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School of Computing

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COMP5112M

Data Management

Answer ALL THREE questions

Time allowed: 2 hours

Question 1

Read the following description and then answer the questions below.

> The University of East Westland delivers modules. These modules are each required to recommend at least one book in their reading list. Copies of these books are held in the university library and normally there are several copies, sometimes ten or more, of all the recommended books. Students are allowed to borrow books from the library, but no more than six at any one time.
>
> An information system is required to record which books are recommended by which modules, as well as which students study which modules and what books have been borrowed by each student. The system will include details about all books in the library, not just the ones that are recommended by modules. The information about student borrowing shows just the books that each student currently has out on loan, and for each of these the date due for return is recorded. The library also records how many times each copy of a book has been borrowed because it uses this to predict when it is likely to need to replace worn out textbooks.

(a) Draw an Entity-Relationship (ER) diagram which models the information system described above. Your answer should include:

   (i) Entity types with each having one or two appropriate attributes. These entity types should include **Module** and **Student**. **[4 marks]**

   (ii) Relationship types with any associated attributes which are needed. These relationship types should include **studies** between **Student** and **Module**. Each relationship type should have an approriate name and direction. **[4 marks]**

   (iii) Participation constraints on all the relationship types except for the **studies** relationship type. **[4 marks]**

(b) Suppose that the **studies** relationship type had participation constraints $5..8$ at the **Module** end of the arrow and $10..100$ at the **Student** end. What would this mean in terms of the rules that the university had about students studying modules? **[4 marks]**

(c) Give a database schema for the information system, including the primary keys in all the tables. You only need specify the attributes; types of attributes are not needed. You are not required to produce tables which are normalised. **[4 marks]**

[question 1 total: 20 marks]

Question 2

An automated factory manufactures items for the intergalactic starship maintenance business. The tables can contain data as in the example below.

Composition

product	quantity	part
compressitor	14	nut
connector hub	4	wheel
connector hub	24	nut
compressitor	28	bolt
spread flange	4	axle

Stores

part	stock
wheel	1024
nut	2048
bolt	2199
screw	4298
axle	534

Weight

part	weight
axle	120
wheel	230
screw	54
bolt	75
nut	47

The Composition table records how many of each type of part are used to make one of the products that the factory produces. The tuples in the example show that a compressitor has at least 42 components of which 28 are bolts and 14 are nuts. The Stores table is used to record how many of each of the parts is currently in stock, and the Weight table records the weight of each type of part.

(a) What SQL statement would you use to create the Composition table, including specifying the primary key? **[2 marks]**

(b) What SQL statement would you use to find out how many different products the factory produces? **[2 marks]**

(c) What SQL statement would you use to find how many component nuts are used to make each 'spread flange'? **[3 marks]**

(d) Write an SQL statement, using the **inner join** construct, that will calculate the weight of a 'connector hub'? You should assume that the weight is calculated by adding up the weights of all the individual components it contains. **[4 marks]**

(e) Write a request for information in simple English about the factory's products to which the SQL query on the right provides the answer.

```
SELECT product, SUM(quantity) AS total
FROM composition
GROUP BY product
HAVING total < 50;
```

[4 marks]

(f) Suppose all the axles and nuts in the store were used to make 'compressitors' and that there is no shortage of any of the other types of part needed for this product. Write an SQL statement, using the **natural join** construct, that will calculate the number of 'compressitors' that would be produced. **[5 marks]**

[question 2 total: 20 marks]

Question 3

The following table holds data on the sweets produces by a sweet manufacturer.

Formulation

Shape	Colour	Price	Size
star	red	100	50
ball	blue	200	90
cube	red	100	100
pyramid	green	150	75
star	blue	250	50
ball	green	300	90
cube	green	150	100
pyramid	red	400	75

The price of a sweet depends on both the colour and the shape of the sweet. However the size of each of the kinds of sweet they produce depends only on the shape of the sweet.

(a) Write down two functional dependencies using the standard notation. **[2 marks]**

(b) State a candidate key for this table, and show why it is a candidate key. **[3 marks]**

(c) Is this table in the Second Normal Form? Explain your answer. **[3 marks]**

(d) Write down a transitive dependency that exists in the table. **[2 marks]**

(e) Write down a functional dependency that demonstrates that the table is not in Boyce Codd Normal Form, saying why. **[3 marks]**

(f) How could the table be decomposed into two tables each of which is in Boyce-Codd Normal Form (BCNF)? Your answer should include a clear justification that the tables are in this normal form. **[7 marks]**

[question 3 total: 20 marks]

[grand total: 60 marks]