



# Database Design and Development

**7 August 2018**

## Marking Scheme

This marking scheme has been prepared as a **guide only** to markers. This is not a set of model answers, or the exclusive answers to the questions, and there will frequently be alternative responses which will provide a valid answer. Markers are advised that, unless a question specifies that an answer be provided in a particular form, then an answer that is correct (factually or in practical terms) **must** be given the available marks.

If there is doubt as to the correctness of an answer, the relevant NCC Education materials should be the first authority.

**Throughout the marking, please credit any valid alternative point.**

**Where markers award half marks in any part of a question, they should ensure that the total mark recorded for the question is rounded up to a whole mark.**

<b>Answer ALL questions</b>
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**Marks**

**Question 1**

The table below contains data for a boat hire company about the vessels they have available to hire. Model Code and Name might take any values as new vessels are added but all vessels will have a hull colour of Red, Blue, Black or White. Types of vessels are defined as Yacht, Speed Boat and Cruiser.

Vessel Models

Model Code	Name	Hull Colour	Type
P87-1	Pluto Mark I	Red	Yacht
P87-2	Pluto Mark I	Blue	Yacht
V21-5	Venus Star	Red	Speed Boat
V21-1	Venus Star	Black	Speed Boat
VY-77	Venus Midi	Black	Cruiser

- a) Identify the columns in this table which would likely be specified as having domains. 2

***Colour (1 mark)***

***Hull Type (1 mark)***

- b) Supply the SQL to change this table to enforce the domains you have identified. 6

***ALTER TABLE Vessel Model***

***ADD CHECK (colour in ('Red', 'Blue', 'Black', 'White'))***

***Up to 3 marks: (1 mark for 'Alter Table', 1 mark for 'Add Check', 1 mark for the condition)***

***ALTER TABLE Vessel Model***

***ADD CHECK (Hull Type in ('Yacht', 'Speed Boat', 'Cruiser'))***

***Up to 3 marks: (1 mark for 'Alter Table', 1 mark for 'Add Check', 1 mark for the condition)***

- c) How does the concept of a domain differ from the concept of a data type? 2

***A data type is the format of the column in terms of whether it is a number or character string etc (1 mark). A domain is a more strict definition of the values of a column limited to a more clearly defined set of values (1 mark).***

**Total 10 Marks**

## Question 2

- a) Provide definitions of a *super key*. 2  
**Award 1 mark for each bullet point up to a maximum of 2 marks.**
- ***An attribute or set of attributes that uniquely identifies a tuple.***
  - ***An attribute or set of attributes upon which all the other attributes are functionally dependent***
- b) Briefly explain the concept of a *candidate key*. 3  
**Award 1 mark for each bullet point up to a maximum of 3 marks.**
- ***A candidate key should be a super key.***
  - ***However, ALL the attributes of this super key must be necessary to uniquely identify it; i.e. there should be no superfluous attributes that are part of the key.***
  - ***It should not be the case that any subset of the attributes that go to make up this key should qualify as a super key; ALL the attributes are necessary.***
- c) Give a definition of each form of normalisation up to 3rd normal form. 3  
**1st normal form aims to remove repeating groups.**  
**2nd normal form: removed an partial key dependencies**  
**3rd normal form: remove any non-key dependencies.**  
**1 mark for each definition.**
- d) Explain what you understand to be the purpose of normalisation. 2  
**Normalisation aims to overcome potential anomalies that can occur when data is replicated (1 mark). Normalisation aims to eliminate replication (1 mark).**  
**Credit alternative answers.**

Total 10 Marks

## Question 3

- a) Outline the main tasks and activities of physical database design. 3

***Translates logical database structures (entities, attributes, relationships, and constraints) into a physical design (1 mark).***

***The physical design should be suitable for implementation by the chosen DBMS (1 mark).***

***involves producing a design that describes the base relations and takes into account file organization, indexes, integrity constraints and security measures (1 mark)***

***Note: Credit other valid definitions and examples.***

- b) In a data model a minority of students (represented on a 'students' entity) might be allocated a laptop (represented on a 'laptop' entity). This is shown with a one to one relationship optional at both ends. 3

Suggest how such a model might be represented in physical design.

***Here the relationship is optional at both ends. The entities are kept separate and implemented as two separate tables. (1 mark). It would be sensible to place the foreign key on the laptop table to represent allocation of a laptop because lap tops would be likely be allocated but it might not be the case that most students would have a laptop. (Up to 2 marks for this or similar explanation)***

- c) With the use of an example, explain why it is important to resolve many-to-many relationships in an Entity Relationship Model. 4

***Award 3 marks for the explanation and 1 mark for the example.***

***It is important because many-to-many relationships cannot be represented in the database (1 mark) since they could lead to data that is in contradiction (1 mark). Also many-to-many relationships often hide meaning (1 mark) For example a doctor – patient m:n relationship hides the entity 'appointment' (1 mark for this or other example.)***

**Total 10 Marks**

## Question 4

- a) With the use of an example, explain the concept of a *recursive relationship*. 2  
**Award 1 mark for the explanation and 1 mark for the example up to a maximum of 2 marks.**

**Explanation**

- **A recursive relationship is where an entity has a relationship to itself. (1 mark)**

**Example**

- **A student has mentor who is also a student. A mentor can look after many students.**

**Note: Credit alternative valid explanations and examples.**

- b) With the use of an example, briefly explain how a recursive relationship can be represented on a database table. 2  
**This is represented in the table with a foreign key to itself (1 mark) In the example a 'mentor id' being added to the table; the mentor id is in fact a foreign key to the student id on the student table (1 mark for example)**

- c) With the use of an example, briefly explain what is meant by a *redundant relationship*. 3

**Explanation**

- **A relationship is redundant if the same information can be found via some other relationships (1 mark)**
- **A relationship that represents something that might be derived through one or more other relationships (1 mark)**

**Examples**

- **Examples include an Order Line having a Customer ID when the Customer ID is also on the parent Order entity (1 mark)**

**Note: Credit alternative valid explanations and examples.**

- d) Explain what is meant by the term de-normalisation and say why it might be used. 3

**Award 1 mark for each bullet point up to a maximum of 3 marks.**

- **De-normalisation is the process of using data replication and compromising the normalised structures of the database.**
- **It can make the database more efficient.**
- **It does this by making queries quicker by minimizing the need for joins across tables.**

**Total 10 Marks**

## Question 5

- a) With the use of an example, explain the concepts of 'Super Type' and 'Sub Types' in the Extended ER model. 7

***Super Type: is a generalisation of data (1 mark) based on a set of more specialised sub types (1 mark)***

***The super type would have all the attributes that are shared by its sub types (1 mark).***

***1 mark for example of Super Type such as Students being a super type of Home and Overseas students.***

***Sub Type: A specialisation of a more general entity (a super type) (1 mark). The sub-types would have only those entities that pertain to them (1 mark).***

***1 mark for an example of Sub Type such as that of home and overseas students where it might make sense to keep information about the Home Country for overseas students but not for Home Students.***

***NB. If a single example is used to demonstrate both super type and sub type, rather than separate examples for each, then allocate 2 marks to this.***

- b) With the use of an example, explain what is meant by the Disjoint constraint in the Extended ER model? 3

***Award 1 mark for each bullet point up to a maximum of 3 marks.***

- The Disjoint constraint asks the question can a member of a super-class be a member of more than one sub-class (1 mark)***
- It defines if sub-class are mutually exclusive within a super-class (1 mark)***
- In the example above it is no since a student cannot be a home AND overseas student ( 1 mark)***

**Total 10 Marks**

## Question 6

- a) Explain the use of 'derived data' in a database system. 2

***Award 1 mark for each bullet point up to a maximum of 2 marks.***

- ***Derived data is defined as a column whose value is derived from the value of one or more other columns in the database.***
- ***These might be columns within the same table or columns from one or more other tables.***

- b) With the use of TWO (2) examples, explain the role of SQL aggregate functions in generating derived data from existing data in a database. 4

***The maximum number of marks awarded for this question is 4.***

***Award up to 2 marks for the explanation***

***Explanation***

- ***Aggregate functions are used to perform calculations on rows of data in SQL.***
- ***They can be used as ways of calculating data such as generating totals from subtotals.***

***Award up to 2 marks for the example***

***Examples include bills where totals for a job are calculated from costs of materials stored in a database (1 mark) and invoices where calculations of work done based on hourly rates can be performed on data stored in database (1 mark) .***

***Note: Credit other valid examples such as explaining the use of SUM, COUNT etc. as examples.***

- c) With the use of an example, explain the use of indexes in a database system. 4

***Indexes are a way of increasing the performance of a query. (1 mark)***  
***Indexes in databases are separate files that contain location pointers to the actual rows in the database. (1 mark)***  
***Instead of a topic title like in a book index, they usually contain one or more attributes that belong to a row (1 mark). They could, for example, contain just customer numbers from a customer table, rather than all the data for the customers as the actual database contains (1 mark).***

**Total 10 Marks**

## Question 7

- a) Why does referential integrity affect the order in which data can be inserted into a database? 2  
***Where data is referencing data in another table via a foreign key then that foreign key cannot be inserted into the database (1 mark) until the parent (primary or candidate) key is populated. (1 mark)***
- b) In a database of students and their exam marks it happens that occasionally students are deleted from the students table. What options exist to deal with this with regards to the exam marks table? 5  
***Propagation constraints would need to be defined to enforce the rules as to what happens if data that is referenced elsewhere is altered or deleted (1 mark). There are four options:***
  - No action means the record in the table with the foreign key is left as it is (1 mark)***
  - Cascade which means that any change (including a delete) is replicated in the table with the foreign key in it (1 mark)***
  - Set Default, which means that the change in the parent table causes the record in the child table to be set to some sort of default (1 mark)***
  - Set Null. Similar to Set Default except that the table with the foreign key has that foreign key set to Null (1 mark)***
- c) Using an example, explain the function of database triggers. 3  
***Database triggers are pieces of procedural logic that are attached to database objects (1 mark). They operate ('fire') upon some event happening such as a new row being inserted into the database (1 mark). (1 mark for example such as: updating an audit table when a row is entered into a base table)***

Total: 10 Marks



## Question 8

- a) Identify THREE (3) ways in which a Database Administrator (DBA) would have a role in the database development process. 3

***Award 1 mark for each bullet point up to a maximum of 3 marks.***

- ***Consultation about which product to purchase for integration.***
- ***Investigation of possibilities of particular DBMS.***
- ***Consultation on implementation issues such as data structures.***
- ***Consultation on physical implementation for performance.***

***Note: Credit other valid points.***

- b) Identify THREE (3) activities a database administrator (DBA) might undertake with regard to the granting of access to data. 3

***Award 1 mark for any of the following points. Maximum of 3 marks.***

***Could include:***

***Creation of views (1 mark)***

***Granting of insert rights onto specific tables to specific users (1 mark)***

***Granting of delete rights onto specific tables to specific users (1 mark)***

***Granting of update rights onto specific table to specific users (1 mark)***

***Granting of retrieval rights onto specific tables to specific users (1 mark)***

***Revoking rights as above (1 mark each for any of these)***

***Creating users (1 mark)***

***Creating user groups (1 mark)***

***Alternative points should be credited.***

- c) Outline FOUR (4) ways in which the role of the Database Administrator (DBA) is different to that of the Data Administrator (DA). 4

***DBA is a technical role; DA is an administrative/managerial role (1 mark).***

***DBA concerned with access to database; DA concerned with access to Data (1 mark).***

***DBA primary knowledge is of technical specifications of a given vendor's Database product (1 mark) DA's primary knowledge will be of legislation such as Data Protection Act (UK) or equivalents in other countries (1 mark).***

**Total: 10 Marks**

## Question 9

- a) Suggest FIVE (5) reasons why organisations operating in a modern business environment might choose to develop a distributed database. 5

***Award 1 mark for each bullet point up to a maximum of 5 marks.***

- ***Organisations of any success tend to get bigger and diversify.***
- ***It often happens that they will develop new sites both within the boundaries of one country and sometimes to other countries.***
- ***This trend has been enhanced in the last century and even more so in recent decades by the use of technology that makes it easier to operate at a distance (from the telephone to the World Wide Web).***
- ***Firms might also be involved in takeovers where they inherit databases from those firms they have taken over or merged with.***
- ***With the increasing importance of database to any organisation they the need for distributed databases has grown alongside the trend in organisations being distributed.***

- b) Explain how a DBMS for a distributed database differs from that from a standard database system. 5

***Any DBMS that needs to operate for a distributed database will be more complex than for a stand-alone database (1 mark).***

***More complex system catalogue. To keep track of potentially different structures in different sites and to record location of specific structures (1 mark).***

***Concurrency control. Needs to be more sophisticated for example to make sure an update that affects more than one site operates in such a way to keep the database consistent and maintain integrity (1 mark)***

***Query optimiser. Tracing paths through tables for queries becomes more complex when the tables may be fragmented across different sites (1 mark)***

***Finally the DBMS itself must be distributed which means that tuning and managing it becomes a more complex set of tasks (1 mark)***

- ***Alternative answers should be credited.***

**Total: 10 Marks**

## Question 10

- a) What is data integration and why is it important in data warehouse systems? 4

***Award 1 mark for each bullet point up to a maximum of 4 marks.***

- ***Data integration is the merging and consolidation of data from different sources in a data warehouse.***
- ***The data could be in different formats in the different source systems.***
- ***The format will be defined by a set of meta-data.***
- ***It is important because then data from different sources can be compared.***

- b) Identify and discuss THREE (3) types of tools that can be used for interaction with a data warehouse. 6

***Query tools: using a standard query language like SQL or query languages specific to the commercial tool.***

***OLAP: On-line analytical processing. Which allows multi-dimensional views of data.***

***Statistics: Statistical analysis tools.***

***Discovery tools. Used to uncover trends in database. What is known as 'data mining' whereby the tools discover trends that the users might not necessarily be aware of.***

***1 mark for listing (up to 3 marks)***

***1 mark for detail (up to 3 marks).***

**Total 10 Marks**

**End of paper**

## Learning Outcomes matrix

Question	Learning Outcomes assessed	Marker can differentiate between varying levels of achievement
1	3	Yes
2	2, 3	Yes
3	3	Yes
4	2, 4	Yes
5	3, 4	Yes
6	5	Yes
7	5	Yes
8	1	Yes
9	1	Yes
10	1	Yes

## Grade descriptors

Learning Outcome	Pass	Merit	Distinction
Understand the enterprise application of database systems	Demonstrate adequate level of understanding	Demonstrate robust level of understanding	Demonstrate highly comprehensive level of understanding
Understand how to enhance the design of and further develop a database system	Demonstrate ability to perform the task	Demonstrate ability to perform the task consistently well	Demonstrate ability to perform the task to the highest standard
Be able to enhance a logical database design	Demonstrate ability to perform the task	Demonstrate ability to perform the task consistently well	Demonstrate ability to perform the task to the highest standard
Be able to develop a physical database design	Show adequate development	Show sound and appropriate development	Show innovative and highly appropriate development
Be able to enhance a database system using SQL	Demonstrate ability to perform the task	Demonstrate ability to perform the task consistently well	Demonstrate ability to perform the task to the highest standard