Sample Database Midterm Exam
(60 min., closed book and closed notes)

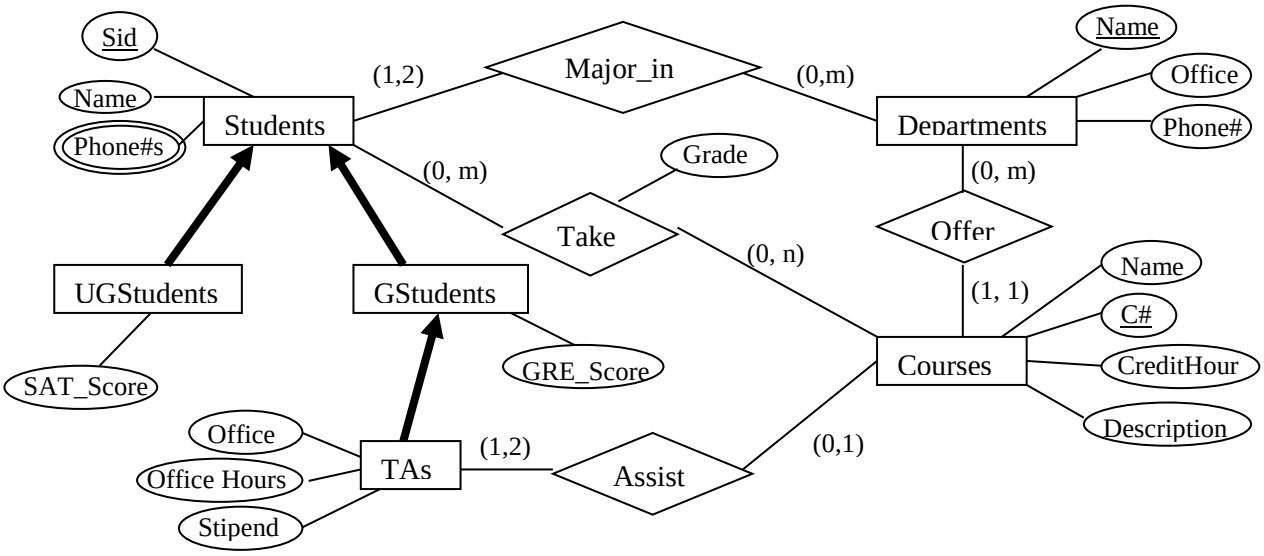
1. (6 points) Explain the difference between a procedural query language and a non-procedural query language.

2. (9 points) Let E1 and E2 be two entity sets. List three factors that support the creation of a super entity type for E1 and E2 (i.e., E1 and E2 become sub entity types of the super entity type).

3. (9 points) Answer "true" or "false" to each of the following statements (no justification is required):
   a. Given a relation R with a set of tuples T and let A denote an attribute of R. If all values under A in T are always different, then A must be a candidate key of R.
   b. Suppose X and Y are two different subsets of the attributes of relation R. If X is the primary key of R and X is a subset of Y, then Y must be a superkey of R.
   c. If A is a foreign key of relation R referencing the primary key B of relation S, then the number of distinct values under A (excluding null value) in R cannot exceed the number of distinct values under B in S.

   Answer (Circle one for each question): (a) true false; (b) true false; (c) true false

4. (30 points) Transform the following ER diagram into relations. Use Method 1 to transform the IS-A hierarchy. You need to indicate the key and foreign key(s) of each relation.



5. (7 points) Let R(A, B, C) be a relation schema and F = {A → B, B → C, B → A} be a set of functional dependencies on R. Is the decomposition of R into R1(A, B) and R2(A, C) dependency-preserving? Justify your answer.

6. (9 points) Answer "Yes" or "No" to each of the following questions (no justification is required).
    a. Let A be an attribute of relation R. If A → (attr(R) – {A}) is true, where attr(R) is the set of all attributes of R. Is A a candidate key of R?
    b. Let A, B and C be attributes of a relation. Is there redundancy in {A → BC, B → AC}?
    c. Suppose attribute A is a candidate key of relation R and X is a subset of attributes of R. Suppose further that X → A. Must X be a candidate key of R?

   Answer (Circle one for each question): (a) Yes No; (b) Yes No; (c) Yes No

7. Given a relation schema R(A, B, C, D, E, G) and a set of FDs F = {AB → C, A → DE, B → BC, D → CE}.
    a. (6 points) Find the minimal cover Fmin of F. (Note that all trivial functional dependencies such as A → A are redundant.)

    b. (6 points) Find all candidate keys of R. Show the dependency graph, Vni and Voi.

    c. (6 points) Is the schema in 3NF? You must justify your answer.

    d. (6 points) Apply Algorithm LLJ-DPD-3NF to decompose R regardless of whether R is already in 3NF.

8. (6 points) Let R(A_1, …, A_n) be a relation and X be a (sub)set of attributes of R. Argue that if X → $A_1A_2…A_n$, then X is a superkey of R. (Note that our Lecture Notes have a theorem that says that if X can determine all attributes of a relation, then X is a superkey of the relation. You are not allowed to use this theorem to answer this question. This question actually asks you to prove the correctness of this theorem.) (Hints: Use the definition of functional dependency, the Unique Row Rule, and contradiction to make the argument.)