UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 1997

BEng Honours Degree in Computing Part II
MEng Honours Degrees in Computing Part II
BSc Honours Degree in Mathematics and Computer Science Part II
MSci Honours Degree in Mathematics and Computer Science Part II
for Internal Students of the Imperial College of Science, Technology and Medicine

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

PAPER 2.2 / MC2.2

DATABASES

Thursday, May 8th 1997, 10.00 - 11.30

Answer THREE questions

For admin. only: paper contains 4 questions

1a Explain briefly, but precisely, the meanings of the following terms:

i) a functional dependency,
ii) a primary key,
iii) Armstrong's augmentation axiom.

b A database comprising a single relation R contains data relating students to their courses, tutors, terms in which taught, and so on. The full scheme is

R (Snum, Course, Tutor, Term, Class, Level)

with primary key {Snum, Course}, and the content of R is

Snum	Course	Tutor	Term	Class	Level
2016	maths	smith	1	msc	4
2042	logic	jones	2	m2	2
2031	hardware	white	2	b1	1
2042	maths	jones	1	m4	4
2018	systems	white	2	m1	1

Each student has a unique identifier Snum. The student 2042 is an Occasional Student permitted to be assigned to more than one class. Level denotes how advanced a class is.

i) Comment on the problems entailed in updating R to assign a tutor to a new student 2046, and in updating R to delete the fact that student 2031 is taught hardware.

ii) Transform R into second normal form (2NF) and comment on whether the updates mentioned in part bi) then become viable.
Note — make clear the basis on which you transform the database, and remember to identify the primary key of each relation.

c It is required of the database that Class→Level shall always hold.

i) Comment on the problem of inserting into the 2NF database the fact that class b3 is of level 3.

ii) Transform the 2NF database into third normal form (3NF) and comment on whether the update mentioned in part ci) then becomes viable.
Note — again, make clear the basis on which you transform the database, and remember to identify the primary key of each relation.

The three parts carry, respectively, 15%, 50% and 35% of the marks.

2 ***For this question you will need to refer to the Supplementary Sheet showing the Suppliers-and-Parts database.***

a Formulate in relational algebra the following queries, and in each case show the answers they produce:

i) Find the cities other than London in which a supplier supplies at least one red part.

ii) Find the parts having weight less than 17 for which there are at least two distinct suppliers who supply the same quantity of it.

b Describe the framework of the tuple calculus, and suggest some advantages it may have over relational algebra.

Reformulate in tuple calculus the query in part aii), declaring the ranges of your variables.

c Show how you would create, using tuple calculus, a view SPAIRS(Sup1, Sup2) comprising pairs (SX, SY) of distinct suppliers such that SX supplies every part that SY does but has a lower status than SY. Declare the ranges of your variables.

Describe two benefits provided by views and two practical problems in their use.

The three parts carry, respectively, 60%, 20% and 20% of the marks.

Turn over ...

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

$$\begin{array}{ll} AB \rightarrow E & B \rightarrow F \\ F \rightarrow D & C \rightarrow A \\ C \rightarrow D & AD \rightarrow C \end{array}$$

a i) Define the Boyce-Codd normal form (BCNF).

ii) Given the functional dependencies FD, show that AB and BC are candidate keys for R.

iii) Hence, show that R is not in BCNF.

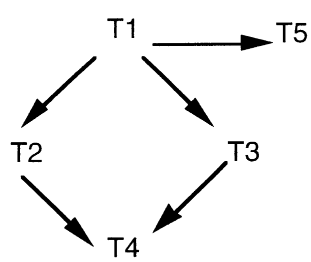
b i) Give a lossless decomposition of R into a set of BCNF relations. Show at every step of your decomposition that it is lossless.

ii) Is your decomposition dependency preserving? Explain. There is no need to give the definition of dependency preservation.

The two parts carry, respectively, 50%, 50% of the marks.

4a Explain what is meant by *conflict serialisable* and *serialisable* schedules.

b Consider the following precedence graph of a schedule S involving transactions T1, T2, T3, T4, T5.



i) Give two serialisations for S.

ii) In schedule S, suppose T1 finishes after T2 finishes. Suppose further that S runs under the two phase locking protocol (2PL) that acquires shared locks for reading and exclusive locks for writing, and releases the locks acquired by a transaction after it commits.

Explain why at some point the "wait-for" graph of locks for S will contain the arc

$$T2 \xrightarrow{\text{waits for}} T1.$$

c Prove that any schedule running under 2PL will be *conflict serialisable* if it does not deadlock.

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

End of paper

Supplementary Sheet for Paper 2.2=MC2.2

The Suppliers-and-Parts database

Relation S

S#	SNAME	STATUS	CITY
S1	Smith	20	London
S2	Jones	10	Paris
S3	Blake	30	Paris
S4	Clark	20	London
S5	Adams	30	Athens

Relation P

P#	PNAME	COLOUR	WEIGHT	CITY
P1	Nut	Red	12	London
P2	Bolt	Green	17	Paris
P3	Screw	Blue	17	Rome
P4	Screw	Red	14	London
P5	Pin	Blue	12	Paris
P6	Brace	Red	19	London

Relation SP **(quantities of parts supplied by suppliers)**

S#	P#	QTY
S1	P1	300
S1	P2	200
S1	P3	400
S1	P4	200
S1	P5	100
S1	P6	100
S2	P1	300
S2	P2	400
S3	P2	200
S4	P2	200
S4	P4	300
S4	P5	400