Last Name: **First Name:**

COM S 363: Exam 1

Time: 90 minutes

NOTES:

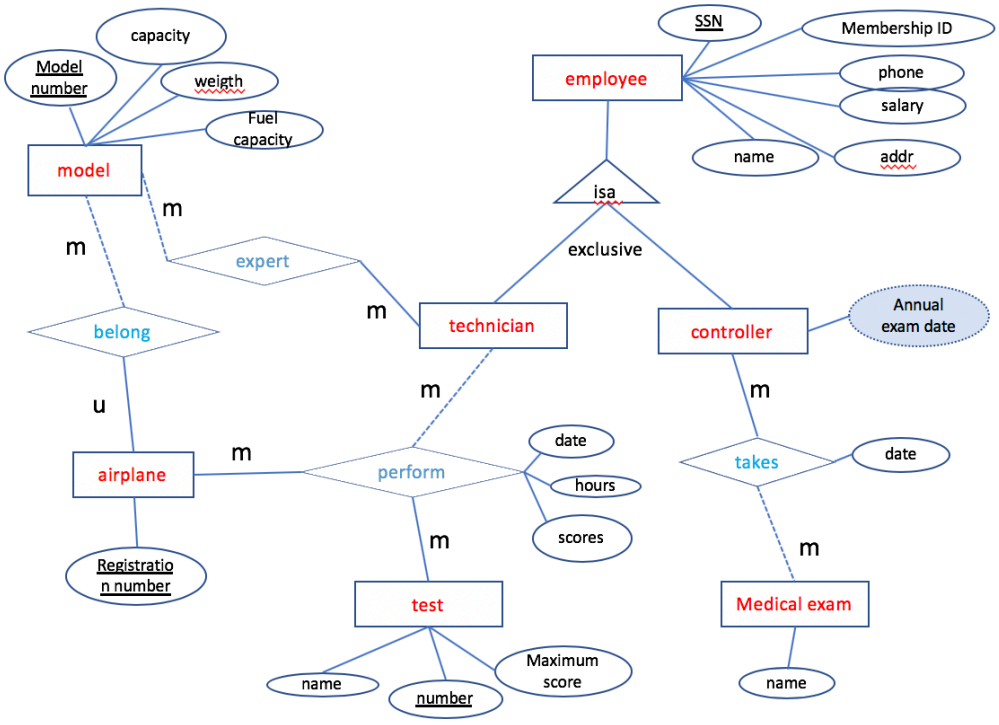
- This is a closed book closed notes exam.
- Write your name and answer legibly; if the grader can't read, you receive no point.
- Attempt all problems. Write solutions on these sheets.
- Fill in your name now, but do not turn the page until the signal is given.

Problem	Max Points	Points
1	30	
2	20	
3	8	
4	6	
5	6	
6	10	
7	20	
Total	100	

1. (30 points) You are asked to design a database for Story County Airport to store the following information.

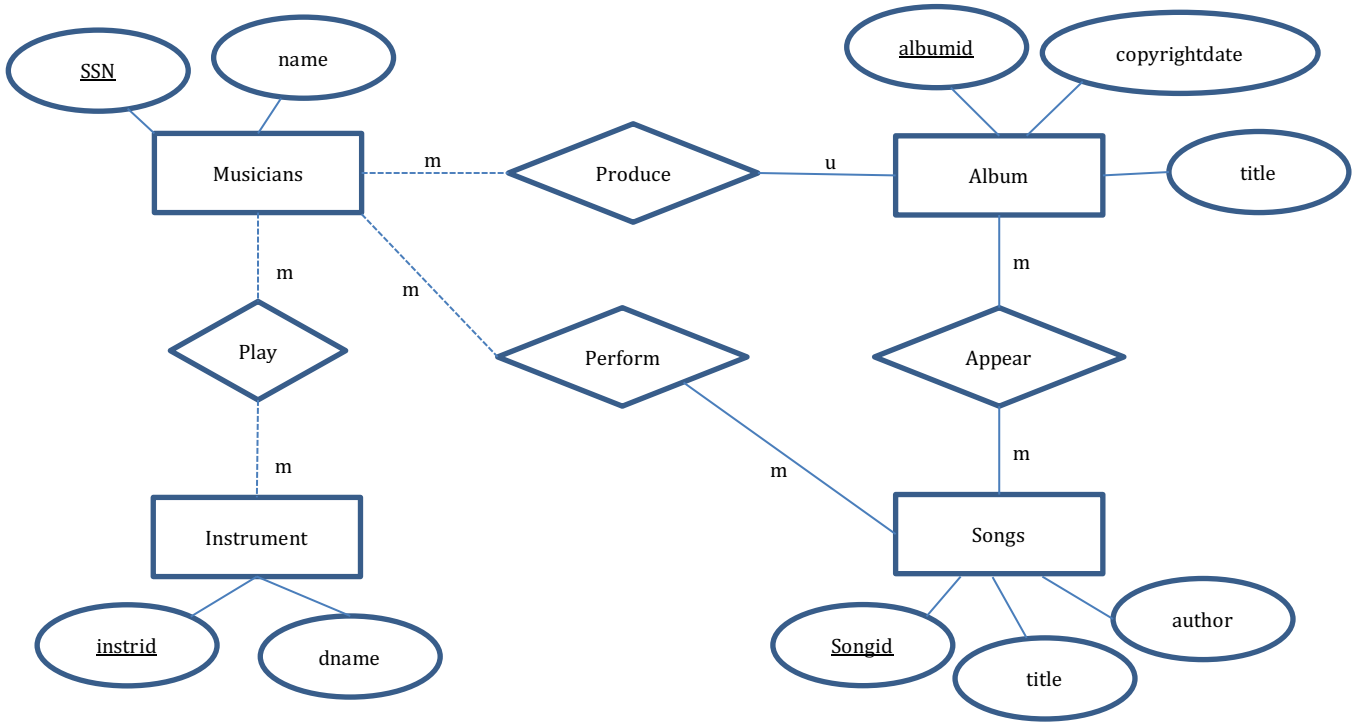
- Each airplane is identified by a registration number and must be of a specific model.
- Each plane model is identified by a model number (e.g., DC-10) and has a capacity, weight, and the amount of full-tank gas.
- All airport employees (including technicians and traffic controllers) belong to a union. Store the union membership number of each employee along with name, address, phone number, and salary. Each employee is uniquely identified by a social security number. Each technician is an expert on at least one plane model. His or her expertise may overlap with that of other technicians. Technicians must not be traffic controllers and vice versa.
- Traffic controllers must have an annual medical examination. For each traffic controller, the date of the most recent annual exam is to be stored.
- The airport has a number of tests that are used periodically to ensure that airplanes are still airworthy. Each test has a Federal Aviation Administration (FAA) test number, a name, and a maximum possible score.
- The FAA requires the airport to keep track of each time a given airplane is tested by a given technician using a given test. For each testing event, the information needed is the date, the number of hours the technician spent doing the test, and the score the airplane received on the test.

Draw an ER diagram that captures all attributes of each entity set and each relationship set for the above requirements. Specify the key for each entity set and all the constraints for each relationship set. Specify any necessary overlap and covering constraints (in English). Use the ER notations introduced in our lectures.



- 6 entity sets:
  - 2 points for each
  - Medical exam could be attribute to controller
- 4 relationship sets:
  - 2 points for each
- 10 constraints:
  - 1 for each

2. (20 points) Convert the following E-R diagram into a set of relations. For each relation, use SQL's "create table" to specify its name, attributes, and constraints (i.e., key, primary key, and foreign key).



- 4 entity tables: 3 points for each
  - Name: 1
  - Attribute: 1
  - Primary key (0.5)
  - Foreign key (0.5)
- 4 Relationship tables ("produce" could be part of Album): 2 points for each
  - Name: 1
  - Attributes: 1
    - Primary key (0.5)
    - Foreign key (0.5)

3. (8 points) Prove the following implied dependency using Armstrong's Axions (given below) or disprove using counter examples.

- Reflexivity: If $X \supseteq Y$, then $X \rightarrow Y$.
- Augmentation: If $X \rightarrow Y$, then $XZ \rightarrow YZ$ for any Z.
- Transitivity: If $X \rightarrow Y$ and $Y \rightarrow Z$, then $X \rightarrow Z$

(a) (3 points) {X --> Y, WY --> Z} ==> {WX --> Z}

(b) (3 points) {X --> Y, X --> W, WY --> Z} ==> {X --> Z}

(c) (2 points) {X --> Y, Z --> Y} ==> {XZ --> Y}

4. (6 points) Consider a relation R with attributes A, B, C, D, E and H, and the set of dependencies F = {A --> C, AC --> D, E --> AD, E --> H} that holds on R.

(a) (3 points) Compute $\{A\}^+$

(b) (3 points) Find a key for R.

5. (6 points) 2. Give minimal covers of the following sets of functional dependencies

(c) {AB -> CD, A -> B}

(d) {A -> B, B -> C, C -> A}

6. (10 points) Consider a relation R(S, E, P, N, L, H) and a set of dependencies holding on this relation F = {S-->E, SP-->H, P-->NL}. Suppose R is decomposed into R1, R2, and R3, where R1 = {S, E}, R2 = {P, N, L}, and R3 = {S, P, H}. Determine whether this decomposition is lossless-join. You are required to explain why.

D={R1,R2, R3} is a lossless join decomposition:

- R1 and R3 can be joined to create R4(S, E, P, H). Since S is their common attribute and S is a key in R1, this join is lossless.
- R4 and R2 can be joined to recover D. Since their common attribute is P and P is a key in R2, so this join is lossless.

7. (20 points) Consider a relation schema Contracts(contractid, supplierid, projectid, deptid, partid, qty, value). We will use C, S, J, D, P, Q, and V to denote contractid, supplierid, projectid, deptid, partid, qty, and value, respectively. The schema has the following dependencies:
C->CSJDPQV, JP->C, SD->P, and J->S.

a. (4 points) For each dependency, check if it violates BCNF, explain why.

   i. SD->P
   ii. J->S

b. (8 points) Perform a loss-less BCNF decomposition on Contracts

   i. Decompose Contracts(C, S, P, D, P, Q, V) into R1(S, D, P), R2(J, S) and R3(C, J, D, Q, V)

c. (4 points) Is the decomposition dependency-preserving? List lost dependencies if any.

   i. No. JP->C is lost

d. (4 points) Give a 3NF decomposition that is lossless and dependency preserving.

   Have to join relations to enforce dependency