



THE UNIVERSITY
of LIVERPOOL

JANUARY 2002 EXAMINATIONS

Bachelor of Arts : Year 2
Bachelor of Science : Year 2

DATA STRUCTURES AND INFORMATION SYSTEMS

TIME ALLOWED : Two Hours

INSTRUCTIONS TO CANDIDATES

Attempt *all* questions in Section A
Attempt any *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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And any TWO questions from Section B

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Section A

Attempt ALL questions from this section.

1. Give short answers for each of the following questions.
 - (a) What is the structure of the entity-relationship (E-R) data model? (4 marks)
 - (b) Describe the different attribute types used in entity-relationship models (e.g., composite). (4 marks)
 - (c) What is a superkey and a candidate key for a relation r on a relation schema R ? (4 marks)
 - (d) When is a relation schema R in *Boyce-Codd Normal Form* (BCNF) with respect to a set F of functional dependencies? (4 marks)
 - (e) What form does a typical SQL query have? (4 marks)
 - (f) The **from** clause of an SQL query corresponds to an operation of the relational algebra. To which one? (4 marks)
2. Consider the fragment of a banking enterprise ER-diagram given below. In this fragment the entity set *bank-branch* is a weak entity set which is dependent on the entity set *bank* (the attribute *branch-no* is a discriminator). The attribute *telephone* is a multivalued attribute, its values are sets of telephone numbers. Create the relational database schema for this fragment. Explain your steps. Indicate the primary key for every relation you created. (12 marks)





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3. Relational database design.

- (a) Create a collection of functional dependencies F to capture the constraints of the *health-club* relation described below. (10 marks)

The records of the relation *health-club* are 5-tuples of the form

(*club-no, location, manager, facility, rate*).

The location is a city, and several clubs can have the same location. The club-no value is unique within a given city although duplicates may exist in different cities. The combination of club-no and location determines a unique tuple. A manager is a person assigned to a particular location, and he manages all clubs in that city. A facility is a subunit of a club, such as a swimming pool, a sauna, or a tennis court. Each club has only one facility. The rate is the charge per hour for using a particular facility. The rate is constant for a given facility across all clubs in the same city.

- (b) Let $F = \{B \rightarrow A, AB \rightarrow C\}$ be a set of functional dependencies on the set of attributes ABC . Is the dependency $B \rightarrow AC$ logically implied by F ? Explain your answer. (6 marks)
- (c) Demonstrate that the decomposition of the relation r into the relations r_1, r_2 and r_3 given below is not lossless-join. (8 marks)

A	B	C	D
a_1	b	c	d_1
a_2	b	c	d_2

r

A	B
a_1	b
a_2	b

r_1

B	C
b	c

r_2

C	D
c	d_1
c	d_2

r_3



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Section B

Answer any TWO of questions 4, 5 and 6

4. Relational algebra I

(a) Find the natural join and full outer join of the following relations: (10 marks)

A	B
a_1	b_1
a_2	b_2
r	

B	C
b_1	c_1
b_3	c_3
t	

(b) Given the tables r and t below

A	B
3	5
7	4
r	

C	D
3	1
3	4
7	1
t	

compute the relation $\Pi_{A,C}(\sigma_{B>D}(r \times t))$. (10 marks)

5. SQL

Consider the beer drinkers' database with relation schemas

$frequents = (student, pub)$

$serves = (pub, beer)$

$likes = (student, beer)$

We suppose the values of *beer* attribute are sorts of beer and each student is described uniquely by the value of *student* attribute.

Write the following query in SQL:

(a) Find the pubs that serve any sort of beer student John likes. (8 marks)

(b) Find the students who frequent at least one pub that serves a beer they like. (12 marks)



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6. Relational algebra II

Let *movie1* be a relation with the schema (*title, year, length, studio-name*) and the primary key (*title, year*). The attributes *length* and *studio-name* show how long the movie is and which studio made it, respectively. Let *movie2* be a relation with the schema (*title, year, star-name*).

Let the following tables be instances of the relations *movie1* and *movie2*:

<i>title</i>	<i>year</i>	<i>length</i>	<i>studio-name</i>
Star Wars	1977	124	Fox
Star Wars	1979	104	Fox
Mighty Ducks	1991	114	Disney
Wayne's World	1992	95	Paramount

movie1

<i>title</i>	<i>year</i>	<i>star-name</i>
Star Wars	1977	Carrie Fisher
Star Wars	1977	Mark Hamill
Star Wars	1979	Harrison Ford
Mighty Ducks	1991	Emilio Estevez
Wayne's World	1992	Dana Carvey
Wayne's World	1992	Mike Meyers

movie2

Consider the relational algebra expression

$$\Pi_{title, year}(\sigma_{length \geq 110 \text{ and } studio-name = 'Fox'}(movie1))$$

- (a) Compute the result of applying this expression to the given tables. (5 marks)
- (b) Describe the meaning of this expression in English. (5 marks)

Consider the relational algebra expression

$$\Pi_{star-name}(\sigma_{length < 110}(movie1 \bowtie movie2))$$

- (c) Compute the result of applying this expression to the given tables. (5 marks)
- (d) Describe the meaning of this expression in English. (5 marks)