

1. What is a foreign key constraint? Why are such constraints important? What is referential integrity?
  - a. A foreign key constraint determines a set of fields in one relation that is used to 'refer' to a tuple in another relation. Such constraints are important because a database needs to be able to restrict the entry of incorrect information, and in the case of foreign key constraints it will help keep track of modified data and provide data consistency. Referential integrity is simply when all foreign key constraints are enforced.
2. Explain the difference between external, internal, and conceptual schemas. How are these different schema layers related to the concepts of logical and physical data independence?
  - a. External schema - allows data access to be customized (and authorized) at the level of individual users or group of users.
  - b. Internal schema, or physical schema - specifies additional storage details. It summarizes how the relations described in the conceptual schema are stored on secondary devices.
  - c. Conceptual schema - describes the stored data in terms of the data model of DBMS.
  - d. Relations in the external schema generated on demand from the relations corresponding to the conceptual schema and when the conceptual schema is changed, the external schema can also be modified to shield the users from changes in the logical structure of the data, also known as logical data independence.
  - e. In return, the conceptual schema insulates users from changes in the physical storage of the data, which is called physical data independence.
3.
  - a.

```
SELECT P.pname
FROM Parts P, Catalog C
WHERE P.pid = C.pid
```
  - b.

```
SELECT S.sname
FROM Suppliers S, Parts P, Catalog C
WHERE S.sid = C.sid AND C.pid = P.pid
AND C.cost = (SELECT MAX (C2.cost)
              FROM Catalog C2)
```
  - c.

```
SELECT S.sid
FROM Suppliers S
WHERE S.sid NOT IN (SELECT C.sid
```

```

FROM Catalog C
WHERE C.pid NOT IN (SELECT P.pid
                    FROM Parts P
                    WHERE P.color = 'red')

```

d.

```

SELECT S.sname
FROM Suppliers S
WHERE NOT EXISTS (( SELECT P.pid
                    FROM Parts p
                    EXCEPT
                    (SELECT C.pid
                     FROM Catalog c
                     WHERE C.sid = S.sid ))

```

4.

- a.  $\pi_{\text{person-name}}(\sigma_{\text{company-name} = \text{'Auburn Bank'}}(\text{Works}))$
- b.  $\pi_{\text{person-name, city}}(\sigma_{\text{company-name} = \text{'Auburn Bank'}}(\text{Works}) \bowtie \text{Employee})$
- c.  $\pi_{\text{person-name, street, city}}(\sigma_{\text{company-name} = \text{'Auburn Bank'} \wedge \text{salary} > 50,000}(\text{Works}) \bowtie \text{Employee})$
- d.  $\pi_{\text{person-name}}((\text{Employee} \bowtie \text{Works}) \bowtie \text{Company})$