UNIVERSITY OF LONDON

BSc EXAMINATION 2019

For Internal Students of
Royal Holloway

DO NOT TURN OVER UNTIL TOLD TO BEGIN

CS2855: Databases
CS2855R: Databases

PAPER FOR FIRST SIT/RESIT CANDIDATES

Time Allowed: **2 hours**

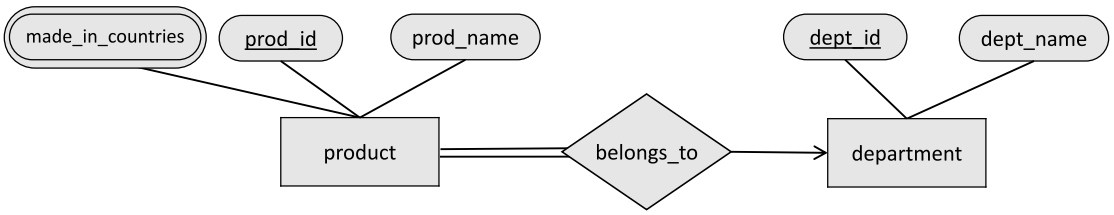
Answer ALL questions

Calculators are not permitted

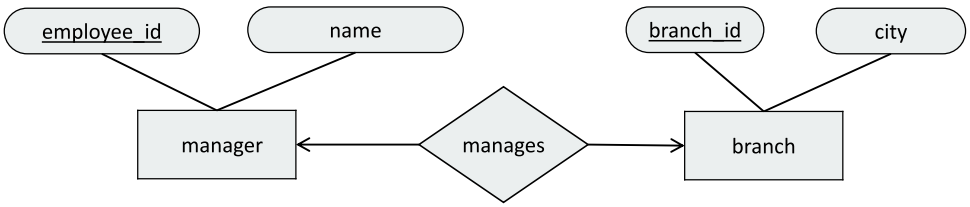
1. (a) Consider the following scenario: a chain store sets up a design for its database. In particular, the chain store records products. Every product is identified by a product ID. In addition, the made-in country and manufacturing date are recorded. Some (but not all) of the products can be classified as either clothes or electronics; where *all* clothes are either for Men, Women or Children, with their unique attributes. Draw an E-R diagram for this scenario (do not add information that is not present in the description).

[12 marks]

(b) Transform the E-R diagram below to table schemas (i.e., a sequence of attributes, specifying their primary keys and below their foreign keys if they exist), taking into account schema combinations (i.e., reducing the number of necessary tables): [10 marks]



(c) Transform the E-R diagram below to table schemas (i.e., a sequence of attributes, specifying their primary keys and below their foreign keys if they exist), taking into account schema combinations (i.e., reducing the number of necessary tables): [8 marks]



2. Consider the following relational schemas (i.e, tables):

product = (productID, productName, madeInCountry, manufactureDate, price)

productInDepartment = (productID, departmentID)

Foreign Key: productID referencing productID in product table
Foreign Key: departmentID referencing departmentID in department table.

branch = (branchID, branchName, city)

department = (departmentID, branchID, departmentName)

Foreign Key: branchID referencing branchID in branch table.

(a) Write the **SQL** definition of the relation **product** (including integrity constraints); in other words, *create the table* in **SQL**. Use appropriate types for attributes (assume that product IDs are integers, product names are alphanumeric, and price is in pounds allowing for two digits to the right of the decimal point designating pence). [8 marks]

(b) Express the following query in **SQL**: "*Return the record of the product with the maximal price*." [8 marks]

(c) Consider the following instances of the tables:

product:

productID	productName	madeInCountry	manufacturedDate	price
101	funnyHat	China	2018-05-01	40.50
199	strangeMac	UK	2018-04-03	99.20
203	crayons	Bulgaria	2017-01-21	32
201	flashyShoes	China	2018-10-20	81

productDepartment:

productID	departmentID
101	71
199	71
199	77
201	79

department:

departmentID	branchID	departmentName
71	20	Men
73	22	Stationary
77	25	Men
79	20	Women

branch:

branchID	branchName	city
20	Kensington	London
22	ChurchRoad	Leeds
24	Regent	Birmingham
25	Daleware	Liverpool

i. Explain briefly what is wrong with the following SQL query and suggest a *quick* fix for it.

```
SELECT MAX(p.price), departmentName
FROM product AS p, productDepartment AS pd, department AS d
WHERE p.productID = pd.productID AND pd.departmentID = d.departmentID;
```

ii. What will be the answer retrieved when running your fixed SQL query on the tables above?

[10 marks]

(d) Consider the following SQL query:

```
SELECT city
FROM product, department AS d, branch, productDepartment
WHERE  (product.productID = productDepartment.productID
AND productDepartment.departmentID = d.departmentID
AND  d.branchID = branch.branchID
AND  product.madeInCountry = 'UK');
```

i. What will be the answer retrieved when running this SQL query on the tables in the previous section (that is, section (c))? Explain briefly your answer by describing in plain English what the query above asks for.

ii. Express the above query in **relational algebra** (i.e., write a relational algebra expression that expresses the same query).

[12 marks]

(e) Consider the following table $menDepartments$:

departmentID
71
77

What will be the result of the following **relational algebra** expression on the tables in (c) above? Express briefly in plain English what this relational algebra query asks for.

$$\text{productDepartment} \div \text{menDepartments}$$

[6 marks]

3. (a) Given below is the set F of functional dependencies for the relation schema: $R = (A, B, C, D, E)$.

$$F = \{A \rightarrow B,\ B \rightarrow C,\ \ C \rightarrow D\}\,.$$

i. Find a candidate key for R with respect to F.

ii. Decompose the relation into a collection of relations that are in **BCNF** (i.e., Boyce-Codd Normal Form). Explain very briefly why your solution is in BCNF (i.e., why it conforms to the conditions of BCNF).

[12 marks]

(b) Determine whether the following relation schema R is in 3NF with respect to the following set F of functional dependencies, and explain briefly your answer:

$$R = (A, B, C, D)$$

$$F = \{A \rightarrow B,\ BC \rightarrow AD\}\,.$$

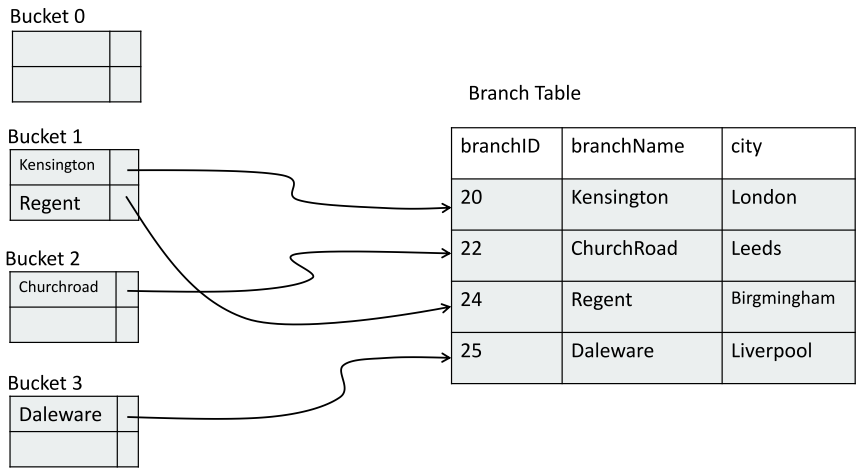
[8 marks]

4. A **hash index**, together with the hash function, is shown in the following figure:

Hash Function

branchName	*h(branchName)*
Kensington	Bucket 1
Churchroad	Bucket 2
Regent	Bucket 1
Daleware	Bucket 3
Northcote	Bucket 1

Hash Index



Suppose that we **insert** into the branch table the following information:

(28, Northcote, London) .

What will be the outcome of this insert operation on the hash index (illustrate briefly your solution). [6 marks]

END