



## BCS THE CHARTERED INSTITUTE FOR IT

BCS HIGHER EDUCATION QUALIFICATIONS  
BCS Level 5 Diploma in IT

### DATABASE SYSTEMS

Thursday 1<sup>ST</sup> October 2015 – Morning  
Answer **any** FOUR questions out of SIX. All questions carry equal marks  
Time: TWO hours

**Answer any Section A questions you attempt in Answer Book A**  
**Answer any Section B questions you attempt in Answer Book B**

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

Calculators are <b>NOT</b> allowed in this examination.
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#### Section A

**Answer Section A questions in Answer Book A**

**A1**

Refer to the following scenario and Figure A1 that follows.

'AZT' is a company that supply a number of **courses** (eg *Visual Basic; Python; SQL, Java*) delivered in the form of computer aided learning (CAL) **packages** that **students** study on-line. Students first register for an **attendance** on a course that AZT **offer** many times, occasionally over the same period of time. Then they **access** and work through a predefined set of packages in sequence (one at a time). After completing the last package for a course, students are then assessed by a practical test and the result is recorded as pass or fail. AZT log student access to each package recording the following information:-

*SessionID, The unique identifier whenever the package is accessed.*

*StudentID this is the identifier of the student logged into this session*

*PackageID this identifies the package a student is logged into*

*LoginTime this is the unique login time and date of this session*

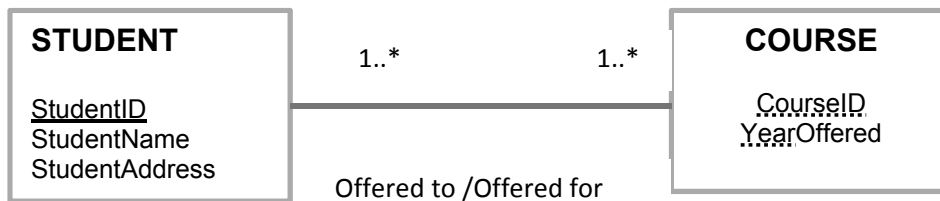
*LogoutTime this is the unique logout time and date of this session*

*LoginTimeLeft this is a derived field showing what time is left at the start of a session*

A student can access a particular package for a maximum of 18 hours over a predefined period after which the package is unavailable to that particular group of students. Each course has a selection of different packages unique to a particular course. The same course can be offered to students many times for example if they wish to re study.

An incomplete ER Model (using UML notation) has been produced below in Figure A1

Figure A1 ER model (UML Class diagram notation) for use in question A1



- a) Explain using the supplied ER model (figureA1) the concept of *cardinality* and *participation* constraints used to describe relationships between entity types.

(5 marks)

- b) Using any standard ER modelling notation, produce a **complete** ER model that includes **all** the Entity Types highlighted in bold in the scenario resolving any many to many relationships. State any assumptions you made.

(14 marks)

- c) Explain, using examples, the objectives of the following data modelling stages

- (i) Logical
- (ii) Physical

(6 marks)

## A2

Refer to the following Table definitions and then answer the question parts that follow.

### Customer

Column Name	Type	Length	Nulls	Key
CustID	Integer	4	No	PK
CustName	Varchar	25	No	
Custaddress	Varchar	25	No	
CustPostCode	Char	8	No	

### Products

Column Name	Type	Length	Nulls	Key
ProductID	Integer	4	No	PK
Description	Varchar	25	No	
StorageAddress	VarChar	25		
StoragePostCode	VarChar	12		
Reorderquantity	Integer	4	No	
QuantityInStock	Integer	4	No	
Unitprice	Decimal	8,2	No	
Total_quantitySold	Integer	4	Yes	

### Orders

Column Name	Type	Length	Nulls	Key
OrderID	Integer	4	No	PK
CustID	Integer	4	No	FK
OrderDate	Date		No	
PromiseDate	Date		No	

### LineItems

Column Name	Type	Length	Nulls	Key
ProductID	Integer	4	No	PK,FK
OrderNo	Integer	4	No	PK,FK
QuantityOrdered	Integer	4	No	

- a) With reference to the above table definitions explain the concept of a **Domain**. List 2 examples from the above tables of columns that could be defined as a domain. **(5 marks)**
- b) Suppose you were required to implement (create and populate) the tables listed above using an SQL script containing a set of CREATE TABLE and INSERT operations. List the logical sequence the tables should be populated to ensure referential integrity is preserved. **(4 marks)**
- c) TotalQtySold is a column that contains derived data. Write a SQL SELECT statement that computes a value for this column for a specific product. **(5 marks)**
- d) What are the advantages and disadvantages of storing derivable data in a table? **(4 marks)**
- e) Write an SQL UPDATE statement that updates the column TotalQtySold given a specific product. **(7 marks)**

**A3**

- (a) A University stores student records in the format shown below:

<b>StudentID:</b> S0012	<b>Name:</b> John Silver	<b>Course:</b> Computing	
<b>Module Code</b>	<b>Module Name</b>	<b>Grade</b>	<b>Pass/Fail</b>
M001	Databases	C	Pass
M002	Web Technologies	E	Fail

Module grades A-D are pass grades and E-F are fail grades.

- (i) Identify the repeating group of attributes and transform the above format into tables that are in 1<sup>st</sup> Normal Form. **(4 marks)**
- (ii) Identify any partial dependencies and transform into tables that are in 2<sup>nd</sup> Normal Form. **(5 marks)**
- (iii) Identify any transitive dependencies and transform into tables that are in 3<sup>rd</sup> Normal Form. **(2 marks)**
- (b) (i) Explain the term *candidate key*. **(2 marks)**
- (ii) List **three** candidate keys for the following table (A, B, C and D are the attributes of the table):

<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
a1	b1	c1	d1
a2	b3	c3	d1
a1	b2	c1	d2

**(6 marks)**

- (c) The following table stores details of employees and the projects they work on and for how long. The Primary Key is (EmpID, ProjID).

**Workload**

<u><b>EmpID</b></u>	<b>EmpName</b>	<u><b>ProjID</b></u>	<b>ProjName</b>	<b>HoursPerWeek</b>
E01	Smith	P02	Database	10
E01	Smith	P01	Web Portal	5
E02	Robinson	P02	Database	20

- (i) Explain why the above table is not in 2<sup>nd</sup> Normal Form. **(2 marks)**
- (ii) Transform the table into 2<sup>nd</sup> Normal Form tables. **(4 marks)**

## Section B

### Answer Section B questions in Answer Book B

**B4**

- (a) *Using your own simple Relational Algebra (RA) examples and any appropriate diagrams, list the eight RA operators, explaining the essence of each and providing at least one suitable example based on a sample relation of your own choosing. Good diagrams will gain extra credit. You should also highlight which RA operators originate from mathematics and which were developed specifically for relational databases – and by whom.* **(10 Marks)**

- (b) For each of the following two relational concepts, explain the key ideas behind them and, *using a sample relation of your own choosing*, provide suitable examples...

- Entity Integrity
- Referential Integrity

**Each item is worth five marks**

**(10 Marks)**

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

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

Each item is worth one mark

**(5 Marks)**

**B5**

- (a) Using a *suitable diagram and any appropriate examples*, address the following two points:

- Describe how *database forms* relate to the three-level ANSI-SPARC architecture of a typical database system
- Describe how *SQL views* relate to the three-level ANSI-SPARC architecture of a typical database system and how they compare with database forms

**(10 Marks)**

- (b) *Data validation* is a key requirement when entering data into a database. Discuss the relative strengths and weaknesses of performing this data validation at the *application form* level and at the *database level* as well as briefly explaining the methods that each level uses to ensure that validation is achieved. **(10 Marks)**
- (c) Explain the roles, responsibilities and relationships of application forms and databases in a three-tier web-based architecture, taking special care to discuss the concepts of presentation, business logic and data management. You are not expected to write any software code but you should support your discussion with a clearly annotated diagram illustrating how all three components of a three-tier architecture interact and where they reside within that structure. **(5 Marks)**

## **B6**

- a) A major objective of the ANSI-SPARC architecture is to provide data independence.
- (i) Draw a diagram illustrating this architecture. **(3 marks)**
  - (ii) Using examples, discuss the concepts of logical data independence and physical data independence. **(6 marks)**
- b) Describe four features (functions) you would expect to find in a DBMS. **(8 marks)**
- c) The 'client-server architecture' is commonly used to implement a database system.
- (i) Draw a diagram to illustrate this architecture. **(3 marks)**
  - (ii) Describe the advantages of this approach and comment on whether it is appropriate for the Web. **(5 marks)**



