1. Write an SQL query based on the chess tables used in class all semester. A copy is included at the end of the exam.

   (a) Create a view consisting of the names of all players and each opening they have used.  \(10\)

   (b) Using your view, find all players who have used all openings used by players named John Smith.  \(10\)
2. Consider a chess tournament in which every player plays every other player. A player receives 1 point for a win, one half point for a draw, and no points for a loss. The winner is the player with the most points at the end of the tournament. Players are given unique IDs, but they also need a name and a nationality in the database. Tournaments are held at one location over several days, and all have a unique name.

(a) Create an ER diagram for recording chess tournaments.
(b) Use SQL to create the database tables required by your ER diagram.
3. List each of Armstrong’s Axioms and its definition. \( 5 \) 

4. Provide a schedule that consists of at least three transaction such that the schedule is (a) serializable; (b) cascadeless and (c) not strict. No transaction may perform the same operation on the same data item more than once (i.e., a transaction can only do \( \text{R}(X) \) one; it may read any other data item and it may also write \( X \), but it cannot \( \text{R}(X) \) again). \( 10 \)
5. Assume a $B^+$-tree has 4 pointers. Insert the following values into the tree in this order: $2, 3, 5, 7, 9, 11, 13, 17, 19, 23$. Show the $B^+$-tree after every node split.
6. Use k-means to cluster the following 1 dimensional points into 3 clusters: 2, 3, 5, 7, 9, 11, 13, 17, 19, 23.
7. For each set functional dependencies, assume \( R = (A, B, C, D, E) \) is the relation and the domain of each attribute is integer. In the blank, put the highest normal form for \( R \) given the rules presented in class.

(a) \( A \rightarrow BCDE, BC \rightarrow A \) \( (3) \)

(b) \( AB \rightarrow CDE, BC \rightarrow A \) \( (3) \)

(c) \( AD \rightarrow BCE, BC \rightarrow A \) \( (3) \)

(d) \( A \rightarrow BCDE, BC \rightarrow A, B \rightarrow C \) \( (3) \)

(e) \( AB \rightarrow CDE, BC \rightarrow D \) \( (3) \)

8. Fill in the blank.

(a) \( \) requires that if a transaction executes on a database with all constraints satisfied, then it will terminate with all constraints satisfied \( (1) \)

(b) \( \) requires that either all of a transactions updates are performed on the database, or none of them are \( (1) \)

(c) JSP stands for \( \) \( (1) \)

(d) Isolation allows \( \) to behave as if they are the only ones executing \( (1) \)

(e) Writing the \( \) to stable storage is the commit point for a transaction \( (1) \)

(f) The \( \) algorithm is used to find the large item sets in association problems \( (1) \)

(g) The WHERE clause in an SQL statement is translated to the \( \) symbol in relational algebra \( (1) \)

(h) The primary cost of a database query is measured in \( \) \( (1) \)

(i) ORM stands for \( \) \( (1) \)

(j) \( \) requires that once a transaction has committed, all of its updates are permanent \( (1) \)