BCS THE CHARTERED INSTITUTE FOR IT

BCS HIGHER EDUCATION QUALIFICATIONS

BCS Level 5 Diploma in IT

DATABASE SYSTEMS

Answer **any** FOUR questions out of SIX. All questions carry equal marks
Time: TWO hours

The marks given in brackets are **indicative** of the weight given to each part of the question.

Calculators are **NOT** allowed in this examination

Overall Comments

Compared to last September, the overall pass rate of 60% is significantly higher this year. This could be due to the participation of a different cohort of centres. No moderation of marks was considered necessary and the examination appeared to be a true test of the ability of candidates.

SECTION A, Question 1

This question was fairly popular, having been attempted by 53% of the candidates. Around 59% achieved pass level marks.

SECTION A, Question 2

This question was very popular with 76% of candidates making an attempt. It covered the topic of data modelling on the syllabus. Performance was generally good with a wide range of marks achieved. The percentage pass rate was 50%.

SECTION A, Question 3

Surprisingly not a popular question with 44% of candidates attempting it. The average mark was very disappointing at around 7/25.

SECTION B, Question 4

This was a popular question with 66% of candidates attempting it with 50% achieving pass level marks.

SECTION B Question 5

This was a popular question with 66% of candidates attempting it with 49% of attempts achieving pass level marks.

SECTION B Question 6

This was a very popular question with 76% of candidates attempting it with 63% achieving pass level marks.

Section A

A1

(a) A tennis club uses the following table to record details of players and their coaches.

Players

PlayerID	Name	Ranking	CoachID	CoachName
P001	Little	12	C003	Spode
P002	Widgeon	03	C013	Glossop
P003	Prosser	17	C003	Spode
P004	Twistleton	09	C006	Travers

(i) Explain why the above table is not in 3rd normal form.

(2 Marks)

(ii) Transform the table into 3rd normal form.

(4 Marks)

(b) The table below records orders for items. Each order is placed on a given date, and may include a variety of items in different quantities.

Orders

OrderNo	**ItemNo**	**Description**	**Date**	**Quantity**
1	12	Screw	Jan 6th	100
1	15	Bolt	Jan 6th	50
2	7	Flange	Feb 2nd	10
2	15	Bolt	Feb 2nd	40
2	12	Screw	Feb 2nd	80

(i) Give an example of an insertion anomaly and an example of modification (update) anomaly that might occur in the above table.

(4 Marks)

(ii) Explain why this table is not in 2nd Normal Form.

(3 Marks)

(iii) Transform the table into 2nd Normal Form

(6 Marks)

(c) Given the table below, where A, B, C, D and E represent the attributes of the table. A → D is one example of a functional dependency in this table. Find two other dependencies.

A	B	C	D	E
a1	b1	c1	d1	e1
a1	b2	c2	d1	e2
a1	b3	c1	d1	e3
a2	b1	c1	d2	e4
a2	b2	c2	d2	e5

(6 Marks)

Answers & Marking scheme – A1

(a) (i) The table is not in 3rd normal form because it includes a trAnsweritive dependency:

PlayerID → CoachID → CoachName (2 marks)

(ii) To remove the dependency, move the dependent attribute coachName into a new table together with the attribute coachID that it depends on, giving:

Players(playerID, Name, ranking, coachID*) (2 marks)

Coach(coachID, coachName) (2 marks)

(b) (i) Insertion Anomaly:

You can't add a new item/description to the table until that item has been ordered.

Alternatively:

If you add a new item to the table and make a mistake in the description, then you may end up with (e.g.) two different descriptions for the same item. (2 marks)

Modification Anomaly

If the description of an item changes, and if you neglect to change all the descriptions, then the table will contain conflicting values for the description of this item. (2 marks)

(iii) The table is not in 2NF as it contains 2 partial dependencies (1 mark)

OrderNo → Date (1 mark)

ItemNo → Description (1 mark)

(iv) Remove each of the dependant attributes, together with the attribute(s) each one depends on, to give:

OrderLine(OrderNo, ItemNo, Quantity) (2 marks)

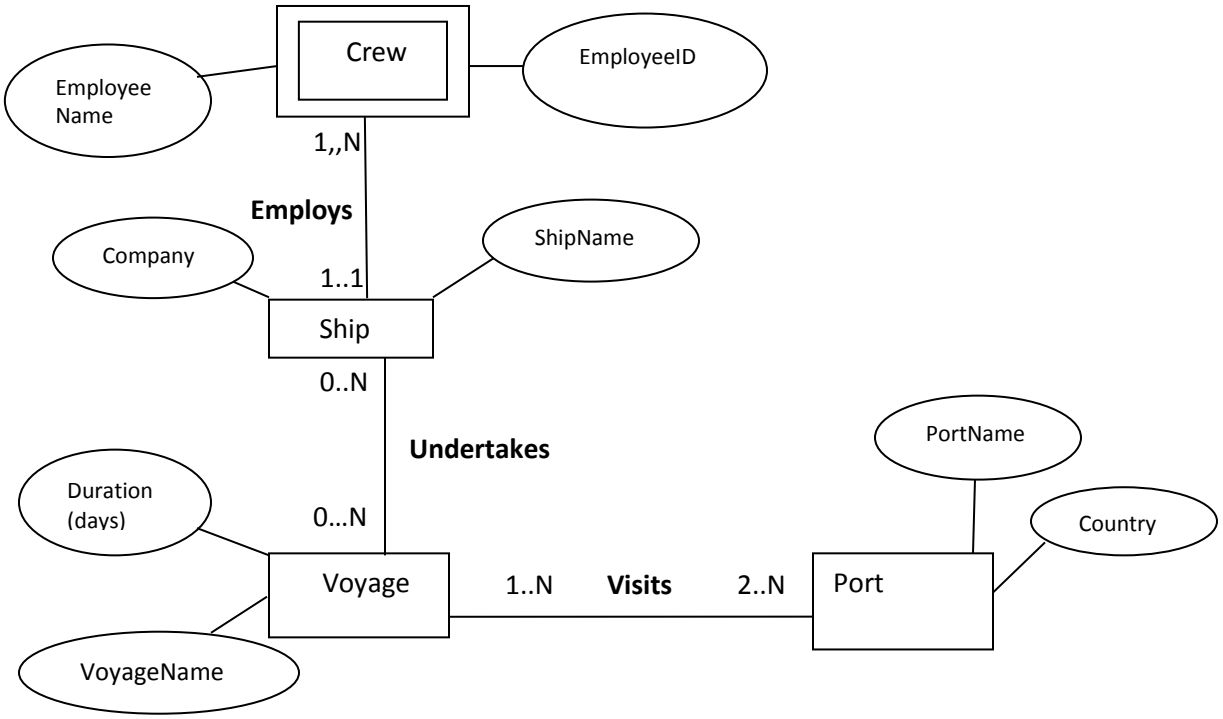
Order(OrderNo, Date) (2 marks)

Item(ItemNo, Description) (2 marks)

c) B → C (3 marks) A, B → E (3 marks)

A2

Examine the following ERD (using UML notation) which is used to model the voyages of ships and their movement during a voyage from port to port. Then answer the question parts that follow**.**



a) With reference to the ER model above, explain the concept of relationship participation involving the Visits relationship and the Employs relationship. (Hint your answer should include a diagram of entity occurrences)

(6 Marks)

ANSWER

A voyage involves the visit to at least two ports (possibly start/end) and a port is visited during at least one voyage.

A diagram of entity occurences similar to a semantic net of participating entity occurences (ie v1 --- p1 v1----p2 v2----p2 v2---p3. Worth an extra 2 marks

A crew member is assigned to one ship and a ship contains more than one crew

b) Identify and explain the difference between a weak entity type and a strong entity type.

(5 Marks)

ANSWER

Crew could be a weak entity as it has dependence on strong entity. It needs the EmployeeID,ShipName to identify it
It is existence-dependent on another entity, i.e.,
it cannot exist without the entity with which it has a relationship.
It inherits at least part of its primary key from the entity to which
it is related. EmployeeID,ShipID

c) Explain how you would assign the following attributes to the appropriate relationships in the ER model

(i) DestinationPort,
(ii) VisitStartDate
(iii) VisitEndDate
(iv) VoyageStartDate

(4 Marks)

Answer

Undertakes would be assigned VoyageDate because the voyage date depends on each Voyage undertaken by different ships Visits would be assigned VisitStart and Enddate because each visit is recorded when a ship enters and leaves a port during its voyage Voyage would be assigned Destinationport because this is determined by the particular voyage ie each voyage has a distinct destination

d) Explain how you would translate the ERD above to an equivalent relational model. Identify the primary keys and foreign keys for each relation. (hint remember to reconcile the many to many relationships and assign attributes to appropriate relations)

(10 Marks)

Answer

ship(**Sname**, company)
Undertakes(**Sname,VoyageName, VoyageDate)**
Voyage(**Voyagename,**DestinationPort,Duration)
Visit(**Voyagename,portName StartDate**,EndDate)
Port(**PortName,***CountryName*
Crew(**employeeID,**EmployeeName,*ShipID*)

NB candidates should realise that the 1:M relationship permits posting of attributes for entity port and thus Crew is assigned ShipID as a FK

A3

a) Write out the output and express in English the result of running each of the following queries against the following tables –

Loan

LoanID	BorrowerID	LoanDate	DueDate	ReturnDate
123	874	12-23-2013	01-24-2014	01-24-2014
124	874	12-23-2013	01-24-2014	NULL
125	876	12-29-2013	01-28-2014	NULL
123	874	01-25-2014	02-21-2014	NULL

Borrower

BorrowerID	BorrowerFname	BorrowerLname
874	Leon	Small
875	Gary	Lowe
876	Mark	Sanchez
877	Clywd	Morgan

Query 1:

```
SELECT Count(*) , BorrowerLname
FROM Loan, Borrower
WHERE Loan.BorrowerID = Borrower.BorrowerID
GROUP BY BorrowerLname
HAVING Count(*) >2
```

Query2:

```
SELECT DISTINCT BorrowerID
FROM Loan
WHERE ReturnDate IS NULL
AND DueDate < getDate()
```

Note GETDATE returns the current date which you should assume is = 01-27-2014

Query3:

```
SELECT BorrowerID
FROM Borrower
WHERE BorrowerID NOT IN (SELECT BorrowerID FROM Loan);
```

(9 Marks)

Answer
SMALL Which borrower have borrowed more than 2 articles
874 Which borrower have borrowed articles that are due back but are not overdue
875,877 878 Which borrowers have not borrowed any articles

b) SQL allows the database developer to create indexes. Describe using example SQL code the range of indexing techniques that could be used to improve the performance of each of the above queries.

(9 Marks)

ANSWER Discuss particular indexing techniques (eg SQLserver uses clustered indexes non clustered indexes) and the concept of range queries and specifying indexes on frequently accessed column names. Example SQL from SQLserver (or Oracle)

CREATE INDEX AK_ProductCategory_Name UNIQUE NONCLUSTERED ON Borrowers.LName ASC)

c) Describe the use of various DBMS software tools that allow the performance of queries to be monitored.

(7 Marks)

ANSWER Indexing metrics via query execution plan to show/recommend indexes Automatic tools query plan optimiser performance metrics other tools Tools provided to assist the DB developer/administrator such as profiling queries and possible partitioning strategies etc

Section B

Answer Section B questions in Answer Book B

B4

This question uses the 'Electricals' relation below…

Electricals

Code	**Description**	**Supplier**	**Price**	**Stock**
1	DVD	Sunshine Electricals	99.99	24
2	Netbook	Electro-Pro	149.99	65
3	HDTV	Sunshine Electricals	499.99	24
4	Speakers	Pro-Sound	129.99	58
5	MP3 Player	Pro-Sound	29.99	350
6	Smart Phone	Talk2Go	149.99	125
7	Tablet Computer	Electro-Pro	199.99	134

(a) For each of the following descriptions *name the correct relational concept* and give *an example* based on the 'Electricals' relation…

(i) Provides a mechanism for identifying each row in the relation **(2 Marks)**

(ii) Describes the number of rows in the relation **(2 Marks)**

(iii) Describes the number of columns in the relation **(2 Marks)**

(iv) Describes the permitted values in any given column **(2 Marks)**

(v) Provides a mechanism for linking to another relation **(2 Marks)**

Answer

- **Primary key (or candidate key) = Code**
- **Number of rows = cardinality (depth of relation) = 7**
- **Number of columns = degree (width of relation) = 5**
- **Permitted values = domain – various examples**
- **Linking = foreign key – could be Code again**

(b) For each of the following relational concepts, explain the key ideas behind it and use the 'Electricals' relation to provide suitable examples…

- Entity Integrity
- Referential Integrity

(6 Marks)

Answer

Entity Integrity – all about primary keys (following concepts + examples):

- **No nulls**
- **No duplication**
- **Must guarantee unique row identification – forever**
- **Atomic versus composite candidate and primary keys**

Referential Integrity – all about foreign keys (following concepts + examples):

- **FK column(s) must match domain of referenced column(s)**
- **Names do not matter**
- **Can contain nulls**
- **Can contain duplicates**
- **ON DELETE CASCADE etc**

(c) Write a *single sentence* with a *simple example* (based on *any* relation) to illustrate the following relational concepts…

- Candidate Key
- Alternate Key
- Atomic Key
- Composite Key
- Primary Key

(9 Marks)

Answer

Any sensible comments accepted as long as the key concept(s) are captured. Only award full marks if some concrete examples are also provided.

B5

(a) Explain the phrase 'three-tier architecture' with respect to the following two distinct systems:

(i) Databases and the ANSI-SPARC model **(5 Marks)**

(ii) Databases and the Web **(5 Marks)**

Good diagrams are essential in each case.

ANSWERI-SPARC:

- **The three levels (external, conceptual and physical)**
- **The function of each level**
- **Mappings (logical and physical data independence)**
- **A good diagram essential**

Web:

- **The presentation layer (web browser/web page)**
- **The business logic layer (web server/application server)**
- **The data layer (DBMS and database functions)**
- **A good diagram essential**

(b) Explain, using your own examples, how the following database concepts are implemented and how they relate to each other:

(i) Data integrity **(5 Marks)**

(ii) Data validation **(5 Marks)**

(iii) Data security **(5 Marks)**

B6

(a) Describe four possible benefits of "Views" in databases. **(8 Marks)**

(b) Describe the role, and content, of the system catalog in a DBMS **(6 Marks)**

(c) Discuss what is meant by "Integrity" in a database, and describe two possible mechanisms for achieving data integrity.

(6 marks)

(d) Describe five advantages of using a database system over the use of spreadsheets.

(5 marks)

Answer

Data integrity: The need to prevent incorrect, inconsistent, nonsensical or erroneous data being (accidentally) stored inside the database. This is enforced via table-level constraints such as primary and foreign keys, NOT NULL, UNIQUE, CHECK and DEFAULT clauses plus programmatic logic in the form of triggers.

Data validation: Closely related to data integrity in the sense that it seeks to prevent incorrect, inconsistent, nonsensical or erroneous data being (accidentally) stored inside the database BUT the thrust here is more at the user interface level – on forms and web pages – to help and guide users what to enter in the first place and thus prevent invalid data from getting to the database at all. Enforced by use of drop-down lists, calendars, radio buttons, context-sensitive help etc.