CS-250/CS-219
DATABASE SYSTEMS
Example exam questions set by RDS.

Please note:
These questions come from a variety of examination papers so you can ignore the (a), (b), (c) labels. Some similar questions can have different marks assigned to them; use the marks as an indicator of the depth needed for answers.

Transactions, Concurrency Control, Backup/Recovery

(a) Explain what is meant by a transaction. Why are transactions important units of operation in a DBMS? Describe what the four basic, or so-called ACID, properties of a transaction are. **[6 marks]**

(a) Explain what is meant by a transaction. Why are transactions important units of operation in a DBMS? Describe how commit and rollback actions operate. Describe what the four basic or so-called ACID properties of a transaction are.

[6 marks]

(b) Discuss the methods available in modern database systems to maintain concurrency control. Include in your answer an explanation of why concurrency control is required, and a definition of the terms "serializability" and "two-phase locking protocol".

[10 marks]

(a) Discuss the types of failure that may occur in a database environment. Explain why it is important for a multi-user DBMS to provide a recovery mechanism and describe the facilities typically available in a modern relational database management system to enable recovery of the database after the detection of an error condition. Include in your answer an explanation of the terms transaction log, checkpoint and before/after image.

[10 marks]

(a) Describe the facilities typically available in modern relational database management systems to enable recovery of the database after the detection of an error condition. Include in your answer an explanation of the terms transaction log, checkpoint and before/after image.

[12 marks]

(c) Explain the meaning of transaction log, checkpoint and before/after image and how these features enable the recovery of a DBMS from an error condition.

[7 marks]

Database Design

(a) Database design has three main phases: conceptual, logical and physical design. Describe these three phases, explaining clearly the differences between them.

[6 marks]

(b) What update anomalies can occur with a badly designed or structured relation, and illustrate each using a suitable example.

[3 marks]

(b) What update anomalies can occur when too many attributes are included in a relation, and illustrate each with respect to the following relation:

student (studentnumber, name, dept, dept_telephone)

[3 marks]

Convert the relation 'student' above into relations in BCNF.

[2 marks]

(c) Define the term "functional dependency".
Convert the 'personnel' data below into relations in third normal form (3NF):
personnel (employee#, dept#, manager#, training (course#, course_title, date))
State any assumptions that you make about the data.

[6 marks]

(d) Convert the 'student' data below into relations in third normal form:
students (student#, tutor, tutor_email, modules (course#, course_title, credits))
State any assumptions that you make about the data.

[4 marks]

(c) What is the difference between logical database design and physical database design?

[3 marks]

(d) Convert the 'personnel' data below into relations in third normal form:
personnel (employee#, dept#, manager#, training (course#, course_title, date))
State any assumptions that you make about the data.

[4 marks]

(e) When constructing an Entity-Relationship (E-R) diagram, the participation of entities in a relationship can be described as total or partial. Briefly explain what this means and give an example of each. **[4 marks]**
Attributes may be single-valued, multi-valued, or derived. Explain each of these 3 terms and give an example of each. **[6 marks]**
The cardinality of a relationship can be of 3 types. Give an example to illustrate each of them. **[4 marks]**

SQL

(b) Using the SPJ database with which you are familiar from lectures, i.e.

S (Sno, Sname, Status, City)
P (Pno, Pname, Colour, Weight)
J (Jno, Jname, City)
SPJ (Sno, Pno, Jno, Qty)

formulate SQL queries which satisfy the following queries:

(i) Get the names of all the suppliers.
(ii) Get the name and city of suppliers that supply part P1.
(iii) Get the supplier numbers of suppliers who supply part P1 but do not supply part P2.
(iv) Get the supplier number for suppliers that supply more than one part.
(iv) Get the part number for parts which are supplied by more than one supplier.
(v) For each supplier get the supplier number and the total number of parts they supply (even if it is zero).

[10 marks]

(c) Using the SPJ database with which you are familiar from lectures, i.e.

S (Sno, Sname, Status, City)
P (Pno, Pname, Colour, Weight)
J (Jno, Jname, City)
SPJ (Sno, Pno, Jno, Qty)

formulate SQL queries which satisfy the following queries:

(i) Get the name and status of suppliers in London.
(ii) Get the name and colour of parts supplied by supplier S1.
(iii) Get the supplier numbers of suppliers who supply part P1 and part P2.
(iv) Get the supplier number for suppliers that supply more than one part.
(v) For each supplier get the supplier number and the total number of parts they supply.

[12 marks]

Relational Algebra

(d) For queries (ii) and (iii) in (c) above, give the solutions in the form of relational algebra queries.

[4 marks]

(c) What is Relational Algebra? Explain 4 of the 8 main Relational Algebra operations and give an example of each using the SPJ database or similar. Give the equivalent SQL statement for each of these 4 examples.

[10 marks]

(d) Using the SPJ database with which you are familiar from lectures, i.e.

S (Sno, Sname, Status, City)
P (Pno, Pname, Colour, Weight)
J (Jno, Jname, City)
SPJ (Sno, Pno, Jno, Qty)

formulate the following queries in Relational Algebra:

(i) Get the names and weights of all blue parts.
(ii) Get the supplier number of suppliers who supply blue parts.
(iii) Get the supplier number of suppliers who supply part P3 but do not supply part P5.
(iv) Get the supplier number for suppliers who supply more than one different part.

[7 marks]

Views

(b) **(i)** What is a view and how does it differ from a base relation? What purposes do views serve?

[3 marks]

(ii) Give an example in SQL of how to create and how to remove a view.

[2 marks]

(iv) It what circumstances can or cannot a view be updated?

[3 marks]

(v) Many Relational DBMS manufacturers have introduced materialized views or snapshots into their products. Explain what a materialized view is and what purpose they serve.

[3 marks]

Other

(Database Security)

(c) Explain the following in terms of providing security for a database:

(i) authorisation;
(ii) access controls;
(iii) schemas;
(iv) views;
(v) integrity constraints.

[10 marks]

(Nulls)

(c) Outline the problems of allowing null values in relations and explain how null values are interpreted in SQL in arithmetic and logical expressions, aggregate functions, and inner and outer joins.

[6 marks]

(Data Dictionary)

(c)(i) One component of a Database Management System (DBMS) is the data dictionary (also known as the data catalog or system catalog). What is the function of this component and what information does it contain in a typical relational DBMS?

[6 marks]

(ii) What is the Information Schema which is defined in the SQL Standard? Why is it included in the standard?

[4 marks]

Relational Model

(a) Explain the following terms for the Relational Model: *relation*, *tuple*, *attribute*, *domain*, *cardinality*, *degree*, *primary key*, *foreign key*, *entity integrity*, *referential integrity*.

[10 marks]

(a) Two of Codd's rules or functions required for a relational database are *logical data independence* and *physical data independence*. Explain the meaning of these two terms and give a specific example of each to illustrate your answer.

[4 marks]

(a) In the context of the Relational Model explain the meaning of the following terms: *primary key*, *foreign key*, *entity integrity*, *referential integrity*.

[4 marks]

(b) The SQL:2003 standard specifies five different referential actions that can be defined with a foreign key constraint following update or deletion of the referenced primary key, i.e. `CASCADE`, `RESTRICT`, `NO ACTION`, `SET NULL` or `SET DEFAULT`. For example:

```
CONSTRAINT attr5_fk FOREIGN KEY(attr5)
      REFERENCES other_table(pk_attr) ON DELETE CASCADE
```

Explain the effect of each of these actions.

[5 marks]