THIS PAPER IS NOT TO BE REMOVED FROM THE EXAMINATION HALLS

UNIVERSITY OF LONDON

CO2209 ZB

(291 0209 ZB)

BSc Examination

COMPUTING AND INFORMATION SYSTEMS AND CREATIVE COMPUTING

Database Systems

Tuesday 15 May 2012 : 10.00 – 1.00 pm

Duration: 3 hours

There are 5 questions in this paper. Candidates should answer **4** questions. All questions carry equal marks, and full marks can be obtained for complete answers to a total of **4** questions. The marks for each part of a question are indicated at the end of the part in [.] brackets.

Only your first 4 answers, in the order that they appear in your answer book, will be marked.

There are 100 marks available on this paper.

Calculators may be used. Electronic calculators must not be programmed prior to the examination. Calculators which display graphics, text or algebraic equations are not allowed. The make and type of machine must be stated clearly on the front cover of the answer book

Question 1 General

The following question follows the example of a database underlying an online fantasy-genre computer game. The quotes given are from developer documentation. Read each carefully and answer the questions given.

(a) "An advanced magician can cast the fireball spell"

From this statement, give an example of:

i. an entity [1]

ii. a property [1]

iii. a relationship [1]

(b) "Players choose the **alignment** of their characters using an *ethical* axis (good, neutral or evil) and a *attitude* axis (lawful, neutral or chaotic), so a character can be, for example, lawful-evil or chaotic-neutral. **Race** can be selected from any combination of (at least one of) human, dwarf, elf, halfling, gnome and frog."

This text describes the attributes of alignment and race. For each of these attributes, indicate whether it is:

i. simple

ii. base

iii. single-valued

iv. multi-valued

v. composite

vi. derived

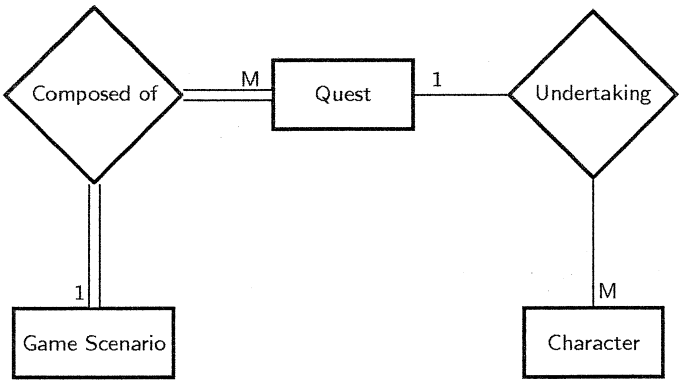
[6]

(c) Draw an Entity/Relationship diagram showing the relationship between **characters** and their **alignment** and **race.** [4]

(d) What, if anything, would you need to change to adapt this E/R model into a relational model? [2]

(e) "A game scenario consists of several predefined quests. A character can undertake only one quest at a time. When a character completes a quest, new ones become available as a result of talking to villagers"

The documenation provides the following E/R diagram to illustrate this.



This diagram shows an example of a *chasm trap*.

i. What is a chasm trap? [2]

ii. Draw a new E/R diagram that resolves the issue, showing both cardinality and participation constraints on your diagram. [3]

iii. An earlier version of this game automatically assigns new quests to characters as soon as they complete a previous one, so that characters are always associated with one (and only one) quest. For this previous version, would your new E/R diagram be preferable to the one shown above? Give a reason for your answer. [2]

iv. What is a "weak" entity type? Which entities, if any, in your E/R diagram are weak (make sure that any you do find are indicated on your diagram)? [3]

Question 2 Database and Relation theory

(a) What is the difference between the conceptual and the internal levels in the ANSI/SPARC DBMS architecture? [3]

(b) ANSI/SPARC specifies three levels of a database, and each level has an associated schema. How many mappings are there between layers? Why? [1]

(c) Edgar Frank Codd (1923–2003) was a British computer scientist. Amongst his most famous achievements are the Boyce-Codd normal form (BCNF) and 'Codd's 12 rules' for relational database management systems.

i. Codd defined a relational database as 'a database that is perceived by the user as a collection of normalised relations of assorted degrees'. What is a 'normalised relation'? [2]

ii. What, specifically, is BCNF? Include an example of a relation before and after normalisation to BCNF. [5]

iii. Rule 3 of Codd's 12 rules requires the 'Systematic treatment of Null values'. In the relational model, what is a Null value? [1]

iv. Codd's fourth rule requires that the system 'catalogue' (also called a data dictionary) be represented in the same, relational way as ordinary data. What is a data dictionary? [2]

v. Codd's fifth rule discusses sublanguages. SQL, a partial implementation of Codd's ideas, has two main component languages. What are they, and what do they do? [4]

vi. Codd's sixth rule is about views and automatically updating them. What is a view? [2]

vii. Rule 10 ('integrity independence') requires that integrity constraints be stored in the 'catalog'. What is an integrity constraint? [2]

viii. Why might it be useful to store the information about integrity constraints in a way that allows them to be changed independently of the data they refer to? [1]

ix. Rule 11 requires 'Distribution Independence' – the main objective of distributed databases. What is 'Distribution Independence? [2]

Question 3 SQL

A supermarket is setting up a database for online ordering of groceries for home delivery. The supermarket sells many products, each of which is stored in several warehouses. Each product will have a table giving a unique product code, a short name, a description, price and quantity per unit (size of pack). A second table will be required with warehouse location information with a unique warehouse code, and a third will provide stock levels for each product in each warehouse.

(a) Provide the SQL required to create the `Product` table, including specifying a primary key. [4]

(b) Provide the SQL required to create the table of stock levels (the third table described above). Include all relevant keys. [5]

(c) Stock levels are never negative.

i. Would you specify this fact as a data type or as a constraint? Why? [1]

ii. How would you specify this? [2]

iii. Is the form you used in (c)ii. above a domain integrity constraint, a column constraint, a base table integrity constraint or a database integrity constraint? Explain your answer. [2]

(d) Construct a query that lists all warehouses at which the product with the short name "TEABAGS" is in stock. [2]

(e) Construct a view that lists all products (by code and short name) that are out of stock in *all* warehouses. [3]

(f) Construct a view that lists all products (by code and short name) that are out of stock in *at least one* warehouse. [2]

(g) It is suggested that an object-oriented approach is used by the supermarket. Give some of the possible advantages and disadvantages of such a move. [4]

Question 4 Normalisation and database design

(a) Central to normalisation is the concept of functional dependency. What is a functional dependency? [2]

(b) Name and describe two important types of update anomaly that normalisation is intended to avoid. [4]

(c)

President	Took office	Party
Grover Cleveland	1885-3-4	Democratic
	1893-3-4	Democratic
William McKinley	1897-4-3	Republican

i. What about this table means that it is not a relation in first normal form? [1]

ii. Give the information given in the table in second normal form, making your choice of candidate keys clear. Explain any assumptions that you are making in your design. [3]

iii. George Washington had no party affiliation. Should the Party field be `NULL` in his case? Explain your answer. [2]

(d) What is third normal form? [2]

(e) What is fifth normal form? [3]

(f) In the United Kingdom, addresses have a functional dependency such that:

$\{Housenumber, Postcode\} \rightarrow \{Streetname, City\}$, however companies rarely use this dependency in designing customer databases. Suggest a reason why this might be the case. [2]

(g) Ternary relationships must be simplified when transforming an E/R model into a relational one.

i. What is a ternary relationship? [1]

ii. Give an example of a ternary relationship and draw an E/R diagram showing it. [2]

iii. Why must ternary relationships be simplified when developing a relational model? [1]

iv. Perform the simplification on your example diagram, resolving the problem. [2]

Question 5 Security and Data Recovery

The following tables are extracts of a book seller's database.

Books

ISBN	Title	AuthorID	Date	Format
0393090906	Medieval Music	RHH001	1978	Hardback
0847832961	The Infinity of Lists	UE0231	2009	Hardback
0099422395	Baudolino	UE0231	2003	Paperback

Authors

AuthorID	AuthorName	DateOfBirth
RHH001	Richard Hallowell Hoppin	1913-2-22
UE0231	Umberto Eco	1932-1-5

(a) We wish to add a new book, called Bad Science, a paperback with ISBN 000728487X and that was published in 2009. The book is by Ben Goldacre, who is a new author for the database. No date of birth is available for him, and he has been allocated an AuthorID of BG0173. Use pseudocode or any SQL dialect to create a command to add this information in a single transaction. [3]

(b) What are the ACID properties for databases? Briefly explain each property. [4]

(c) Name and briefly explain two of the three problems associated with concurrency [4]

(d) What is serialisability and what is its role in concurrency evaluation? [3]

(e) What is a *shared lock*? [2]

(f) What is an *exclusive lock*, and how does it differ? [2]

(g) A new member of staff (with a user id of `CD9802`) is to have an account created which allows him to view the two tables above (and only these two), but not to edit them. What command(s) would be needed? [3]

(h) A new administrator (user id: `FW4387`) is appointed who can edit either of these tables, and create new users. What command(s) is needed to create this user account? [2]

(i) The administrator leaves the company. What command would remove the staff member's account without removing any users that he or she might have created? [2]