

1. Define recall and precision in IR systems. (5%)
2. Explain in detail the different types of SQL injection attacks. (10%)
3. Explain in detail two multiversion techniques for concurrency control. (10%)
4. What is the order  $p$  of a B<sup>+</sup>-tree? Explain in detail the structure of both internal and leaf nodes of a B<sup>+</sup>-tree. (10%)
5. Describe the two alternatives for specifying structural constraints on relationship types. What are the advantages and disadvantages of each? (5%)
6. Assume the following table schema:

SHIP(S\_Name, Captain)  
CREW(C\_Name, Planet, S\_Name)  
GROWS(Planet, Flower)  
ALLERGIES(C\_Name, Flower)

Translate the following query into SQL:

Get the names of crewmembers allergic to all the flowers that do not grow on their home planet. (10%)

7. Discuss the correspondences between the ER model constructs and the relational model constructs. Show how each ER model construct can be mapped to the relational model. (10%)
8. Define the following terms with respect to the tuple calculus: tuple variable, range relation, atom, formula, and expression. (10%)
9. What are the main differences between designing a relational database and an object database? (10%)
10. Describe the three-schema architecture. Why do we need mappings between schema levels? How do different schema definition languages support this architecture? (10%)
11. In what way do the generalized definitions of 2NF and 3NF extend the definitions beyond primary keys? (10%)