-title, price)

The entity is in 1<sup>st</sup> Normal Form and a functional dependency diagram shows the following dependencies:



What is required to change the entity to 2<sup>nd</sup> Normal Form?

- a) nothing, the entity is already in 2<sup>nd</sup> normal form
- b) remove invoice number and invoice date from the entity and create a new entity
- c) remove line number and stock number from the entity and create a new entity
- d) remove invoice date from the entity and place in a new entity which has also has invoice number (retaining invoice number in this entity also)
- e) remove stock number from the entity and place in a new entity which has also has line number (retaining line number in this entity also)

(4 marks for a correct answer, -1 for an incorrect answer)

- 8) A systems analyst has identified 4 major requirements for a new train ticket issuing system . The analyst has asked stakeholders to perform a pair-wise comparison of each set of requirements. Where one requirement has a stronger preference over another, the analyst has assigned a weight with a value of 1 or more and where the requirement has a negative preference over another, the analyst has assigned a weight with a value of less than one. The analyst has therefore been able to construct the following table, in which the columns have been added together and each column total shown on the last row of the table.

	Any station ticket purchase	Sales report for management	Increased change capacity	Acceptance of credit card payment
Any station ticket purchase	1	0.33	9	3
Sales report for management	3	1	5	5
Increased change capacity	0.11	0.20	1	0.14
Acceptance of credit card payment	0.33	0.20	7	1
Column Totals	4.44	1.73	22	9.14

Using the data gathered by the analyst, which is the correct ranking of requirements by order of importance.

- Any station ticket purchase (most important), Sales report for management, Increased change capacity, Acceptance of credit card payment (least important)
- Sales report for management (most important), Any station ticket purchase, Increased change capacity, Acceptance of credit card payment (least important)
- Sales report for management (most important), Acceptance of credit card payment, Any station ticket purchase, Increased change capacity (least important)
- Sales report for management (most important), Increased change capacity, Acceptance of credit card payment, Any station ticket purchase (least important)
- Sales report for management (most important), Any station ticket purchase, Acceptance of credit card payment, Increased change capacity (least important)

(4 marks for a correct answer, -1 for an incorrect answer)

For your convenience, you may use the following calculation table and the grid for your workings (however workings do NOT need to be shown).

***QUESTION 8) CONTINUED ON NEXT PAGE***

(9)

**QUESTION 8) CONTINUED**Division Table

Use this table to divide two numbers. To divide 0.33 by 9.14, look up 0.33 in the first column, then look across the top row to find 9.14. Find the intersection of the row and column to identify the answer 0.04.

	1.73	4.44	9.14	22	37.31
0.11	0.06	0.02	0.01	0.01	0.00
0.14	0.08	0.03	0.02	0.01	0.00
0.20	0.12	0.05	0.02	0.01	0.01
0.33	0.19	0.07	0.04	0.02	0.01
1	0.58	0.23	0.11	0.05	0.03
3	1.73	0.68	0.33	0.14	0.08
5	2.89	1.13	0.55	0.23	0.13
7	4.05	1.58	0.77	0.32	0.19
9	5.20	2.03	0.98	0.41	0.24

	Any station ticket purchase	Sales report for management	Increased change capacity	Acceptance of credit card payment
Any station ticket purchase				
Sales report for management				
Increased change capacity				
Acceptance of credit card payment				

(10)

9) The following statements concern the role of coupling and cohesion in system module design. Which statement is most appropriate when attempting to design a *good module hierarchy* using the structured design approach:

- a) you must try and minimise coupling and minimise cohesion
- b) you must try and maximise coupling and maximise cohesion
- c) you must try and minimise coupling and maximise cohesion
- d) you must try and maximise coupling and minimise cohesion
- e) none of the above

(1 mark for a correct answer, -1/4 for an incorrect answer)

10) *Message passthrough* is:

- a) never desirable in the design of an object-oriented system
- b) always desirable in the design of an object-oriented system
- c) acceptable in the design of an object-oriented system without inheritance
- d) acceptable in the design of an object-oriented system when there is inheritance
- e) acceptable in the design of an object-oriented system when there is aggregation

(1 mark for a correct answer, -1/4 for an incorrect answer)

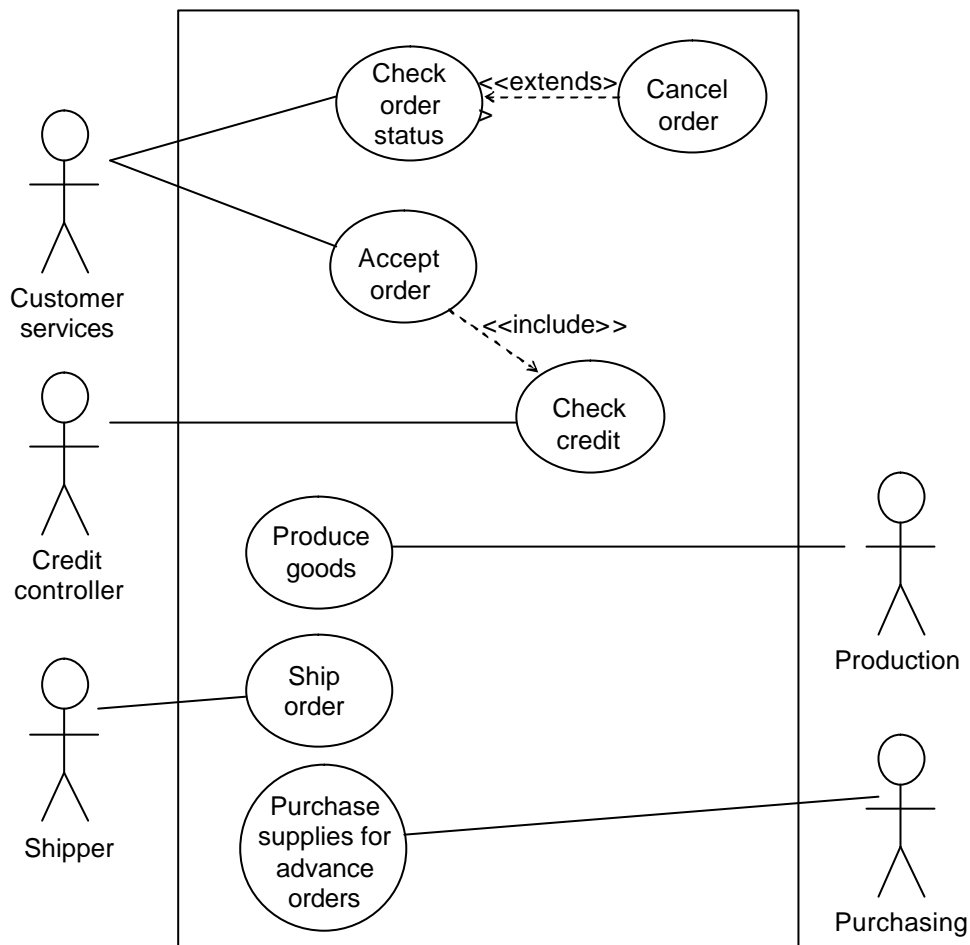
11) In his study on the impact of poor quality and cancelled projects on the software labour shortage, Capers Jones identified the percentage of staff time spend on testing and defect repairs, Year 2000 problems and related repairs, cancelled projects and productive work on projects. What was the percentage of time spent on productive work on projects:

- a) 15%
- b) 24%
- c) 25%
- d) 28%
- e) 36%

(1 mark for a correct answer, -1/4 for an incorrect answer)

(11)

12) Consider the following Use Case diagram which illustrates an order processing system.



Three questions need to be answered from this diagram:

- i. which users can check a customer's credit rating?
- ii. who can cancel an order?
- iii. is credit checked for all orders placed

Select an option below which shows the correct answers for all three questions:

	Question i.	Question ii.	Question iii
a)	Customer services	Nobody	Yes
b)	Customer services and Credit controller	Anytime	No
c)	Credit controller	After checking order status	Not relevant
d)	Customer services and Credit controller	After checking order status	Yes
e)	Customer services	Nobody can directly cancel an order	No

(4 marks for a correct answer, -1 for an incorrect answer)  
PTO

13) The following statements about *requirements* are all incorrect except one. Which statement is correct?

- a) a *mutable* requirement is one resulting from a change in the users' view of the system during development, whilst a *consequential* requirement is one resulting from changes in the implementation environment
- b) a *mutable* requirement is one resulting from the introduction of a new system, whilst a *consequential* requirement is one resulting from changes in the implementation environment
- c) a *compatibility* requirement is one resulting from the introduction of a new system, whilst a *mutable* requirement is one resulting from changes in the implementation environment
- d) an *emergent* requirement is one resulting from the introduction of a new system, whilst a *consequential* requirement is one resulting from changes in the implementation environment
- e) an *emergent* requirement is one resulting from a change in the users' view of the system during development, whilst a *mutable* requirement is one resulting from changes in the implementation environment

(2 marks for a correct answer, -1/2 for an incorrect answer)

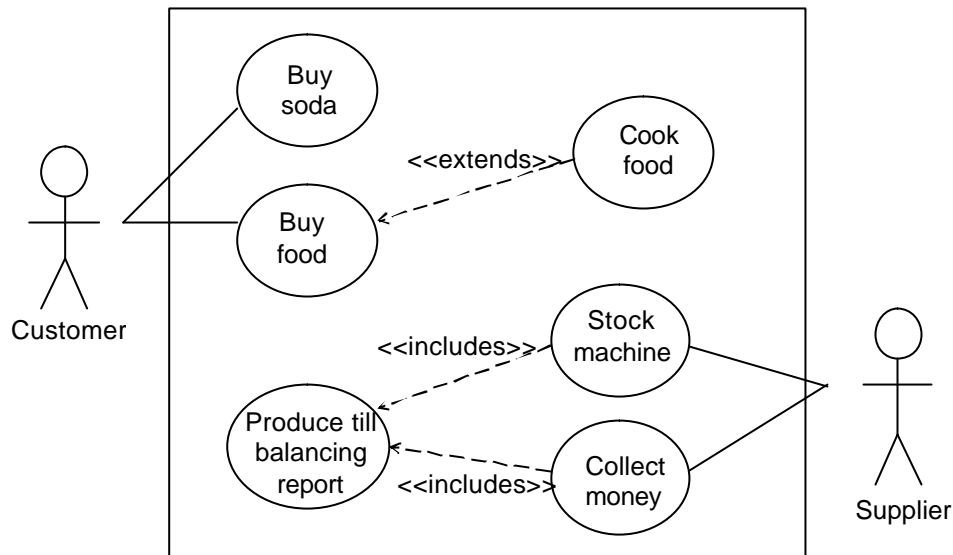
14) Brainstorming seeks to:

- a) generate a number of ideas which must be discussed and agreed as feasible, even if they are all desirable or essential
- b) generate a number of issues which can only be concerned with the implementation of a proposed system
- c) generate a number of ideas which are validated and agreed by a stakeholder group
- d) generate a number of ideas which are later validated and agreed by a stakeholder group
- e) generate a number of ideas from individual stakeholders, so that they are not encouraged by others to think in a particular fashion.

(1 mark for a correct answer, -1/4 for an incorrect answer)

(13)

15) Consider the following Use Case diagram and identify the correct interpretation.



- a) when the *buy food* function is executed, the system will automatically include a *cook food* operation
- b) when the *cook food* function is executed, the system may extend its functionality to include a *buy food* operation
- c) when the *buy food* function is executed, the system may optionally include a *cook food* operation
- d) when the *stock machine* function is executed, the system will optionally include a *produce till balancing report* operation
- e) none of the above are correct.

(2 marks for a correct answer, -1/2 for an incorrect answer)

16) The purpose of a *system specification* is to:

- a) show how a software system is to be implemented
- b) present the details of design decisions made
- c) assist in the future maintenance of the system
- d) provide a statement of the problems which the system is intended to address
- e) present an implementation-independent description of the system which can be reused for a number of designs.

(1 mark for a correct answer, -1/4 for an incorrect answer)

17) Which statement is true about a sequence diagram:

- a) a sequence diagram shows the lifetime of a set of objects and how they pass messages between one another
- b) a sequence diagram shows the possible interactions which may exist between a set of classes
- c) a sequence diagram shows the lifetime of a set of objects through the events which may occur in a time-ordered sequence
- d) a sequence diagram shows the interfaces between users (actors) and the system
- e) none of the above.

(2 marks for a correct answer, -1/2 for an incorrect answer)

18) Which statement is true:

- a) efficiency in software development is concerned with producing software with minimum errors, budget and duration; whilst effectiveness is about producing the software that meets users' needs
- b) efficiency in software development is concerned with producing software that requires on one iteration of the software lifecycle; whilst effectiveness is about producing software without errors
- c) efficiency in software development is concerned with producing software with the minimum of maintenance change; whilst effectiveness is about producing software without errors
- d) efficiency in software development is concerned with producing software that meets all the specified requirements; whilst effectiveness is about producing software which passes acceptance testing
- e) efficiency in software development is concerned with producing the software that meets users' needs; whilst effectiveness is about producing software with minimum errors, budget and duration.

(2 marks for a correct answer, -1/2 for an incorrect answer)

19) Read the following case study.

Passengers using a rapid transit system buy tickets to travel from their station of origin to their destination. The ticket issuing machine is activated when the user indicates the zone to which they wish to travel. The machine then displays the fare and the user opts to pay either by cash or by credit card- depending upon the method selected the machine then processes the payment (receives cash or makes a credit card charge) and then issues the ticket. Ticket machines are emptied daily by station ticket office staff.

Which of the following concepts described in the above case study are both events?

- a) passenger buys ticket and machine receives cash
- b) user indicated payment method and user indicated required travel zone
- c) machine processes payment and ticket machine emptied
- d) ticket machine emptied and machine displays fare
- e) passenger and ticket.

(2 marks for a correct answer, -1/2 for an incorrect answer)

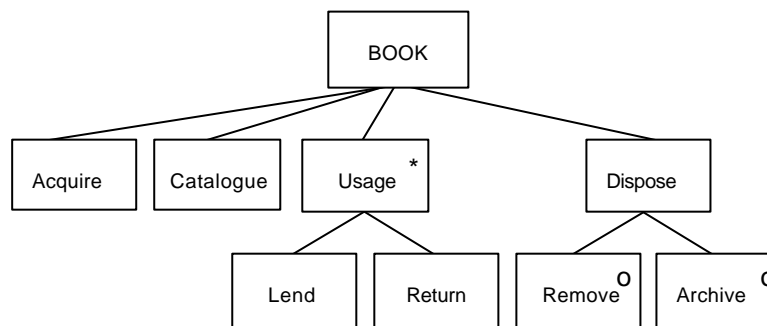
(15)

20) Which statement most accurately describes a requirement:

- a) a requirement is a problem which must be solved by the proposed system
- b) a requirement is an optional system feature which, if implemented, will increase user satisfaction
- c) a requirement is a user-oriented statement about the manner in which the proposed system must carry out its functional characteristics
- d) a requirement is a statement of the minimum achievement of the proposed system which may cover functional and/or non-functional characteristics
- e) a requirement is a full conceptual description of the proposed system which can be used by system designers to plan and subsequent implement the system.

(1 mark for a correct answer, -1/4 for an incorrect answer)

21) Consider the following life history for the class book. Which statement is NOT true:



- a) a *lend* event can happen after a *catalogue* event or a *return* event
- b) a book can only be catalogued after it has been acquired
- c) a *remove* event can only occur after a *return* event
- d) when a book has been subject to a *lend* event, it must next be the subject of a *return* event
- e) a book can only be subject to a *archive* event after it has been catalogued or returned following *lend* event

(2 marks for a correct answer, -1/2 for an incorrect answer)

22) A questionnaire is to contain a question about staff attitude towards a possible replacement or enhancement for a customer order processing system. Which of the following questions would be the most suitable.

- a) "List all features for a new order processing system".
- b) "Management has decided that the existing order processing system is no longer suitable because it has limited functionality. What features should a new or revised system contain?"
- c) "A new order processing system is being commissioned to provide to enable staff respond more effectively to customers. What features should a new system contain?"
- d) "What system features could be provided in a new or revised order processing system, which would enable you to respond more effectively to customers?"
- e) "Would you like a new or revised order processing system which would reduce the time it takes to do your job?"

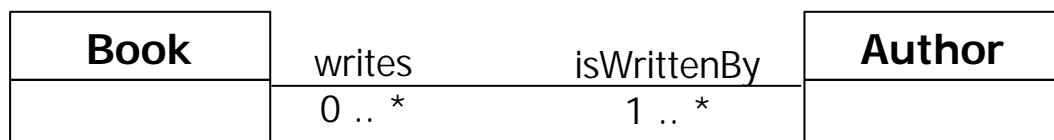
(2 marks for a correct answer, -1/2 for an incorrect answer)

23) Which of the following statements is true.

- a) object oriented analysis and design was developed and more widely used before structured analysis and design.
- b) object oriented analysis and design is concerned with encapsulating data and the operations which can be performed on that data.
- c) structured analysis and design seeks to develop a series of autonomous modules which can act independently.
- d) object oriented analysis and design is about establishing a hierarchy of control.
- e) structured analysis and design and object oriented analysis and design use different techniques, but ultimately result in the same system design and implementation.

(1 mark for a correct answer, -1/4 for an incorrect answer)

24) Consider the following object model which describes the relationship between a book and an author. Which statement is NOT true:



- a) an author must have written at least one book otherwise they can not be an author
- b) a book may be written by more than one author
- c) an author does not necessarily have to have written a book
- d) a book can not exist unless it has at least one author
- e) an author can have written many books

(1 mark for a correct answer, -1/4 for an incorrect answer)

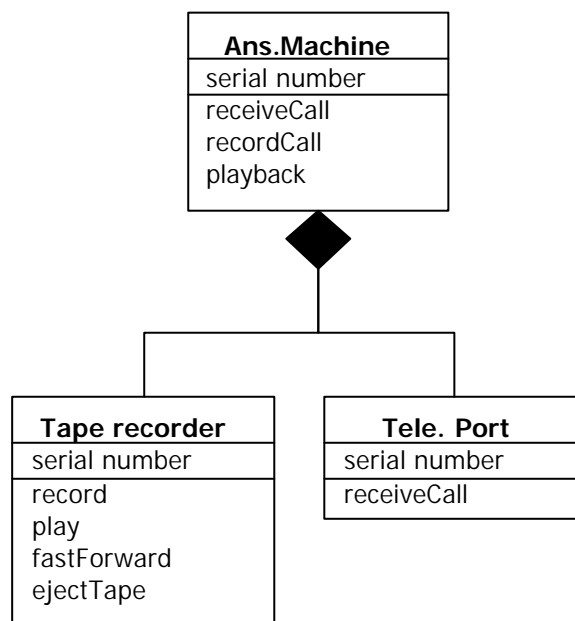
(17)

25) Which statement about attributes in a class description is correct:

- a) attributes in a class description are generally public but may be made private during the development of the system to improve system efficiency and effectiveness
- b) attributes in a class description are generally private so that reuse of the class can be limited to only those classes which know the public operations of the class
- c) attributes in a class description are generally public so that other class can directly manipulate them and thus reduce potential message passthrough and thereby improve the efficiency of the system at run-time
- d) attributes in a class description are generally private so that other classes can not directly manipulate them because they may not understand either the implementation of the attribute or the integrity constraints which must apply across a number of attributes in the class
- e) attributes in a class description are generally public so that classes can be more easily reused in other systems and avoid the need for classes in other systems from knowing the operations which manipulate the classes

(1 mark for a correct answer, -1/4 for an incorrect answer)

26) Consider the following class model and identify which statement correctly describes the model.



- a) *receiveCall* in Tele.Port redefines *receivecall* inherited from Ans.Machine
- b) Tele.Port inherits all the properties of Ans.Machine, but redefines the operation called *receiveCall*
- c) When Ans.Machine receives the message *receiveCall*, it is delegated to Tele.Port
- d) Tape recorder cannot inherit the operation *receiveCall* from Ans.Machine
- e) Tape record cannot exist without inheriting properties from Ans.Machine

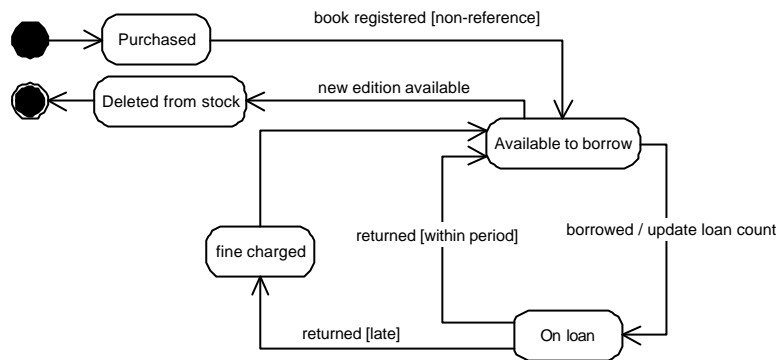
(2 marks for a correct answer, -1/2 for an incorrect answer)

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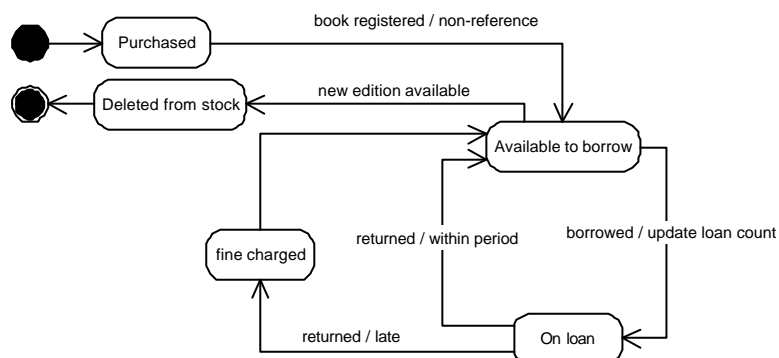
27) Consider the following case study and identify which state diagram best describes the text.

A library purchases books and, provided that they are non-reference books (i.e. they can be borrowed), they are registered and are assigned the status 'available to borrow'. When a book is borrowed, its loan count is updated and cannot be borrowed by other library members until it is returned and once again has the status 'available to borrow'. If the book is returned late from being on loan, a fine is charged.

(4 marks for a correct answer, -1 for an incorrect answer)



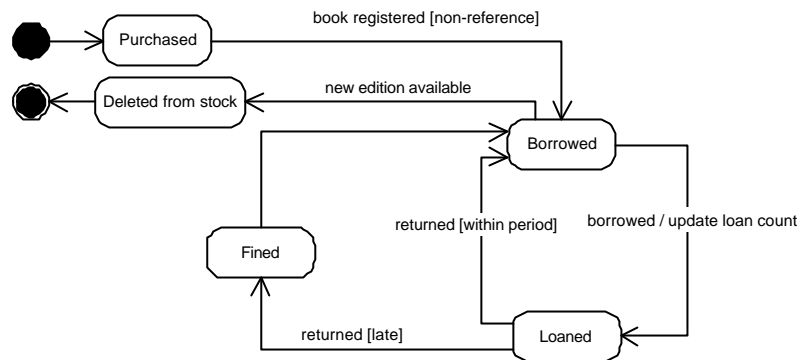
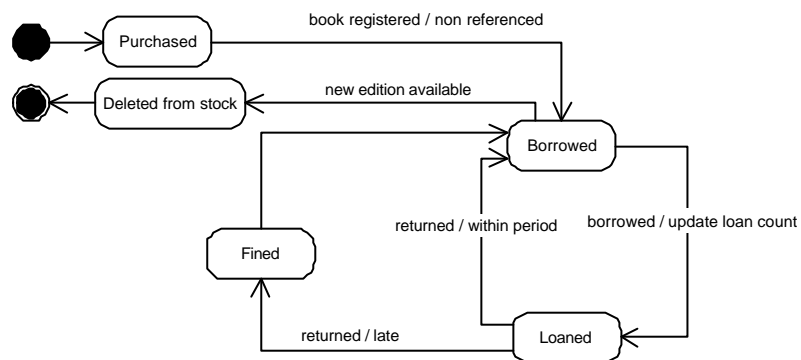
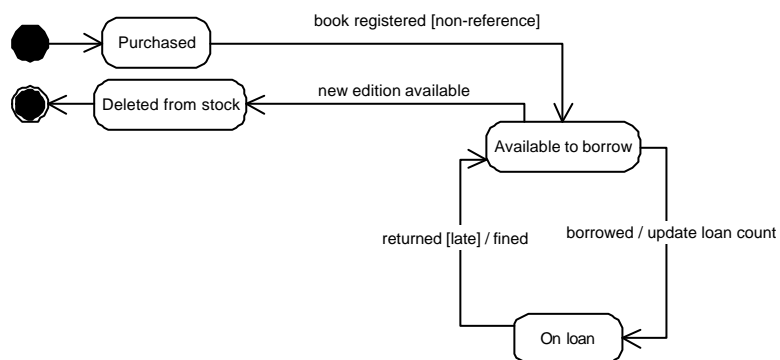
**model a**



**model b**

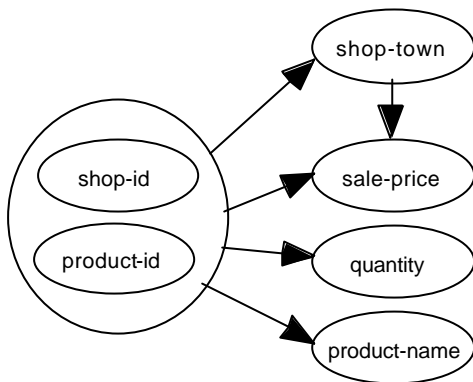
***QUESTION 27) CONTINUED ON NEXT PAGE***

(19)

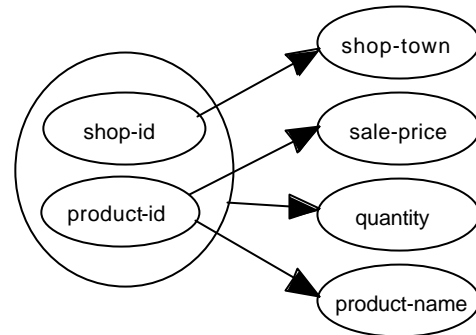
**QUESTION 27 CONTINUED****model c****model d****model e**

- 28) NailIT is nationwide do-it-yourself (DIY) hardware store with shops in a number of towns and, in some cases, more than one shop in a town. NailIT stocks a range of products, each identified by a unique product-id and name. Each shop holds 0 or more items of each stock line. Because the DIY business is extremely competitive, shop managers have the authority to vary the amount of stock they hold and, with authorisation from the company's head office, may vary the sale price of each product.

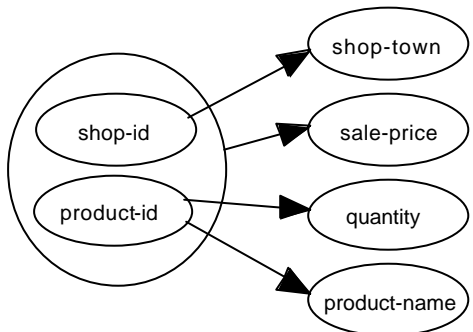
Which of the following functional dependency models is the most accurate?



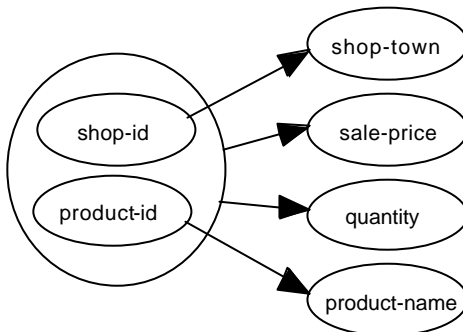
Functional dependency (a)



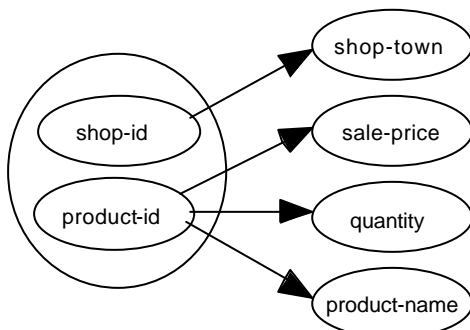
Functional dependency (b)



Functional dependency (c)



Functional dependency (d)



Functional dependency (e)

(4 marks for a correct answer, -1 for an incorrect answer)

(21)

29) With reference to the Data Protection Act, which statement is NOT true:

- a) personal data must be obtained and processed fairly and lawfully
- b) personal data must not be used or disclosed for any purpose other than that for which it has been registered or is required to be disclosed by lawful means
- c) personal data shall not be kept longer than is necessary
- d) data which is held on backup tapes, but is no longer available to applications is exempt from the Data Protection Act
- e) individuals have the right to know of data held, access to data values and have misleading data corrected

(1 mark for a correct answer, -1/4 for an incorrect answer)

30) A stakeholder is:

- a) the person paying for the system
- b) a term used by politicians which has no meaning in the context of software development
- c) the person who will use the system
- d) somebody with an interest in the system being developed
- e) none of the above

(1 mark for a correct answer, -1/4 for an incorrect answer)

**SECTION B: Answer ONE question from this section. Write your answer in the standard answer book and attach this question paper and multiple choice answer sheet to the standard answer book.**

**Section B comprises 40% of the total marks for this paper. You should only attempt ONE question to earn the maximum number of marks. If you answer more than one question, only the first answer in the answer book (which is not crossed out) will be marked, with all remaining answers ignored.**

31) Attempt all parts of the question

Read the following case study.

A library lending and reservation system is under construction for the University of Cheshire. In the university's library there are a number of library items, which can be subdivided into written works (e.g. books, magazines etc.) and recorded items (e.g. music, games etc.). All items have a unique ID number and a title.

Written works are classified into those items which can be borrowed and those items which cannot be borrowed (reference items). All written works have a publisher and ISBN (unique book reference number). Recorded items are made up from one or more media (e.g. CDs, tapes, vinyl disks, DVDs etc.). Each media has a media reference number which uniquely identifies the item.

For items which can be borrowed (written or recorded), the system must store the number of times the item has been borrowed (increasing the count immediately the item is borrowed) and, when on loan, must record the date the item is due to be returned.

Library items, which can be borrowed, can have a reservation made for them by library members. Library items can be interrogated to see whether (a) they can be reserved (since reference items cannot be reserved) and (b) whether there is a reservation currently for the item.

The system will record library members, with a membership number, name and number of items currently borrowed. Library members can borrow items, return items and make reservations. The maximum number of items which can be borrowed must not exceed 6.

When a library member attempts to borrow a library item, the system must first check to see whether the item is out on loan and, if not, whether the library member has a reservation for the library item. If a reservation exists and is made by the library member, the reservation can be cancelled and the library item lent out. If a reservation exists for the library item, but is for a different library member, the library item cannot be borrowed by that library member and must remain available for the library member who reserved the item.

When a library item is returned, a check must be made to see if the item has been returned late, in which case a fine is charged.

- (a) Draw a class model for the above case study, showing only those attributes and operations necessary to implement the case study as described. You should not add attributes or operations which are not needed for the case study as described- if you do this, you will lose marks.

(20 marks)

***QUESTION 31) CONTINUED ON NEXT PAGE***

***QUESTION 31 CONTINUED***

- (b) Draw a sequence diagram showing the message interaction when a library member wishes to borrow a library item. Your diagram should be consistent with the model in part (a). (10 marks)
- (c) Draw a statechart for library items which can be borrowed (ignore reference items), showing the states through which a library item can pass (e.g. on loan). Your diagram should be consistent with the model in part (a). (10 marks)

32) Attempt all parts of the question

Read the following case study.

A telephone operating company is developing a specification for part of its call handling and customer accounting system.

A general purpose customer services department receives enquiries and requests from the company's customers. These are generally of two types: (i) payment of invoices, which are acknowledged and passed for processing to a clerk who checks that the invoice is paid in full, separates cheques and payment slips and passes them to the Accounts Department for processing; (ii) a request to open a new telephone account (new number, line and handset). This information is recorded in a CUSTOMER file in the form:

customer-record = customer-number + handset-id + customer-name

When customers wish to make a call, they use their handset to dial the appropriate number. This is received by a call request and validation process which checks to ensure that a valid handset-id has been supplied and if so, checks to see whether all the telephone exchange lines are in use (by reference to a file of EXCHANGE-LINE usage). A check on the customer's credit is also made.

If the handset-id is valid, there are unused exchange lines and the customer's credit is OK, the call is connected by a call-handling process and when completed, a call-billing process writes a record to the CUSTOMER file with details of the call and its cost, in the form:

billing-record = handset-id + number-dialled + call-length

Once per month, a special process is activated to produce invoices for each handset-id by reading data in the CUSTOMER file. The invoices are then passed to the Accounts Department for mailing to customers.

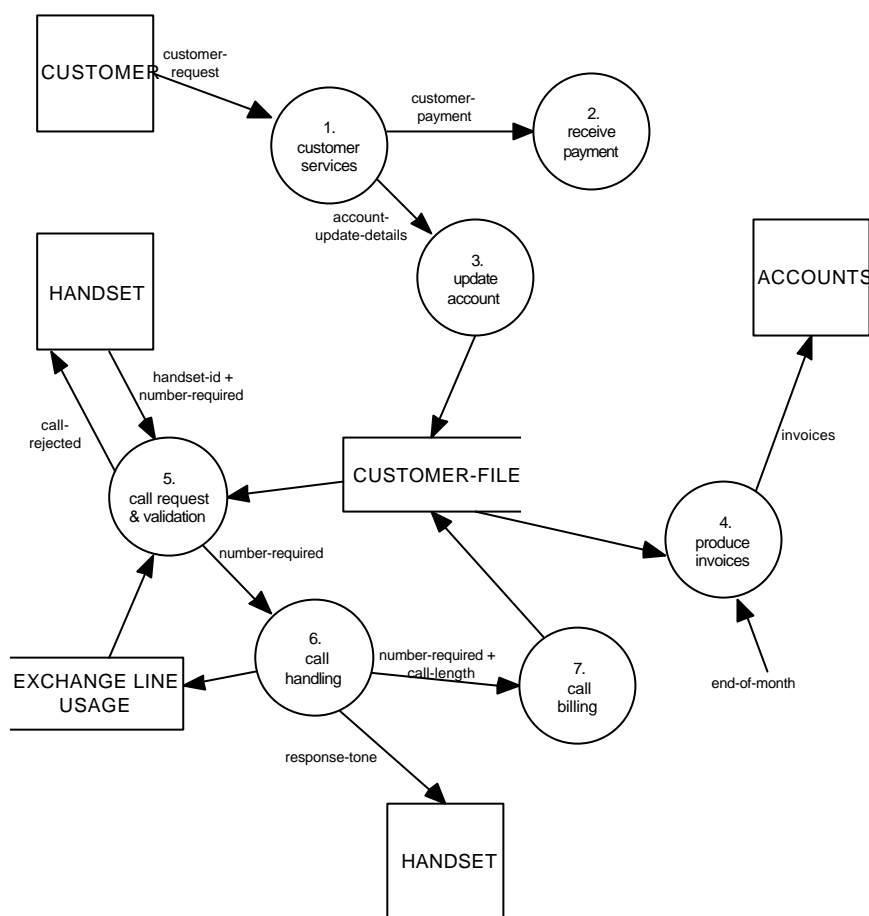
- (a) The data flow diagram shown below represents the current logical specification of the proposed system, but has not been validated or subjected to any quality checks for correctness.

Identify 4 errors or problems with the data flow diagram and say what further work needs to be undertaken to correct them.

Note that some of the errors will be problems with the syntax of the diagram, whilst others relate to the accuracy of the representation of the case study.

(8 marks)

***QUESTION 32) CONTINUED ON NEXT PAGE***

**QUESTION 32) CONTINUED**

- (b) After further analysis the telephone operating company has refined the data flow diagram and has detailed the area concerning process numbers 5 and 6. Using the additional narrative below, complete the data flow diagram on the answer sheet that has been supplied, to show the *control data flows* to and from the *checking control program* and in your answer book, show the state transition diagram for process 5.2 (Checking control program).

Note, you must show both the control data flows and the state transition diagram and ensure that the diagrams are consistent with each other.

Additional narrative

When call checking is initiated (process 5.2) a trigger event is sent to the checking control program (process 5.3). The checking control process first checks the exchange limit to see whether there are any lines available, followed by a check on the customer's credit. If the exchange limit is exceeded (i.e. there are no spare lines) or the customer's credit is exceeded, the call is refused, otherwise the call is accepted and the number-required is passed from the initiate call checking process (process 5.2) to a process which assigns a line (process 6.1). When either the call has been accepted or refused, the checking control program returns to an idle state and awaits the next call.

(20 marks)

**QUESTION 32) CONTINUED ON NEXT PAGE**

**QUESTION 32) CONTINUED**

- (c) Explain the purpose of adding control processes and control flows to a data flow diagram. Why do system developers not add this information when they first construct a data flow diagram?  
(4 marks)
- (d) Draw a limited-entry decision table which represents the processing undertaken by the system when call checking is initiated, as explained in section (b) above. Amend the diagram to show the following additional information:
- (i) if a customer wishes to make an international call, the customer's handset must be validated to permit international calls, otherwise the call is refused
  - (ii) after a call has been successfully made, the system logs details of the call

Your decision table should be accurate, complete and show the minimum number of rules possible.

(8 marks)

33) Attempt all parts of the question

Read the following case study.

This case study concerns the ticketing and access control of a rapid transit system (such as the London Underground, Singapore MRT, New York subway or Paris Metro).

Each station on the system has a number of ticket printers which are used by station staff. The ticket printer can issue a ticket to a given destination, can print the total value of tickets issued to date and can have its ticket total value reset to zero. Normally a station manager will take a print out of the total value of tickets issued at the end of each shift and then reset the total to zero.

In addition, each station will have a number of self-service ticket machines which can be directly used by passengers. These machines comprise of a menu handling display, in which a passenger can select their destination station, a coin handler which accepts coins and a standard ticket printer (as used by station staff) for issuing tickets. The self-service ticket machine will co-ordinate the actions of accepting the destination, accepting coins and, provided sufficient coins have been accepted, will instruct the ticket printer to issue the appropriate ticket. No change is given by the self-service ticket machines and only single tickets are used on the system.

When a ticket is printed, it has a magnetic strip encoded to contain the 'from' and 'to' stations and the current date (the date on which travel is permitted).

At each station on the system, there are a number of automatic ticket gates to control access on to the station platforms and exit from the station platforms. Each gate has a gate ID and can be instructed to open or close the 'paddles' which block the entrance when 'closed' and fold back into the machine when 'open'.

Gates are of two types with each type having some extra, specialist commands. An entry gate has one extra command to validate tickets. An exit gate, has two extra commands, one to read a ticket and the other to retain a ticket in a ticket bin (this ensures passengers cannot reuse tickets after a journey). An exit gate also has an attribute indicating the status of the used ticket bin (empty, part-full, nearly-full, full).

At some stations, there are bi-directional gates, which can operate as entry gates and exit gates. These bi-directional gates have a switch which is used to indicate whether they are to operate in entry or exit gate mode.

For reasons of safety and security, a manager can directly instruct a gate to open or close, without the use of a ticket.

- (a) Draw a class model for the above case study, showing only those attributes and operations necessary to implement the case study as described. You should not add attributes or operations which are not needed for the case study as described- if you do this, you will loose marks.

(20 marks)

- (b) Draw a use case showing the interactions with the three major users of the ticketing system (passenger, station staff, manager). Show the key functions and where functions include or extend functionality.

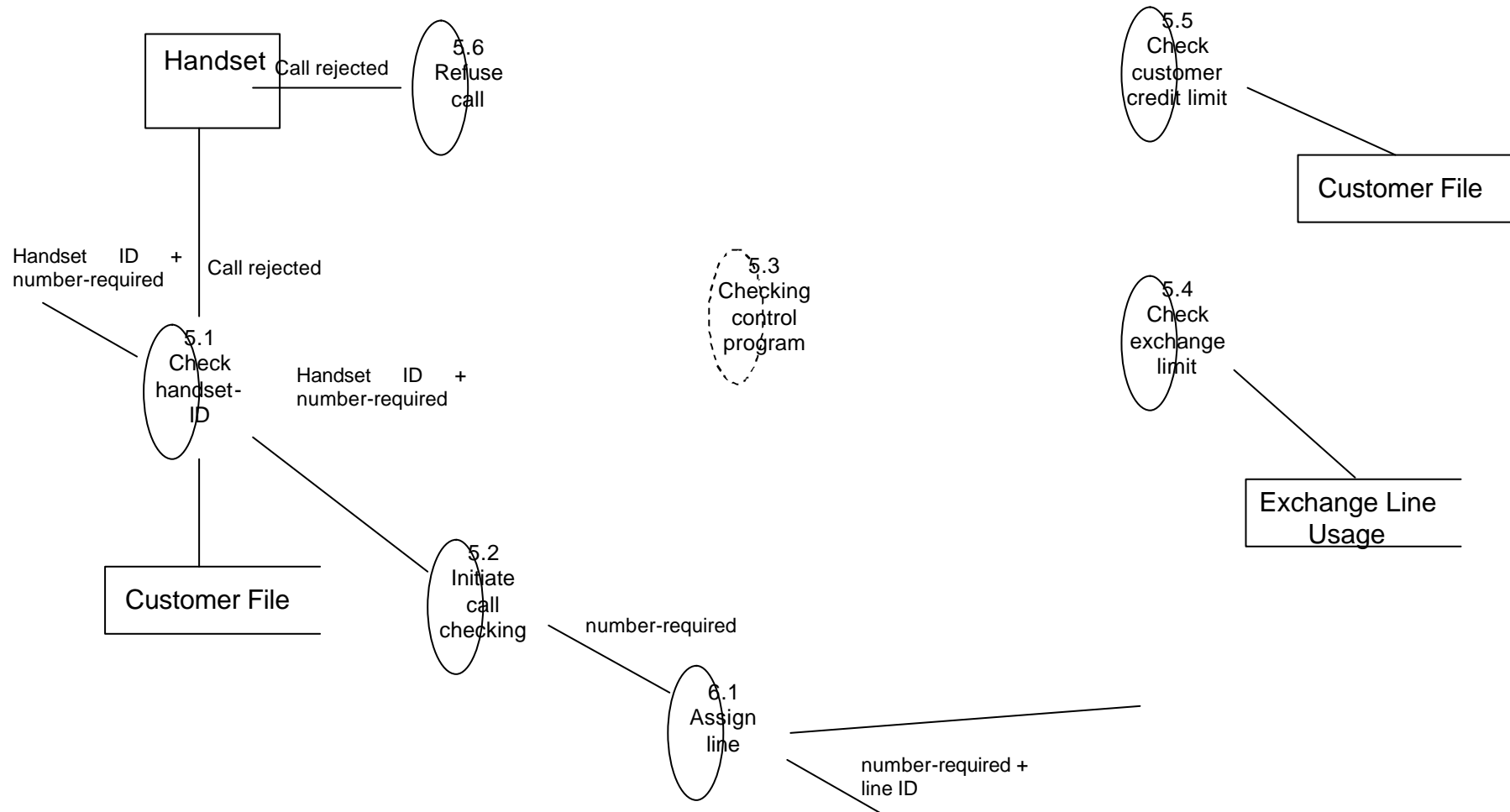
(10 marks)

***QUESTION 33) CONTINUED ON NEXT PAGE***

***QUESTION 33) CONTINUED***

- (c) Explain how you would extend your class model (by adding classes, associations, attributes and/or operations) to manage the interaction between gates and tickets.  
(5 marks)
- (d) Suppose that a new manufacturer supplied ticket gates, which only recognised the general commands 'open gate' and 'close gate'. Explain how you would use inheritance and polymorphism to model entry and exit gates.  
(5 marks)

**END OF PAPER**



**Answer Sheet for Multiple Choice Questions (1-30)**

To indicate your answer, circle the appropriate letter for each question. If you make a mistake, cross out the letter with a cross (X) and write the letter you want at the end of the row.

						Marks for correct answer
<b>Question 1</b>	a	b	c	d	e	2
<b>Question 2</b>	a	b	c	d	e	2
<b>Question 3</b>	a	b	c	d	e	1
<b>Question 4</b>	a	b	c	d	e	2
<b>Question 5</b>	a	b	c	d	e	2
<b>Question 6</b>	a	b	c	d	e	4
<b>Question 7</b>	a	b	c	d	e	4
<b>Question 8</b>	a	b	c	d	e	4
<b>Question 9</b>	a	b	c	d	e	1
<b>Question 10</b>	a	b	c	d	e	1
<b>Question 11</b>	a	b	c	d	e	1
<b>Question 12</b>	a	b	c	d	e	4
<b>Question 13</b>	a	b	c	d	e	2
<b>Question 14</b>	a	b	c	d	e	1
<b>Question 15</b>	a	b	c	d	e	2
<b>Question 16</b>	a	b	c	d	e	1
<b>Question 17</b>	a	b	c	d	e	2
<b>Question 18</b>	a	b	c	d	e	2
<b>Question 19</b>	a	b	c	d	e	2
<b>Question 20</b>	a	b	c	d	e	1
<b>Question 21</b>	a	b	c	d	e	2
<b>Question 22</b>	a	b	c	d	e	2
<b>Question 23</b>	a	b	c	d	e	1
<b>Question 24</b>	a	b	c	d	e	1
<b>Question 25</b>	a	b	c	d	e	1
<b>Question 26</b>	a	b	c	d	e	2
<b>Question 27</b>	a	b	c	d	e	4
<b>Question 28</b>	a	b	c	d	e	4
<b>Question 29</b>	a	b	c	d	e	1
<b>Question 30</b>	a	b	c	d	e	1

**This page must remain attached to the main question book. Attach the full question paper and this answer sheet TOGETHER, with your main written answer book.**