ISYS2120 Final Exam - Harder Practice Exam

This practice exam is designed to be more challenging than the provided one. It covers the same topics but requires deeper understanding and more complex problem-solving skills.

Exam Duration: 2 hours **Total Points:** 100

Relational Database Schema:

```
CREATE TABLE Part (
  PId INTEGER PRIMARY KEY,
  PDesc VARCHAR(30),
  PPrice INTEGER NOT NULL
);

CREATE TABLE Customer (
  CId INTEGER PRIMARY KEY,
  CName VARCHAR(20),
  CAddr VARCHAR(40),
  CLoyaltyDiscount INTEGER
);

CREATE TABLE Shipment (
  SId INTEGER PRIMARY KEY,
  SDate DATE,
  CId INTEGER NOT NULL,
  FOREIGN KEY (CId) REFERENCES Customer(CId)
);

CREATE TABLE Contains (
  PId INTEGER,
  SId INTEGER,
  SPQty INTEGER NOT NULL,
  PRIMARY KEY (PId, SId),
  FOREIGN KEY (PId) REFERENCES Part(PId),
  FOREIGN KEY (SId) REFERENCES Shipment(SId)
);
```

Data Interpretation:

- **Part:** (PId, PDesc, PPrice) - Represents a part with its ID, description, and price in cents.
- **Customer:** (CId, CName, CAddr, CLoyaltyDiscount) - Represents a customer with their ID, name, address, and loyalty discount percentage.
- **Shipment:** (SId, SDate, CId) - Represents a shipment with its ID, date, and the customer ID.
- **Contains:** (PId, SId, SPQty) - Represents the number of parts (SPQty) contained in a specific shipment.

Section A: SQL Queries (30 points in total)

Q1. [6 points] Write a SQL query to find the CId of customers who have placed more than one shipment containing at least one part with a price greater than $10.

Q2. [6 points] Write a SQL query to retrieve the names and addresses of customers who have placed shipments containing at least one part with a description starting with "Small".

Q3. [8 points] Write a SQL query to calculate the total cost (in cents) of each shipment, taking into account the loyalty discount. The output should include the SId and the total cost of each shipment.

Q4. [5 points] Write a SQL query to find the average price of parts contained in shipments shipped before '2022-01-20'.

Q5. [5 points] Write a SQL query to identify the PId and PDesc of parts that are present in at least 50% of the shipments made by customers with a loyalty discount greater than 10%.

Section B: Relational Concepts (25 points in total)

Q6. [6 points] Explain the purpose of using primary keys in relational databases. Describe the benefits of using a composite key (like the one in `Contains`) compared to a single-attribute primary key.

Q7. [8 points] Write a relational algebra expression to find the SId of shipments containing at least one part with a price greater than $10 and shipped by customers with a loyalty discount of at least 20%.

Q8. [6 points] Explain the concept of an index in a relational database. Describe how an index could be used to improve the efficiency of the following SQL query:

```
SELECT * FROM Shipment WHERE SDate BETWEEN '2022-01-01' AND '2022-03-31
```

Q9. [5 points] Based on the provided relational schema, create an ER diagram for a conceptual model of the inventory system. Use clear and descriptive symbols and labels.

Section C: Conceptual Model (10 points in total)

Q10. [10 points] Consider a library management system. It manages books, members, and loans. Each book has a unique ISBN, title, author, and publication year. Members have a unique ID, name, and address. Loans involve a book, a member, the loan date, and the due date.

- Design an ER diagram for this system. Include appropriate entities, attributes, and relationships.
- Based on your ER diagram, write CREATE TABLE statements for a relational database design.

Section D: Relational Design Theory (25 points in total)

Q11. [5 points] Based on the DrugUsage schema and functional dependencies, explain why the following functional dependency is not valid:

- `DiseaseName ® DrugName`

Q12. [8 points] Calculate the attribute closure `(HospitalName, DiseaseName, SizeofDose)+`. Show the steps of the calculation.

Q13. [6 points] Demonstrate that the DrugUsage relation is not in 3NF. Use the definition of 3NF to justify your answer.

Q14. [6 points] Provide a lossless-join decomposition of the DrugUsage relation into three relations. For each relation, identify the primary key, functional dependencies, and whether it is in BCNF. Explain why your decomposition has the lossless-join property.

Section E: Database-backed Applications (15 points in total)

Q15. [5 points] Discuss the concept of SQL injection attacks. How can you mitigate the risk of SQL injection attacks in a web application that interacts with a database?

Q16. [5 points] Describe the importance of hashing in securing user passwords in a database-backed application. How can a hash function help protect user data?

Q17. [5 points] In a web application that uses a database, describe the process of retrieving data from the database, processing it, and displaying it to the user. Highlight the key components involved in this process.

Good luck with your exam preparation!