



THE UNIVERSITY  
*of* LIVERPOOL

## 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  
Master of Science (Eng) : Year 1

### DATABASE DEVELOPMENT AND DESIGN

**TIME ALLOWED : Two Hours**

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#### INSTRUCTIONS TO CANDIDATES

Section A: Answer 6 out of 8 Questions  
(10 marks for each answer; Section A is worth 60 marks)

Section B: Answer 2 out of 4 Questions  
(20 marks for each answer; Section B is worth 40 marks)

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

A1

- (a) Sketch the model of database architecture originally proposed by the ANSI/SPARC Committee. Clearly label all the components and describe what each component provides. (6 marks)
- (b) Associated with these models are two management roles. Name these roles and distinguish between the responsibilities of each role. For each role give one example of the type of action which each might initiate or authorise. (4 marks)

A2 In the relational database model

- (a) Distinguish between relation *degree* and *cardinality*. (2 marks)
- (b) What are the basic properties of a relation ? (4 marks)
- (c) What do we mean by the terms *candidate key*, *primary key*, and *surrogate key*? (4 marks)

A3

- (a) The following attributes are to be used in a relation to store baptism records. Comment on whether you would add a tuple identifier attribute to this attributes list.  
Child\_forename, Family\_surname, Father\_forename,  
Mother\_forename, Baptism\_year, Parish\_name. (2 marks)
- (b) Using the relation described in part (a) construct the SQL that delivers a table containing <Parish\_name, Family\_surname, integer-count> that counts for each parish and each Family\_surname in that parish the number of baptism records found. (4 marks)
- (c) What SQL is required to produce a count of Family\_surname by Parish\_name for the 17th century? (4 marks)



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A4

- (a) Given the attribute domains A, B, C, D, and E and the relations

$$P(A, B1, C1, D1) \\ Q(B2, C2, D2, E)$$

write the relational algebra that would generate  $P'$  and  $Q'$  the *union-compatible* forms of P and Q.

(4 marks)

- (b) Describe in English what the result of performing the following operations on  $P'$  and  $Q'$  described in part (a).

i) the *difference* between  $P'$  and  $Q'$ ,

(2 marks)

ii) the *intersection* of  $P'$  and  $Q'$ ,

(2 marks)

iii) the *division* of  $P'$  by  $Q'$ .

(2 marks)

A5

- (a) Draw the standard notation for the main structures in Jackson Structured Programming (JSP).

(3 marks)

- (b) A Data Processing department has two separate transaction files T1 and T2 that are merged in an overnight run using program P. Describe the JSP *logical data structure* of each separate file and outline the logical data structure of the merged input file.

(5 marks)

- (c) What are the necessary conditions that must apply before program P can be executed?

(2 marks)

A6

- (a) Define what is meant in Data Processing by the *persistence problem*.

(4 marks)

- (b) Describe an example DP application environment where each of the standard solutions to the persistence problem may be found.

(6 marks)



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A7 Given the relation

$R(A, B, C, D)$

and the functional dependencies

F1:  $AB \rightarrow C$

F2:  $AB \rightarrow D$

F3:  $D \rightarrow C$

Identify

- (a) the *determinant* of each dependency, (3 marks)
- (b) which *normal form* R is in, explaining your reasoning, (3 marks)
- (c) how to obtain BCNF relations from R. (4 marks)

A8 In Entity Relationship modelling what is meant by the following:

- (a) a strong entity type (2 marks)
- (b) a weak entity type (2 marks)
- (c) a one to one relationship (2 marks)
- (d) entity grouping (4 marks)

For each give an example of the notation used to represent the component.



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Section B

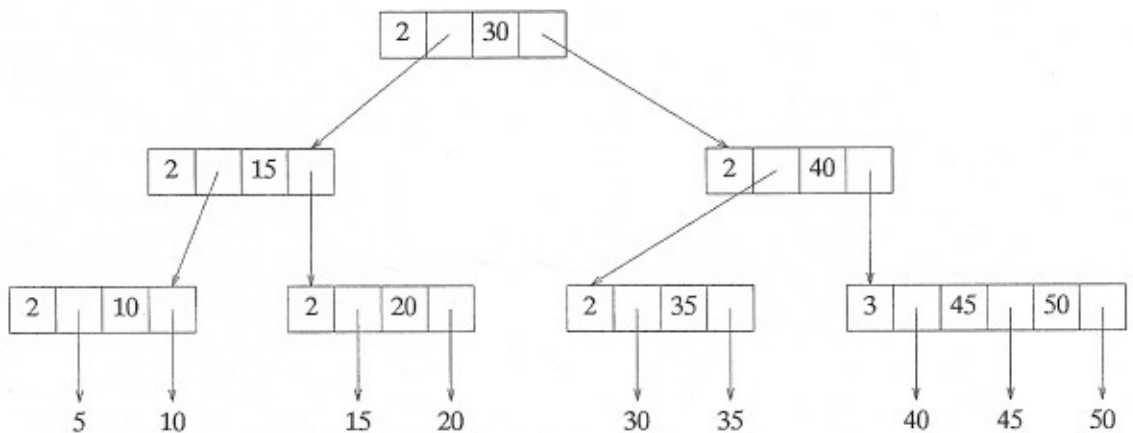
Scenario for Question B1

Kelly Container Transport of Speke has merged with Tonter, a Belgian container haulage company and opened many offices throughout the European Union. Orders are taken at these offices from a range of registered clients. Each client registers with an office and can place one or more orders. Each order describes the load and the collection and delivery addresses. The transportation requirements for the order are then calculated. These describe the number of cab-units and trailers needed to transport the load. Each office has several cab-units and several trailers available for its use. Each cab-unit can pull one or two trailers.

- B1 Use the scenario to develop an Entity Relationship diagram for the database and from that identify the relations that will be required taking care to identify the attributes which constitute the primary and foreign keys. Ensure that you explain all the notation you use in your ER diagram and that you identify the cardinality of all relationships.

(20 marks)

B2



- (a) The diagram above is of a B-tree of order 1, where the first box representing a node contains  $k$  the number of branches currently held in that node. The key values 25 and 55 are to be added to the tree.



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Draw two diagrams to show the state of the tree

- (i) after 25 has been added, and
  - (ii) after both keys have been added. (6 marks)
- (b) A relation containing approximately 2 million key values has a B-tree index of order 7. How many levels will the tree have? In calculating your answer take care to explain all the stages in your thinking. (7 marks)
- (c) A postcode index is to be stored. Typical usage will be to find all postcodes that start in a certain way e.g. L15. Which index storage structure would be most suitable given that Ingres is to be the DBMS used for the data? Explain carefully the reasons for your choice. (7 marks)

**Scenario for Question B3**

The University is to make part of its student registration relational database available over the internet. The intention is to provide students with the ability to check their module registration details and after they have taken their exams to obtain their module marks. To achieve this the following relational views are to be used

STUDENT (**sid#**, surname, forename, address, date-of-birth)

MODULE (**m#**, module-name)

REGN (**sid#**, **m#**, year, mark)

where the key fields are in bold text and **sid#** is the student identifier, **m#** is the module number and mark is the percentage mark a student obtains for a module.

B3 Using the scenario

- (a) What is the SQL query which would be needed to provide the student with the appropriate module registration details and module mark? (7 marks)
- (b) Given that the student fills in an HTML form with his/her **sid#** and submits it to a CGI script which implements the SQL described in part (a), provide an outline of the steps that the CGI script would need to perform to obtain the required details. (7 marks)
- (c) What concerns might the database administrator have regarding the intention to make these data available over the internet? (6 marks)



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Scenario for Question B4

Ye Potion Shoppe in Hogsmead, Potterland makes potions for you while you wait providing they have the ingredients to hand. They determine if they can conjure up the potion you want by examining their supplier-ingredient-potion relational database. This has the following relations:

Supplier (**s#**, sname, status, town)

Ingredient (**i#**, iname, colour, weight, town)

Potion (**p#**, pname, purpose)

SIP (**s#**, **i#**, **p#**, quantity)

The SIP relation identifies the ingredients that are on order, the supplier, and the potion for which each is intended. The **s#**, **i#**, and **p#** attributes are respectively a unique supplier, ingredient, and potion number. The key fields are in bold.

B4 Using the scenario

(a) Give SQL formulations for the following:

- (i) Insert "green" "frogs" from "Belcher" into the Ingredient table. The weight of these frogs is not known.
- (ii) Change the town associated with the supplier "Tonter" from "Peebles" to "Ham".
- (iii) List all the potions that can be made, i.e. those potions for which Ye Potion Shoppe has all the ingredients to hand.  
(Hint: if an ingredient is on order it is not to hand).

(10 marks)

(b) Sketch the ESQL program to list all supplier rows in **s#** order. Each row should be immediately followed in the list by all the potions dependent on that supplier in **p#** order.

(10 marks)