NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
FACULTY OF APPLIED SCIENCE
COMPUTER SCIENCE DEPARTMENT
JULY SUPPLEMENTARY EXAMINATIONS 2005

SUBJECT: ADVANCED DATABASES
CODE: SCS5106

INSTRUCTION TO CANDIDATES

This examination paper consists of six [6] questions, all questions carry marks. Answer all questions in Section A and any two (2) questions from Section B.

Time: 3 hours

Section A

QUESTION ONE

a) Consider the following relation for published books:

Book (ISBN, BookTitle, AuthorName, BookType, Price, Publisher, AuthorAffiliation)

ISBN is a unique international number that is assigned to each new book that is published. This number has been used as the primary key for the relation *Book*.

Assuming that the following functional dependencies hold on it:

BookTitle → Publisher
BookType → Price
AuthorName → AuthorAffiliation

Decompose *Book* into a set of relations, which are in the 3rd normal form. [9]

b) Consider the database of a clinic described below (the primary keys are underlined):

Patient (PatCode, Name, Age, Sex, Occupation)
Operation (OperCode, PatCode, DoctCode, Date, Time, Situation)
Doctor (DoctCode, Name, Speciality, Age)
Is_Seen_By (PatCode, DoctCode, Date, Time, Prescription)

Define the above schema in SQL. Make sure that you specify referential integrity and NULL value constraints to express that no operation can be

done by a doctor to a patient if the complete details about doctors, operations, and patients are not known to the system at any instance of time. Use proper data types for the attributes. [11]

QUESTION TWO

a) Explain what the following relational algebra statements are doing:

i) $\Pi_{\text{Patient.Name, Operation.Situation}} (\sigma_{\text{Date="01012000"}} (\text{Patient} * \text{Operation}))$

ii) $R1 \leftarrow \Pi_{\text{DoctCode, Name}}(\text{Doctor})$ [7]

b) A simple company personnel database is defined by the schema
Staff (StaffId, Name, Salary, DeptCode, SCity)
Department (DeptCode, DeptName, DCity, ManagerId)

where primary keys are underlined. Specify the following relational algebra queries in SQL:

(i) $\Pi_{\text{Salary}} (\sigma_{\text{Name="Sibanda"}} (\text{Staff}))$

(ii) $\Pi_{\text{DeptCode}} (\sigma_{\text{DeptName="Sales" and DCity = "Kwekwe"}}(\text{Department}))$ [6]

c) Given the following relation schemas:
Employee (Emp_No, Emp_Name, Skill, Pay_Rate)
Position (Posting_No, Skill)
Duty_Allocation (Posting_no, Emp_No, Day, Shift)

i) Write an SQL query to find the names and rate of pay of all employees who are allocated a duty. [3]

ii) Explain what the following query would do:

```
(select distinct Emp_No
from Duty_Allocation
where Posting_No = 100)
   minus
      (select Emp_No
      from Employee
      where Skill = 'programmer')
```
[4]

QUESTION THREE

a) Define the concept of functional dependencies and explain how they can be used to improve the design of a relational database. [6]

b) Consider the following requirements for a university library database:

The database will support the services that the university library provides to its customers. These can only be students and members of the university staff. Each library customer is identified by his/her university card. The items available from the library include books, conference proceedings and scientific magazines. Books and conference proceedings have one or more authors, a title, and a unique ISBN number. Note that there might be more than one copy of the same book or conference proceedings in the library. Scientific magazines have a title and a unique ISSN number. Copies of books and conference proceedings may be checked out but not scientific magazines. These have to be used in the library. All items which may be checked out are identified by unique library codes assigned to them after their purchase. The maximum borrowing period allowed for each of them is different. Library users may borrow more than one item at the same time. The starting and the due date of each loan must be recorded.

Design an ER-diagram for this database. Specify keys, mapping cardinalities, participation constraints and existential dependencies in your diagram. If it is necessary, due to incompleteness in the previous specification, state clearly the assumptions justifying your modeling choices. [10]

c) Explain what is meant by a transaction. Why are transactions important units of operation in a DB? [4]

Section B

QUESTION FOUR

a) Briefly explain the concept of granularity of a data item with reference to concurrency control in relational databases. [4]

b) Why are Relational Database Management Systems (RDBMS) products dominating the market for databases today? [5]

(c) Giving an example in each case, outline the difference between database security and database integrity in a Database Management System. [6]

d) Give a brief description of any 5 of the properties of a relation. [5]

QUESTION FIVE

a) Briefly describe the types of failure that may occur in a database environment. Explain why it is important to provide a recovery mechanism. [6]

b) What is a fragment? Describe the different types of data fragmentation techniques. Why is fragmentation a useful concept in distributed database design? [11]

c) Every weak entity set can be converted to a strong entity set by adding appropriate attributes. Why, then, do we have weak entity sets? [3]

QUESTION SIX

a) With the aid of clear examples define the concepts specialization and generalization as applies to EER modeling making clear their differences. [6]

b) Explain the purpose of mappings between the various levels of the 3-schema architecture of the DBMS. [4]

c) Briefly describe the fundamental features of OODBs. What are the advantages of such types of database management systems? [10]

END OF QUESTION PAPER