1. Let the relation $R$ contain 3 attributes, $A, B, C$ and the relation $S$ contain the attributes $C, D, E$. Assume $R$ contains 100 rows and $S$ contains 50 rows. Let $C$ be the primary key for $S$ and $A$ be the primary key for $R$. From the metadata, it is known that $E$ has 10 different values in $S$ and $C$ has 50 different values in $R$. Consider the SQL statement:

```sql
SELECT A
FROM R,S
WHERE R.C=S.C and E=10;
```

(a) (10 points) Provide a relational algebra statement equivalent to this SQL statement.

(b) (10 points) Estimate the number of rows returned by the statement. Show your work.
2. (10 points) Give an example of a non-CSR but Recoverable schedule.

3. (10 points) Describe the non-failure execution of the 2PC protocol. Showing the message diagram is sufficient.

4. (8 points) Define the acronym ACID and describe each part.
5. Assume a B+-Tree index over unique attribute $A$ in relation $R$ exists.
   (a) (6 points) Give an SQL query that typically benefits from the index.
   
   (b) (6 points) Give an SQL query that typically DOES NOT benefit from the index.
6. (20 points) List the steps which must be completed by a relational database after a user submits the SQL COMMIT statement before the database can return success to the user.
7. (10 points) Given $R$ as defined in question 1 and the relational algebra expression 
$(\pi_A(\sigma_{B=7}(R))) \cup (\pi_A(\sigma_{C=2}(R)))$, provide an equivalent relational algebra expression without union ($\cup$).

8. (10 points) Given $R$ and $S$ as defined in question 1, give a relational algebra expression equivalent to $R \bowtie S$. 