

## Winter 21-22: CSC 430 (001)/530 Database Management Systems/ Database Theory

### Mid Term Prep – Study Guide and Sample Questions

#### Topics:

- ☐ What is a Database?
- ☐ What is Data Model and Operations allowed? Formal Definitions
- ☐ Categories of Data Models
- ☐ What is Aggregation and Generalization?
- ☐ Features of a DBMS
- ☐ Different Logical Data Models (Differences)
- ☐ Schemas Vs Instances
- ☐ ACID Properties
- ☐ Three Schema Architecture
  - Mappings
  - DBMS Interfaces
- ☐ DBMS Architecture
  - Centralized
  - Two Tier - Client Server Architecture
  - Three Tier – Client Server Architecture
  - Distributed Database Management Systems
    - Homogeneous DDBMS
    - Heterogeneous DDBMS
    - Federated DDBMS
- ☐ DBMS Component Modules
  - Database Users
  - Query Processing and the steps of Query Processing
  - Stored Data Manager
  - Transaction Management and Concurrency Control
- ☐ Database Design Approaches
  - ER
  - Difference between Functional Analysis and Conceptual Design
- ☐ Constraints
  - Domain of an attribute
  - Simple and Composite attributes
  - Keys: Superkeys, candidate, primary, and Foreign keys
  - Degree and Cardinality of a relation
  - Mapping Constraints: 1-1, 1-N, and N-N
    - Ratio constraints and Existence Dependency constraints
    - Cardinality Ratio and Participation Constraints
  - Weak Entities
- ☐ Relational Algebra
  - Select, Project, Cartesian Product
  - Union, Intersection, Rename,
  - Natural Joins
- ☐ Extended ER
  - Ternary Relationships
  - Specialization
    - Overlapping
    - Disjoint
  - Generalization
    - Total
    - Partial
  - Aggregation
  - Converting Non-Binary relationships to Binary Form
- ☐ SQL
  - Create Queries
  - Simple Select Queries

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#### Instructions:

- The duration of the exam is 60 mins.
  - a. Maximum points (50 points)
  - b. Section A: 20 points (Answer all questions)
  - c. Section B: 30 points (Answer any two out of the three questions)
- Attempt all sections as per instructions provided.
- Using Grade Scope – Date of Examination (Friday Jan 15<sup>th</sup>, 2021).
  - a. Extensions will be provided to those who have health related concerns.
- Closed book, no plagiarism.

#### **SECTION A: Answer all questions**

1. Which of the following does not constitute a data model?
  - ☐ Conceptual data models
  - ☐ Physical data models
  - ☐ Implementation data models
  - ☐ None of the above
2. The Three Schema Architecture consists of:
  - ☐ a. Internal schema, External Schema, and Conceptual Schema
  - ☐ b. Physical data model, Conceptual Schema, User Views
  - ☐ c. None of the above
  - ☐ Both (a) and (b)
3. Below are definitions for the listed formal relational model terminologies:
  - i. **Data Model:** a set of concepts to describe structure of a database, the operations for manipulating these structures, and constraints that the database should obey.
  - ii. **Attributes:** the various properties of an entity stored in a relation.
  - iii. **Relation:** a set of tables in a database.
  - iv. The **Degree** of a relation refers to the number of participating attributes that define an entity.
  - ☐ i, ii, and iii are TRUE
  - ☐ ii and iv are TRUE
  - ☐ ii, iii, and iv are TRUE
  - ☐ i, ii, and iv are TRUE
  - ☐ ALL are TRUE
4. What is a weak entity?
5. Differentiate between
  - a. Database schema and Database state
  - b. Data requirements and Functional Requirements
  - c. Composite attribute and Multivalued attribute
  - d. Super key and primary key
6. (Indicate TRUE or FALSE) To achieve data independence in DBMS design, we define **Physical Data Independence** as the capacity to change the conceptual schema without having to change external applications.
  - ☐ TRUE
  - ☐ FALSE

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7. The concept of **foreign keys** in DBMS enables which of the following?

- ☐ A. The creation of more than one relation
- ☐ B. The establishment of referential integrity constraint between two entities
- ☐ C. The ability to create multivalued attributes
- ☐ A and B
- ☐ A and C
- ☐ None of the above

8. Assume a database schema consists of two relations R(A, B, C) and S(D, E). Consider the following queries in relational algebra:

(a)  $\pi_{A,C}(\sigma_{D=2}(R \bowtie_{A=E} S))$

(b)  $\pi_{A,C}(R \bowtie_{A=E} (\sigma_{D=2} S))$

Are algebraic expressions (a) and (b) equivalent? Use no more than two sentences to explain your answer.

9. List the types of constraints on relationship types in a database.

(4 points)

10. \_\_\_\_\_ describes how data is to be structured and stored in a database.

**SECTION B: Answer any 2 of the 3 questions**

**Note: Please submit scans of your answers while on Grade Scope.**

**Question 1:** An E/R diagram when converted to relations gives rise to the following relations:

R(A, B, C)

S(A, D)

T(D, F, G)

You may assume that the same alphabets refer to the same attribute (e.g., the attributes A in the relations R, and S). What E/R diagram could have produced these relations? Please make sure all constraints are used to derive this schema.

**Question 2:** Draw an E/R diagram to model project groups in CSC430. Keep in mind that each enrolled student (identified by a SID) can work at most one project. Each project is identified uniquely by its name. Be sure to identify all the appropriate multiplicity and referential integrity constraints in the diagram. Indicate key attributes in each entity set. (15 points)

**Question 3:** Consider the relational database whose schema is shown below:

EMPLOYEE (Emp-ID, E-name, gender, DOB, disability, health-status)

COMPANY (Company-name, tax-ID, company-status)

LIVES (Emp-ID, street, city)

WORKS (Emp-ID, Company-name, salary)

LOCATED\_IN (Company-name, city)

The primary key for each relation is denoted by the underlined attribute.

1. Write the DDL commands to create the above relations. (7 points)
2. Write the following queries in Relational Algebra: (8 points)
  - a. List the names of all female employees, who work for the 'Ruston Bank' (a unique company name in the database).
  - b. List all the companies who are in located-in the same city of the company 'Ruston Bank'.
  - c. List the name of all employees who work for the 'Ruston Bank'.
  - d. List the personal information of name, street, and city of all employees who work for the 'Ruston Bank' and earn more than \$10,500.