

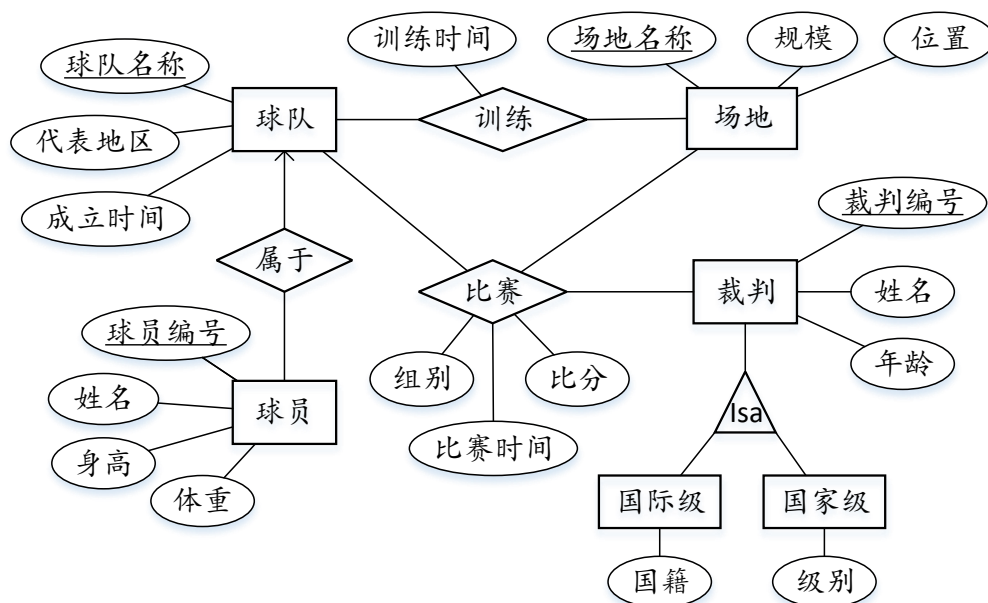
2021—2022 学年第二学期
数据库系统课程期末考试试卷（A 卷）

专业：_____ 学号：_____ 姓名：_____ 成绩：_____

得分

QUESTION 1 [16 points]: Data Models

1) Transform the following E-R diagram into relation model (in 3NF)



a) Based relation model you designed fill the following table. [8]

表名	表中含有属性	主键	外键	参照表名及属性
球队				
球员				
场地				
裁判				
国际级裁判				
国家级裁判				
训练				
比赛				

b) **Write SQL statements** that create the tables including the foreign key and primary key indications according to E-R diagram. [4]

- 给出球队和球员两个表的SQL描述语句（属性类型可自行定义）：

2) For the relational tables you generated in question 1), Describe which insert and delete operations in this database must be checked to ensure that referential integrity is not violated for that foreign key. Please state specifically which operations on which relations can cause problems. [4]

(参照写法：On insert(SC) -> exists(Student) and exist(Course);

On delete(Student) -> delete(SC) or not allowed)

On insert(球员) ->

On delete(场地) ->

On insert(训练) ->

On delete(比赛) ->

得分

QUESTION 2 [12 points]: Join query semantics

There are 4 questions about two relations given below. Please write each result of the following queries.

R:

A	B	C
2	3	4
3	4	5
4	6	7

S:

A	D
2	2
2	4
3	7
4	3

- 1) SELECT R.A, COUNT(R.B) COUNT [3]
FROM R, S
WHERE R.A=2 AND S.A = R.A
GROUP BY R.A

- 2) SELECT R.A, SUM(R.C) SUM [3]
FROM R, S
WHERE R.A=2
GROUP BY R.A

- 3) SELECT R.A, AVG(S.D) AVERAGE [3]
FROM R, S
WHERE R.A=S.A
GROUP BY R.A
HAVING COUNT(S.D)<3

- 4) $\sigma_{S.D \geq 4}(R \bowtie S)$ [3]

得分

QUESTION 3 [15 points]: Normal Form

Consider a relation $R = (A, B, C, D, E)$ with FD's $BC \rightarrow D$, $CD \rightarrow E$, $DE \rightarrow A$ and $AE \rightarrow B$

- 1) What is the attribute closure of DE ? [1]

- 2) Of the following FDs, circle the ones that are implied by the functional dependencies given above: [2]

i. $BC \rightarrow E$ ii. $BE \rightarrow C$ iii. $DE \rightarrow B$ iv. $BD \rightarrow E$

- 3) List all keys for R . [2]

- 4) Which of the given functional dependencies are Boyce-Codd Normal Form (BCNF) violations? [2]

- 5) Does $CE \rightarrow A$ violate Third Normal Form? Justify your answer. [2]

- 6) We decompose R into $R_1(A, D, E)$ and $R_2(B, C, D, E)$. What are the keys of R_1 ? What are the keys of R_2 ? [2]

- 7) What are the FD's that hold in R_2 ? [2]

- 8) Is R_2 in BCNF? If yes, briefly explain why. Otherwise, decompose further until all decomposed relations are in BCNF, and then show your final results. [2]

得分

QUESTION 4 [12 points]: Relational Algebra and SQL Queries

Consider a database schema with the following relations: (有下划线的属性为主键)

职员 (职员号, 姓名, 专业技能)

公司 (公司名, 城市, 负责人) --负责人是外键, 参照职员表中的职员号

工作 (职员号, 公司名, 城市, 年薪)

-- 职员号是外键, 参照职员表中的职员号;

-- (公司名, 城市) 是外键, 参照公司表中的主键 (公司名, 城市);

- 1) 请用关系代数表达式实现: 查找年薪超过 20 万的负责人的职员号、姓名和年薪。[3]
- 2) 请用SQL语言实现: 找到在北京工作过的所有职员信息, 列出职员号, 姓名, 年薪 (如果在北京的多家公司工作过, 请列出平均年薪)。[3]
- 3) 请用SQL语言实现: 查找年薪超过20万的负责人的职员号、姓名和年薪。[3]
- 4) 请用SQL语言实现: 查找哪个城市的公司, 其所属职员的平均年薪超过15万元, 请列出公司名、城市和平均年薪。[3]

得分

QUESTION 5 [16 points]: Concurrency Control

- 1) For each of the following schedules, answer the questions below:

Sa= R1(A) R2(A) R3(B)W4(A) W4(C)R2(B) W3(A) R1(B)W3(C) W4(D)

Sb= R1(B) W4(D) W2(A) R4(A) W3(C) R3(B) W3(A) R2(B) W2(C) R1(A)

- a) What is the precedence graph for the schedule Sa and Sb? [4]
- b) Is the schedule conflict serializable? If so, show all equivalent serial transaction orders. If not, describe why not. [4]
- Sa:
- Sb:

2) Consider the following two transactions:

T1 = R1(A) W1(A) R1(B) W1(B) R1(C) R1(B);

T2 = R2(B) R2(C) W2(C) W2(A) R2(C) R2(B);

a) 请添加合适的读锁 (ls())、写锁 (lx()) 和解锁 (ul()) 命令使事务 T1 和 T2 在并发运行时可以满足冲突可串行化调度。(为提高并发度, 只涉及读的元素要加读锁) [4]

b) 请说明这两个事务会引起死锁吗? 如果会引起死锁, 请给出死锁的示例; 如果不会引起死锁, 请说明为什么? [4]

得分

QUESTION 6 [14 points]: Transaction Management

Assume that a database using Undo/Redo logging and nonquiescent checkpointing crashes with the log records on disk given below. Record $\langle T, X, v, w \rangle$ means that transaction T changed the value of database element X; its former value was v, and its new value is w.

```
<START, T1>
< T1, A, 3, 13>
<START, T2>
< T2, B, 8, 14>
<COMMIT T2>
<START T3>
<START CKPT (T1,T3)>
<T1, C, 29, 15>
<T1, A, 13, 17>
<START T4>
<T3, B, 14, 34>
<COMMIT T3>
<END CKPT>
<T1, B, 34, 24>
<T4, C, 15, 47>
<T4, A, 17, 21>
<COMMIT T1>
```

1) What are the all of the possible values on disk for each of the database elements A, B and C? [3]

For element A: For element B: For element C:

2) Which, if any, transactions will need to be redone and undone in the recovery process?[4]

Transactions to Redo: Transaction to Undo:

3) If finished the system recovery, what are the values on disk for each of the database elements A, B and C? [3]

For element A: For element B: For element C:

4) How would your answers to parts (a) and (b) change if <END CKPT> were not present in the log?[4]

For element A:

For element B:

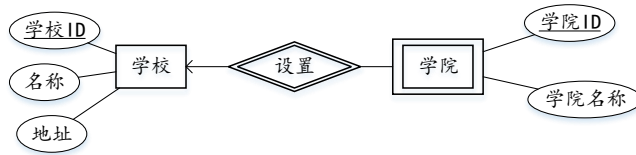
For element C:

Transactions to Redo:

得分

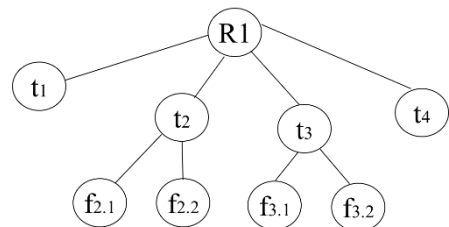
QUESTION 7 [15 points]:简答题

1) 请将 ER 图转为关系模式，给出每个关系模式的主键和外键。[3]



2) 已知关系模式 $R(A, B, C, D, E)$ 上存在函数依赖 $F = \{A \rightarrow C, B \rightarrow C, C \rightarrow D, DE \rightarrow C, CE \rightarrow A\}$ ，请问分解 $R_1(A, D, E)$, $R_2(A, B, E)$, $R_3(C, D, E)$ 是不是无损连接？为什么？[3]

3) 如果数据库元素的层次关系如右图所示，某事务要写 $f_{2.1}$ 元素，按照数据库的封锁协议，该事务应该对哪些元素加什么类型锁？（提示：**S/X/IS/IX**）如果另一个事务要读 t_2 元素，是否可以成功？[3]



- 4) 考虑数据库关系R表, 现有4个用户分别为A、B、C和D, A用户拥有R表的所有权限, 其他用户不拥有A表的任何权限, 如果4个用户按照如下顺序进行授权, 请问授权后4个用户对R表各有哪些权限? [3]

A: GRANT UPDATE ON R TO B

A: GRANT UPDATE(a) ON R TO C WITH GRANT OPTION

C: GRANT UPDATE(a) ON R TO B WITH GRANT OPTION

B: GRANT UPDATE(a) ON R TO D

A: REVOKE UPDATE(a) ON R FROM C CASCADE

A 具有的权限:

B 具有的权限:

C 具有的权限:

D 具有的权限:

- 5) 请将下列SQL语句转为关系代数表达式, 并说明是否可以进一步优化? 优化的基本策略是什么? [3]

SELECT B, D

FROM R, S

WHERE R.C=S.C AND R.A = "c" AND S.E = 2