Preamble

- This exam has seven questions and 13 pages.
- The following table summarizes the questions and their weights:

Question	**Points**
1. Relational Algebra	10
2. SQL	20
3. ER Modeling	16
4. Design Theory	14
5. Physical Design	12
6. Query Processing and Optimization	14
7. Transactions, Concurrency Control, and Recovery	14

Good luck!

1.1 (4 points) Find all the deliverymen who are older than 30. For each such deliveryman, list his/her pid, name, and age.

$$\boxed{\text{Box 1}}_{pid,\ name,\ age}\left(\boxed{\text{Box 2}}_{age\ >\ 30}(deliveryman)\right)$$

1.2 (6 points) Find all the deliverymen that have not delivered orders of any Italian cuisine (the cuisine type is "Italian"). For each such deliveryman, list his/her pid.

$$\Pi_{pid}(deliveryman) - \boxed{\text{Box 3}}_{pid}(dorder \boxed{\text{Box 4}}_{dorder.cid\ =\ cuisine.cid}(\boxed{\text{Box 5}}_{type\ =\ \text{"Italian"}}(cuisine)))$$

Figure 1:

Relational Algebra Operators

Select (σ_p): Selects tuples from a relation that satisfy a given predicate p (e.g., $\sigma_{salary>80000}$).

Project (Π_{A_1,A_2}): Returns the relation with only the specified attributes listed $(A_1, A_2, ...)$. Duplicate rows are automatically removed.

Union ($\cup$): Combines two compatible relations (must have the same arity/number of attributes and compatible domains).

Set-Intersection ($\cap$): Finds tuples that are present in both input relations; relations must be compatible.

Set-Difference ($-$): Finds tuples that are in the first relation but not in the second; relations must be compatible.

Cartesian Product ($\times$): Associates every tuple of the first relation with every tuple of the second relation.

Rename (ρ_x): Provides a name (x) for the result of a relational-algebra expression so it can be referred to later.

Theta Join ($\bowtie_\theta$): A more efficient way to perform a selection on a Cartesian product ($r \bowtie_\theta s = \sigma_\theta(r \times s)$).

Natural Join ($\bowtie$): Performs a join based on common attributes between two relations; each common attribute appears only once in the result.

Assignment ($\leftarrow$): Used to assign parts of a complex expression to temporary relation variables for better readability.

Grouping/Aggregation ($\gamma_{L;F}$): Groups tuples by a list of attributes (L) and applies aggregate functions (F) like *count, sum, min, max,* or *avg* to each group.

1 Relational Algebra (10 points)

1.1 (4 points)

Answer:

Box 1: $\prod$ Box 2: σ

1.2 (6 points)

Answer:

Box 3: $\prod$ Box 4: $\bowtie$ Box 5: σ

2 SQL (20 points)

Insert Question 2 Image Here

2.1 True/False

2.1.1: true 2.1.2: False

2.2 Queries

2.2.1: a
2.2.2: c
2.2.3 (Fill-in):
Box 1: city = "Aarhus" Box 2: "Seafood"
Box 3: Box 4:
2.2.4:

3 ER Modeling (16 points)

Insert Question 3 Image Here

3.1 True/False

3.1.1: _____ 3.1.2: _____ 3.1.3: _____

3.2 & 3.3 Multiple Choice

3.2: _____ 3.3: _____

4 Design Theory (14 points)

Insert Question 4 Image Here

4.1 (T/F): _____ _____
4.2.1 (Superkeys): _____
4.2.2 (Normal Forms): _____
4.2.3 (Decomposition): _____

5 Physical Design (12 points)

Insert Question 5 Image Here

5.1 (T/F): _____ _____
5.2.1 (Delete): _____
5.2.2 (Insert): _____

6 Query Processing and Optimization (14 points)

Insert Question 6 Image Here

6.1: _____ 6.2: _____ 6.3: _____ 6.4: _____

7 Transactions, Concurrency, and Recovery (14 points)

Insert Question 7 Image Here

7.1 (T/F): _____ _____
7.2.1 (Precedence Graph): _____
7.2.2 (Serializability): _____
7.2.3 (Schedule Type): _____