UNIVERSITY OF LONDON

IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 1998

BEng Honours Degree in Information Systems Engineering Part III
MEng Honours Degree in Information Systems Engineering Part III
BSc Honours Degree in Mathematics and Computer Science Part III
MSci Honours Degree in Mathematics and Computer Science Part III
MSc Degree in Computing Science
for Internal Students of the Imperial College of Science, Technology and Medicine

This paper is also taken for the relevant examinations for the
Diploma of Membership of Imperial College
Associateship of the City and Guilds of London Institute
Associateship of the Royal College of Science

PAPER M3.11 / I3.2

DATABASES

Thursday, May 7th 1998, 10.00 - 12.00

Answer THREE questions

For admin. only: paper contains 4 questions

1a i) Let A, B, C be sets of attributes. Which of the following three statements about functional dependencies is (are) true in general, and which is (are) false?

(S1) If $AB \rightarrow C$ then $A \rightarrow C$ and $B \rightarrow C$.

(S2) If $AB \rightarrow C$ then $A \rightarrow C$ or $B \rightarrow C$.

(S3) If $A \rightarrow B$ and $A \rightarrow C$ then $A \rightarrow BC$.

For all of those that are false give a counter-example (i.e. an example that shows the statement is false), and for all that are true give a proof using Armstrong's axioms and set theoretic notions (such as *union*) only.

b i) Explain what transaction atomicity is.

ii) Using the concept of functional dependencies give an example where violation of transaction atomicity leads to violation of database integrity.

iii) Explain what is meant by taking a checkpoint.

iv) Explain in detail how taking checkpoints affects the efficiency of recovery from

- system failure

- media failure.

2a i) Explain briefly when a relation is in Boyce-Codd normal form (BCNF).

ii) Which of the following statements is (are) true and which is (are) false?

(S1) Every BCNF relation is also 4NF.

(S2) Every BCNF relation which has one candidate key only is also 2NF.

(S3) Every 3NF relation is also BCNF.

For one that is true give a detailed proof, and for one that is false give a counter-example (i.e. an example that shows the statement is false).

b Consider a relation scheme R(A, B, C, D, E) with the following set of functional dependencies.

$AB \rightarrow D$ $D \rightarrow A$

$AC \rightarrow E$ $E \rightarrow B$

$BC \rightarrow D$

i) Give three candidate keys for R.

ii) Show that R is not in BCNF.

iii) Give a lossless decomposition of R into a set of BCNF relations consisting of a maximum of four relations. For each resulting relation give its candidate keys. Show that your decomposition is lossless.

iv) By means of an example show one advantage that your decomposed relations have over R.

Turn over ...

3a i) Give a definition of the *natural join* algebraic operation in terms of *projection*, *selection* and *product*.

ii) Suppose relations R and S have n and m tuples, respectively. Give the minimum and the maximum numbers of tuples that the results of each of the following expressions can have.

R JOIN S

(R JOIN S) JOIN R

(JOIN represents the natural join operation).

b A dance and exercise studio maintains a database based on the following schema.

ROOM (RoomName, Facility)

CLASS (Code, Technique, Level)

TIMETABLE (Code, Day, StartTime, TeacherName, RoomName)

ACCOMPANIST (AcName, TeacherName, Code, Day, StartTime)

where relation **ROOM** stores the name of each room (e.g. studio1, gym) and the facilities (e.g. piano, treadmill) contained in it. Relation **CLASS** stores information about the techniques (e.g. jazz dance) and the levels (e.g. beginners) taught at the studio. Each class, i.e. a technique at a given level, is identified by a code. Relation **TIMETABLE** stores the timetable of the classes (i.e. who teaches which class, where, which days and what times). Some classes have live music played by an accompanist. Relation **ACCOMPANIST** stores information about which accompanist, identified by AcName, plays for which teacher in which class and when.

Express the following queries in relational algebra. You may use the following abbreviations: R for ROOM, C for CLASS, T for TIMETABLE and A for Accompanist.

i) Give all the techniques that are taught in classes in studio1.

ii) Give the names of all the rooms with pianos that are free all day on Mondays.

iii) Give the names of all the accompanists, each of whom plays for at least one jazz dance class and does not play for any other technique.

c Express queries b(ii) and b(iii) in relational calculus.

The three parts carry 30%, 40%, 30% of the marks, respectively.

4a i) What is a schedule of a set of transactions?

ii) What is a serial schedule of a set of transactions?

iii) What is a serialisable schedule of a set of transactions?

b Consider the following schedule S involving transactions T1, T2, T3, T4.

S:

T1	T2	T3	T4
	read(C)		
			write(C)
read(A)		read(B)	
			read(B)
read(B)	read(A)	read(D)	
	write(C)		
		read(A)	
	read(B)		write(C)
write(A)	commit		
read(C)			commit
		write(D)	
write(B)		commit	
commit			

i) Draw the precedence graph of schedule S, and thus determine whether or not S is conflict serialisable.

ii) Is S serialisable? If it is give a serialisation. If it is not explain why not.

c i) Give the two phase locking protocol (2PL).

ii) Suggest a modification of 2PL that avoids deadlock as well as guaranteeing serialisability.

The three parts carry 25%, 50%, 25% of the marks, respectively.

End of paper