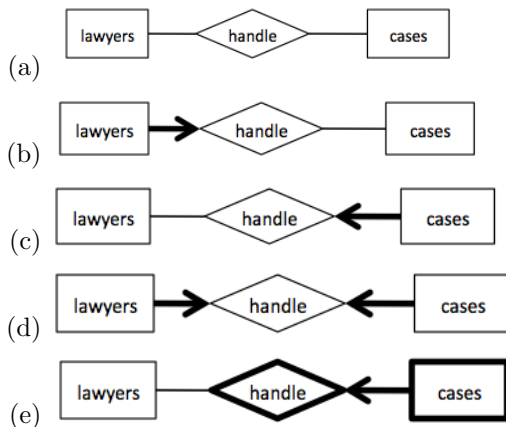


CISC437/637 Database Systems Midterm Exam

You have from 2:00 to 3:15pm to complete the following questions. Use the back of the page if you need more space. Good luck!

Multiple Choice (2 point each; 40 total)

1. In a relational database management system, a rule that ensures that every record in a table is unique is called a ...
 - (a) candidate key constraint
 - (b) referential integrity constraint
 - (c) key constraint
 - (d) participation constraint
2. Which of the following is allowed for relations?
 - (a) There can be a field with a non-atomic value.
 - (b) The columns can be in any order.
 - (c) Some of the values of a field can come from a domain that is not the same as the field's domain.
 - (d) Two rows may be identical.
3. Which of the following is used in an E-R diagram to represent many-to-many total participation?
 - (a) An unweighted arrow from an entity set to an entity set.
 - (b) A thick line from an entity set to a relationship set.
 - (c) An unweighted arrow from an entity set to a relationship set.
 - (d) A thick arrow from an entity set to a relationship set.
 - (e) An unweighted line from an entity set to an entity set.
4. "Each case is handled by exactly one lawyer." Which ER diagram best captures this requirement?



5. A referential integrity constraint policy that ensures that records with a foreign key are updated when the primary key of the referring record in the reference relation is updated is called a
 - (a) incremental delete
 - (b) incremental update

- (c) cascading delete
 - (d) cascading update
6. A “candidate key” is:
- (a) any set of fields that determines the values of all other fields
 - (b) functionally dependent on non-key attributes
 - (c) an attribute or set of attributes that can be the primary key
 - (d) the primary key of a relation
7. Which pair of SQL keywords is used to create and delete a table?
- (a) CREATE, DROP
 - (b) CREATE, DELETE
 - (c) CREATE, ALTER
 - (d) INSERT, DROP
 - (e) INSERT, DELETE
 - (f) INSERT, ALTER
8. Which built-in SQL function computes the number of rows in a table?
- (a) AVG
 - (b) MAX
 - (c) COUNT
 - (d) SUM
 - (e) MIN
9. Which pair of SQL keywords is used to create and delete records in a table?
- (a) CREATE, DROP
 - (b) CREATE, DELETE
 - (c) CREATE, ALTER
 - (d) INSERT, DROP
 - (e) INSERT, DELETE
 - (f) INSERT, ALTER
10. A lossless join decomposition of a relation means
- (a) none of the attributes are lost
 - (b) no functional dependencies are lost
 - (c) the natural join of the relations in the decomposition produces the original relation
 - (d) the relation is the cross-product of the decomposition
 - (e) no information of any kind is lost

The next five questions are based on the following tables:

<u>ssn</u>	name	firmName	firmLoc
111-11-1111	Bob Loblaw	Dewey, Cheatham, and Howe	Boston
222-22-2222	Ally McBeal	Payne and Feares	Los Angeles
222-22-3333	Maury Levy	Baker and Launder	Baltimore
333-44-5555	Saul Goodman	Recht and Greef	Albuquerque
555-55-6666	Atticus Finch	Baker and Launder	Baltimore

(a) Lawyers(ssn:string, name:string, firmName:string, firmLoc:string)

<u>firmName</u>	<u>firmLoc</u>	employees
Dewey, Cheatham, and Howe	Boston	72
Dewey, Cheatham, and Howe	San Francisco	95
Payne and Feares	Los Angeles	55
Recht and Greef	Albuquerque	120
Pope and Gentile	Milwaukee	100
Boring and Leach	Los Angeles	66

(b) Firms(firmName:string, firmLoc:string, employees:integer)

11. A natural join between Lawyers and Firms returns concatenated records with which condition?
 - (a) Lawyers.firmName = Firms.firmName
 - (b) Lawyers.firmLoc = Firms.firmLoc
 - (c) Lawyers.firmName = Firms.firmName AND Lawyers.firmLoc = Firms.firmLoc
 - (d) Lawyers.firmName = Firms.firmName OR Lawyers.firmLoc = Firms.firmLoc
12. A left outer natural join between Lawyers and Firms will return how many records?
 - (a) 3
 - (b) 4
 - (c) 5
 - (d) 6
13. Joining Lawyers to itself on firmLoc will return how many records?
 - (a) 5
 - (b) 6
 - (c) 7
 - (d) 8
 - (e) 25
14. Which of the following would find the number of employees that work at law firms employing lawyers with names starting with 'B'?
 - (a) SELECT F.employees FROM Lawyers L, Firms F
WHERE L.firmName=F.firmName AND L.firmLoc=F.firmLoc AND L.name='B*';
 - (b) SELECT F.employees FROM Lawyers L, Firms F
WHERE L.firmName=F.firmName AND L.name='B*';
 - (c) SELECT F.employees FROM Lawyers L, Firms F
WHERE L.firmName=F.firmName AND L.firmLoc=F.firmLoc AND L.name LIKE 'B%';

- (d) `SELECT F.employees FROM Lawyers L, Firms F
WHERE L.firmName=F.firmName AND L.name LIKE 'B%';`
15. Which of the following is not a valid SQL command?
- (a) `SELECT * FROM Lawyers WHERE firmName LIKE '% and %';`
 - (b) `SELECT firmLoc, COUNT(*) FROM Firms WHERE employees < 100;`
 - (c) `SELECT COUNT(*) FROM Firms WHERE employees < 100;`
 - (d) `SELECT firmLoc, COUNT(*) FROM Firms WHERE employees < 100 GROUP BY firmLoc;`
16. Which of the following is not true?
- (a) Every relation that's in BCNF is also in 3NF.
 - (b) Every relation that's in 3NF is also in 1NF.
 - (c) Relations in 1NF only have atomic values in record fields.
 - (d) Decomposition of a 3NF relation into BCNF preserves functional dependencies.
 - (e) Decomposition of a 3NF relation into BCNF preserves lossless join.
17. What is the first step a high-level database application must perform?
- (a) connect to the database
 - (b) execute queries
 - (c) load the database driver
 - (d) prepare query statements
 - (e) print results
18. A ___ is a stored procedure that is executed automatically in connection with data updates.
- (a) event handler
 - (b) trigger
 - (c) constructor
 - (d) function
19. F is a set of functional dependencies on relation $ABCDE$ with $F = \{A \rightarrow ABCD, B \rightarrow C, B \rightarrow D\}$. Which of the following is in the closure of F ?
- (a) $CD \rightarrow B$
 - (b) $C \rightarrow D$
 - (c) $B \rightarrow CD$
 - (d) $BCD \rightarrow A$
 - (e) none of the above
 - (f) more than one of the above
20. Suppose R is a relation with attributes $ABCDE$, and F is a set of functional dependencies $\{A \rightarrow ABCDE, B \rightarrow C\}$. Which of the following is true?
- (a) $ACDE, BC$ are both in BCNF and preserve lossless-join.
 - (b) $ABDE, BC$ are both in BCNF and preserve lossless-join.
 - (c) ADE, BC are both in BCNF and preserve lossless-join.
 - (d) All of the above.
 - (e) The original relation is already in BCNF and does not need to be decomposed.

Short Answer (30 points) Answer the following questions.

1. (6 points) Three relational schema are given below. Express each of the provided information needs as a relational algebra query using only projection (π), selection (σ), renaming (ρ), inner joins (\bowtie), set union/intersection (\cup , \cap), and division ($/$).

Patient(ssn:string, name:string, address:string, age:integer)

Doctor(ssn:string, name:string, specialty:string, experience:integer)

PrimaryPhysician(patientSSN:string, doctorSSN:string, firstAppointment:date)

- (a) Find the ssns of doctors who see patients that are at least 25 years old.
 - (b) Find the ssns of patients that see a doctor that has more than 20 years of experience or less than 2 years of experience.
2. (6 points; extra credit) You are building a database system for a bank. The bank tells you that it needs to keep track of employees and customers. Every employee and every customer has a (unique) social security number, a name, and an address. Customers also have an account ID, which employees do not have (unless the employee is also a customer). Employees have a hire date, which customers do not have (unless the customer is also an employee). Furthermore, different information is stored about each employee type: tellers work a certain number of hours per week at a certain wage, loan officers work for a salary and have a fixed office location, and managers work for a salary but have no fixed office location.

Draw a simple E-R diagram to capture these requirements. If your E-R model contains any redundancy, describe it.

3. (6 points) The relation below has redundancy because of the FD $A \rightarrow O$.

account	client	office
A	Joe	1
B	Mary	1
A	John	1
C	Joe	2

Table 1: Accounts(client:string, office:integer, account:char) with functional dependencies $F = \{CO \rightarrow COA, A \rightarrow O\}$.

- (a) Give two ways that redundancy can cause problems in the database. Provide examples of those problems arising when manipulating the table above.

- (b) How could you eliminate redundancy in this relation?

4. (6 points) I have implemented the schema described in number 1 above as two SQL relations:

```
CREATE TABLE Doctor (ssn CHAR(11), name CHAR(30), speciality CHAR(30), experience INTEGER, PRIMARY KEY ssn)
CREATE TABLE Patient_Physician (ssn CHAR(11), name CHAR(30), address CHAR(100), age INTEGER, doctorSSN CHAR(11), firstAppointment DATE, PRIMARY KEY ssn, FOREIGN KEY (doctorSSN) REFERENCES Doctor(ssn) ON UPDATE CASCADE ON DELETE SET NULL)
```

Indicate whether each of the following statements is true or false (assuming referential integrity is enforced by the DBMS):

- (a) Every patient must have a primary physician.
- (b) A patient may have two or more primary physicians.
- (c) A doctor may be primary physician to two or more patients.
- (d) Changing a doctor's ssn may directly result in patient records being updated.
- (e) Deleting a doctor may directly result in patient records being deleted.
- (f) A patient may have a NULL value for doctorSSN.

5. (6 points) What does the following Java-like pseudo-code program do? A brief explanation will suffice.

```
loadDriver('jdbc.mysql.Driver');
Connection con = DriverManager.getConnection('jdbc:mysql://localhost/mydb');
PreparedStatement stmt = con.prepareStatement("select * from Doctor where specialty = ?");
stmt.setString(1, "heart");
ResultSet rs = stmt.executeQuery();
while (rs.next()) {
    System.out.println(rs.getString("name"));
}
```

Building a Database (30 points) You have been asked to build a database to handle information about law firms. Each law firm is identified by a name that is unique within a city, and also have a count of how many non-lawyer employees each firm employs. Lawyers are identified by their social security number, and also have a name, address, and salary. A lawyer may be employed by at most one firm. Each lawyer handles a load of cases identified by a case number. Cases may be handled by more than one lawyer, even if the lawyers work for different firms.

1. Draw an E-R diagram for the requirements above.
2. Translate your E-R diagram into SQL schema.
3. Write SQL queries for the following:
 - (a) Find the names of firms employing the lawyers that work on case number 1001.
 - (b) Find the average salary of lawyers employed by each unique firm.
 - (c) For extra credit, find the ratio of the number of lawyers to the number of non-lawyer employees for each unique firm (only using attributes described in the requirements).