| PAPER CODE NO. | EXAMINER : Prof. MJR Shave / Dr. BM Diaz |
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| 2CS46 | DEPARTMENT : Computer Science Tel. No. 3667 / 3696 |



THE UNIVERSITY of LIVERPOOL

Degree of Bachelor of Science : Year 2
Degree of Master of Mathematics : Year 2
Degree of Bachelor of Arts : Year 2
Degree of Bachelor of Engineering : Year 2

## DATA PROCESSING

TIME ALLOWED: TWO Hours

## INSTRUCTIONS TO CANDIDATES

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

## Attempt SIX Questions from this Section. Each question is worth 10 marks.

A1 a) Why is it necessary for the storage area allocated to a random (direct-access) file to be significantly larger than the expected size of the file?

If the expected maximum size of the file is 12000 bytes, what would be a reasonable allocation of storage space?
b) The following key values
$14,23,36,7,12,40,46$
are to be read from left to right and stored as a 'random' file in appropriate locations of the set $0 \ldots 10$, using the modulo 11 hash function. Draw a vector to show the contents of locations $0 \ldots .10$ after the key values have been stored.

If the key value 36 subsequently became redundant, what action would you take, and why?
c) Name three actions which can be taken to minimise the effect of collisions on the efficient use of a random file.
[3 marks]

A2 a) Sketch the classic model of database architecture originally proposed by the ANSI/ SPARC committee. Name each component level.
[2 marks]
b) The use of a database is often said to "treat data as a central resource." What is meant by this phrase?

Name two other aspects of a Company or organisation which may be treated as "a central resource."
[3 marks]
c) A company which adopts a database approach for the storage and processing of its data is likely to identify two associated management roles - those of a Data Administrator (DA) and a Database Administrator (DBA). Distinguish between the responsibilities of these two roles.

Give one example (in each case) of the type of action which a DA and a DBA respectively might initiate or authorise.
[5 marks]

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A3 a) You are given the relations

$$
P=(A, B, C) \quad \text { and } \quad Q=(C, D)
$$

which have the extensions

| $\left(a_{1}, b_{1}, c_{1}\right)$ | and |
| :--- | :--- |
| $\left(a_{3}, b_{3}, c_{3}\right)$ | $\left(c_{1}, d_{1}\right)$ |
| $\left(a_{1}, b_{4}, c_{3}\right)$ | $\left(c_{2}, d_{2}\right)$ |
| $\left(a_{4}, b_{2}, c_{2}\right)$ | $\left(c_{2}, d_{3}\right)$ |
| $\left(a_{5}, b_{2}, c_{2}\right)$ |  |

respectively.

What is the result of the following relational algebra operations?
(i) PROJECT $P$ ON $B, C$
(ii) JOIN $P, Q$ ON $C$
b) Write down two relational calculus (SQL) expressions which are equivalent to (i) and (ii) respectively.

A4 a) What is meant by the phrase Embedded SQL?
[1 mark]
b) Why is it sometimes essential to use Embedded SQL in order to express a query against a relational database? Give an example of such an occasion.
[2 marks]
c) What is the phrase used to introduce or identify an SQL statement within an overall program using Embedded SQL in C?
[1 mark]
d) Explain briefly how a C program with Embedded SQL commands is processed.
[2 marks]
e) What is a host variable in an E-SQL statement, and how is it identified (indicated)?
[2 marks]
f) To enable an E-SQL program to process a number of tuples, one after another, it is necessary to declare a cursor. Apart from the declaration of a cursor, name two other essential statements in which a cursor is involved.
[2 marks]

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A5 a) What is a flow chart? How is repetition represented in such a chart?
[2 marks]
b) Illustrate how selection is represented in a NS-chart. In what ways is this better than the equivalent flow-chart representation of selection?
[3 marks]
c) How are selection and iteration represented in the Jackson Structured Programming approach.
[5 marks]

A6 a) Describe how access to a database may be given using the CGI approach.
[5 marks]
b) What concerns would you have in using a CGI approach for database update.
[5 marks]

A7 a) What is the persistence problem and why are there differing approaches to its solution?
[5 marks]
b) As a COBOL programmer, what strategies do you have available to deal with the persistence problems?
[5 marks]

A8 Given a file of records with the alphanumeric character structure indicated below, write the COBOL DATA DIVISION for a program which will print all G520 students (there are never more than 50) in year of entry 1998 and the fee paid (which is never more than $£ 1000$ per student) and grand total for the group. Ensure that the fee and total is printed as $£$ sterling sums (to two decimal places) suppressing leading zeroes.

| Name(3) | Course(4) | Year-of-Entry(4) | Fee-Paid(7) |
| :--- | :--- | :--- | :--- |
| TAYLOR JAMES | G500 | 1997 | 0100000 |

(N.B. the Fee-Paid character structure is pennies)
[10 marks]

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## SECTION B

## Attempt TWO Questions from this section. Each question is worth 20 marks.

B1 a) Two sets of elements, $A=\{a\}$ and $B=\{b\}$ are such that $B$ is functionally dependent on $A$. Explain the meaning of the statement in italics and draw a dependency diagram to represent it.
[2 marks]
b) The following unnormalised relation contains information about the employees of a company and the jobs to which they have been allocated. Employees have to record the quantity or type of parts which they use in the course of their work. Details are also recorded of bonus payments which are made to employees from time to time, and the date on which a bonus is paid. The relation is

Q : (Emp\#, EmpName, JobCode, JobName, Dept, Date, Bonus, Part\#, PartName, Quantity, Type)

The attributes of Q are known to satisfy the following functional dependencies:

Emp\#
$\rightarrow \quad$ EmpName
Emp\# $\rightarrow$ JobCode, JobName
Emp\# $\rightarrow$ Dept
Emp\#, Date $\quad \rightarrow \quad$ Bonus
Emp\#, Par\#\# $\quad \rightarrow \quad$ Quantity, Type
JobCode $\rightarrow \quad$ JobName
Part\# $\rightarrow \quad$ PartName
(i) Draw a dependency diagram which represents all the dependencies stated above.
[6 marks]
(ii) With the aid of your dependency diagram, write down three relations which can be deduced from the dependency information. Underline the key of each of these relations.
[6 marks]
(iii) Explain why some of the relations you have identified in (ii) are not in third normal form (3NF). Decompose the relations as necessary to obtain a set which are all in 3NF.
[6 marks]

PAPER CODE 2CS46 PAGE 7 OF 9 CONTINUED /


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B2 a) Explain briefly what is meant by
a strong entity type
a weak entity type
a one-to-many $(1, \eta)$ relationship
a multi-valued attribute
in each case, illustrate your answer by an example drawn from the Scenario given below, and demonstrate the conventions used to represent each of these concepts in an Entity Relationship model.
[8 marks]
b) Read the Scenario below and draw an Entity Relationship model to represent the information which the scenario conveys. Make sure that your diagram identifies all key attributes and the cardinality of each relationship.
[12 marks]

## Scenario:

Each lecturer in a University is attached to a department and may teach a number of course modules. Each module is the responsibility of one department, but the department to which the teacher of a module is attached may not be the same as the department which has responsibility for that module (for example, a Mathematician may teach a Physics module). Each department belongs to a Faculty and has a unique name. Each lecturer has a unique staff number and the University also records, for each of its staff, their name, address, date of birth, gender and the name of any dependents.

Each student is registered for a degree course (identified by a UCAS code) and each student attends a number of modules as part of his/her degree course. At the end of each module a mark is awarded to each student who has completed the module, and this is recorded in two forms - as a percentage and as a letter grade.

Each module has a unique code and an appropriate level (an integer in the range 0 .. 3). Each student has a unique student number, and the University also records their name, gender, date of birth, year of entry, home address and degree course code.

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B3 You are an employee of DP4Drs, a data processing consultancy company which advises small medical practices on their information system requirements. You have been asked to make a 30 minute presentation to 8 members of the practice ( 4 doctors, 2 nurses and 2 clerical/receptionist staff) covering the D.P. processes and functions which would be suitable for them to use. You plan to use no more than 8 overhead transparencies and provide a one page summary of your talk.
a What information do you put on each overhead?

## [10 marks]

b Write the presentation summary.
[10 marks]

B4 A local family history society has a parish by parish description file which lists for every one of the 270 parishes the following information. The number of pages in each of the baptism, marriage and burial registers, and for each register the number of pages which have been transcribed (put onto the computer). A program is required which lists the parishes and calculates the percentage of pages transcribed for each event (in the order baptism, marriage, burial). The first record of the output file should contain a heading.

Using the Jackson Structured Programming Method:
a) draw the physical data structure of the input file.

## [5 marks]

b) draw the logical data structure of the input and output program structure and show the correspondences between them.
c) draw the final program structure, and list the elementary conditions and actions.

