# The University of British Columbia

**Computer Science 304**

**Midterm Examination**

**February 23, 2005**

Time: 50 minutes Total marks: 50

Instructor: George Tsiknis

Name_____Student No_____

(PRINT) (Last) (First)

Signature_____

**This examination has 8 pages.**

**Check that you have a complete paper.**

This is a closed book exam. No books or other material may be used.

Answer all the questions on this paper.

Give very **short but precise** answers. Always use point form where it is appropriate.

Work fast and do the easy questions first. Leave some time to review your exam at the end.

The marks for each question are given in {}. Use this to manage your time. Do not spend on a question more minutes than the marks assigned to it.

Good Luck

| MARKS | |
|---|---|
| **1.** | |
| **2.** | |
| **3.** | |
| **4.** | |
| **Total** | |

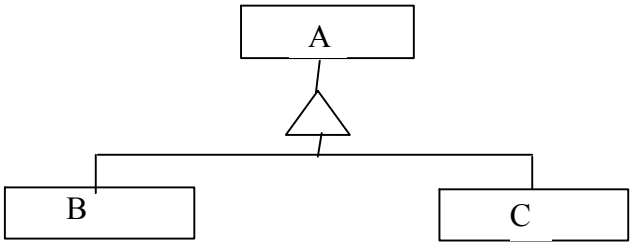
Name Student No

1. {8 marks, 1 mark per question} Circle only **one** answer per question:

| | |
|---|---|
| a. In designing relational databases, we always desire our final tables to be in BCNF and we can always decompose any design to a BCNF design. | True<br>False |
| b. A weak entity set in an ER diagram represents a collection of entities for which we have not discovered a key yet. Later in the design phase when we learn more about the domain, this set will be converted into a strong entity set by adding the appropriate attributes. | True<br>False |
| c. A relation may have a number of candidate keys, but has only one primary key. | True<br>False |
| d. If every attribute of a table functionally depends on the primary key, the table is in 3NF. | True<br>False |
| e. Every table with 2 single-valued attributes is in 1NF, 2NF, 3NF and BCNF.<br>YOU ARE NOT RESPONSIBLE FOR THE 1NF & 2NF PART OF THIS QUESTION | True<br>False |
| f. A table is in the second normal form (2NF) if every attribute is determined by every candidate key, but is not determined by any pure subset of a candidate key.<br>YOU ARE NOT RESPONSIBLE FOR THIS QUESTION | True<br>False |
| g. If r(A, C) and s(A, D) are any relations with the given attributes, the following RA expressions are equivalent .<br>i) $r \bowtie s$<br>ii) $\pi_{A,C,D}( \sigma_{r.A=s.A} ( r \times s))$ | True<br>False |
| h. The Relational Algebra, the Tuple Relational Calculus and the Domain Relational Calculus are three equivalent formalisms that can be used to express queries for relational databases. | True<br>False |

2. {12 marks} Answer the following questions in the space provided. **Be brief and precise**.

a. {4 marks} Consider the following ER diagram:




where A, B and C are entity sets.

i) Specify the condition(s) that is(are) necessary in order to represent all three sets with a single table.

ii) Specify the condition(s) that is(are) necessary in order to represent all three sets with two tables, one for B and one for C.

b. {4 marks} Consider the schema R = (A, B, C, D, E) together with the functional dependencies:

A → C
A, B → D
C, D → E

Suppose we decompose R into

R1 = (A, B, C, D) and
R2 = (A, D, E)

Prove that this decomposition is a lossless-join decomposition

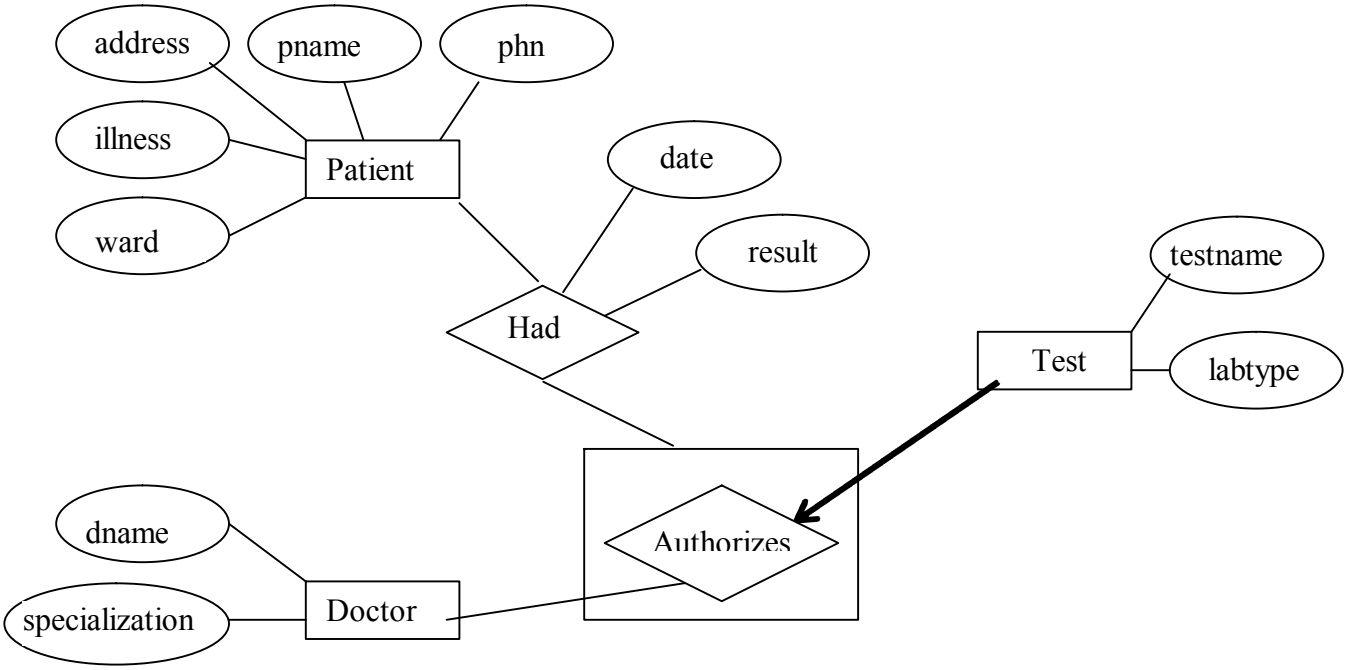
c. {4 marks} Suppose we define a database about the customers of a bank and the loans they have received from the bank. For each customer we need to record information about their name, address , phone number and the company they work for. For each loan we need to record the amount, the interest rate, date the loan was issued, and the date the loan should be paid off.

i) Is it a good idea to represent the company for which a customer works as an attribute of the customer or as a relationship? Briefly justify your answer.

ii) Which is the best way to represent the relationship between the customer and their loans:
- by defining the loan as an attribute of the customer, or
- by making the loan a separate entity set and defining a relationship set between it and the customer?

Briefly justify your answer.

3. {12 marks} Consider the following ER diagram that models a patient database of a local hospital. In this diagram, `phn, pname, illness,` and `ward` are a patient's personal health number, name, reported illness and hospital ward she/he has been admitted to, while `dname`,and `specialization` are a doctor's name and specialization. Medical tests have a name and a lab type required for the test, and are authorized by a doctor. Finally, if a patient had any such test, the date and the results of the test are recorded.




Suppose we have also discovered the following functional dependencies:

**fd1:** phn → pname, address, illness
**fd2**: pname, address → phn
**fd3:** illness → ward
**fd4:** testname → labtype

a. {2 marks}Suppose we define a table

`Patient(phn, pname, address, illness, ward).`

List all the candidate keys for this table

**Candidate keys:**

b. {6 marks}Show the tables you get by applying the ER-to-table algorithm we discussed in the class to this ER diagram. In each table underline the primary key. If a table has many candidate keys, chose the shortest one as the primary key.

c. {4 marks}Show the BCNF tables we get by applying normalization techniques to the tables in part (b). Underline the primary keys of the new tables.

4. {18 Marks} Consider a relational database about hotels, customers (guests) and their bookings that is maintained by an on-line hotel-booking company. The database consisting of the following tables(where the primary keys are underlined):

```
Hotel (hId, hName, hAddress, hCity)
Guest( gId, gName, gAddress, gCity)
Room( hid, roomNo, type, price )
Booking(gId, hId, roomNo, fromDate, year, noOfDays )
```

Where, `hId` and `gId` are identifiers for the hotels and the guests, and the Booking relation indicated that a guest booked a hotel room for a specified number of days (`noOfDays`) starting from `fromDate` of a given `year`. For instance, a tuple < g12345, h5555, 220, Jan05, 2005, 8> in Booking indicates that guest g12345 booked room 220 of the h5555 hotel for 8 days starting on Jan 5, 2005.

a. {6 Marks} Write a **relational algebra** expression that returns the ids of the hotels located in Vancouver which were not booked at all in the year 2005.

b. {6 Marks}Write a **relational algebra** expression that returns the ids of the guests who have booked at least one room of type ”suite” in every hotel located in Vancouver.

c. {6 Marks}Write a **Tuple Relational Calculus (TRC)** query that finds the ids and names of the hotels for which every one of our guests had made a booking during the year 2004.

YOU ARE NOT RESPONSIBLE FOR THE MATERIAL IN THIS QUESTION. BUT DO KNOW HOW TO READ A DOMAIN RELATIONAL CALULUS QUERY