PAPER CODE NO.	EXAMINER : **Dr U Hustadt**
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THE UNIVERSITY
of LIVERPOOL

SEPTEMBER 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 questions 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)**

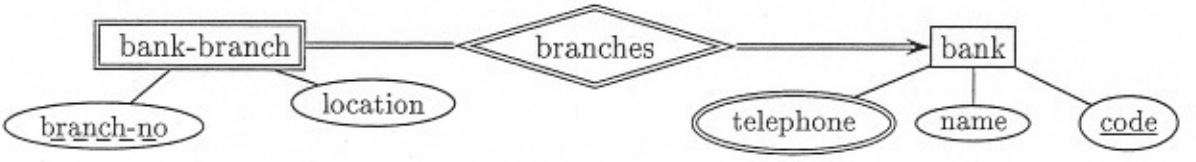
   (c) What is a superkey and a candidate key for a relation r on a relation schema R? **(4 marks)**

   (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 descriminator). 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)**



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 $F = \{B \longrightarrow A, \quad AB \longrightarrow C\}$ be a set of functional dependencies on the set of attributes ABC. Is the dependency $B \longrightarrow AC$ logically implied by F? Explain your answer. **(6 marks)**

(c) Demonstrate that the decomposition of the relation r into the relations $r1, r2$ and $r3$ 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)**

6. Relational algebra II

Let *movie*1 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 *movie*2 be a relation with the schema (*title*,*year*,*star-name*).

Let the following tables be instances of the relations *movie*1 and *movie*2:

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

*movie*1

title	*year*	*star-name*
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

*movie*2

Consider the relational algebra expression

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

(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)**