A. Fundamental Concepts

1. Enumerate at least 4 advantages of a DBMS.
2. What is a data model?
3. What is the physical or internal schema?
4. What is the logical or conceptual schema?
5. What is an external schema?
6. Define logical data independence.
7. Define physical data independence.
8. What is a DB transaction?
9. What is a key constraint in terms of the ER model?
10. What is a participation constraint in the ER model?
11. What is a weak entity set?
12. What is class hierarchy in the ER model?
13. Define aggregation in terms of the ER model.
14. What is a superkey?
15. What is a (candidate) key?
16. What is a primary key?
17. What is a partial key?
18. What is the difference between overlap and covering constraints?
19. What are integrity constraints?
20. What are domain constraints?
21. What is a key constraint in terms of the Relational model?
22. What are foreign key constraints?
B. Entity-Relationship Diagram

You have been hired to design the DB for an automotive dealer. The dealer sells vehicles for a given price, and cars are uniquely identified by a vehicle ID number or vin. Vehicles are of two distinct types: electric and gas. An electric car requires to store its battery life, while a gas vehicle needs to record its cylinder capacity.

Each individual vehicle is of a particular model which belongs to a brand or manufacturing company which we can recognize by a unique name (e.g., the Cambri is a model name of the car brand Toyota). We assume that a model name is unique among the models produced by its company. When a brand company is removed from the system, we need not keep information about its models in the DB. Additionally, a car company produces the same model in different years, but the dealer is interested on selling only the latest version. Further, a model comes with one or more options. We can distinguish options by looking at their unique name.

1. Provide the ER diagram for the problem described above and make sure to indicate any participation and/or key constraints.
2. Translate your ER diagram to SQL create statements. Indicate if there are any constraints that you can’t capture in your create statements.

C. Relational Algebra

Consider the (simplified) relation schemas:

\[
R(a, b) \quad S(a, b) \quad T(b)
\]

Express the following relational algebra operations using only the elementary operators: \(\pi, \sigma, \times, \cup\) and \(-\).

1. \(R \cap S\)
2. \(S/T\)

D. Relational Algebra + Domain Relational Calculus

Consider these schemas, where the Flights relation contains only non-stop flight information between two points, and an Aircraft’s cruisingrange is equivalent to the distance that an airplane can travel without recharging fuel.

Flights( flno: int, from: string, to: string, distance: int, departs: time, arrives: time )
Aircraft( aid: int, aname: string, cruisingrange: int )
Certified( eid: int, aid: int )
Employees( eid: int, ename: string, salary: int )

Express the following queries in relational algebra and domain relational calculus.

1. Find the eids of pilots certified for some ‘Boeing’ aircraft.
2. Find the names of pilots certified for some ‘Boeing’ aircraft.
3. Find the aids of all aircrafts that can be used on non-stop flights from ‘LAX’ to ‘GDL’.
4. Identify the flnos of the non-stop flights that can be piloted by every pilot whose salary is more than $100,000.
5. Find the eids of employees who are certified to fly exactly 2 aircrafts.
6. Find the names of pilots who can operate planes with a range greater than 3000Km but are not certified on any ‘Boeing’ aircraft.