

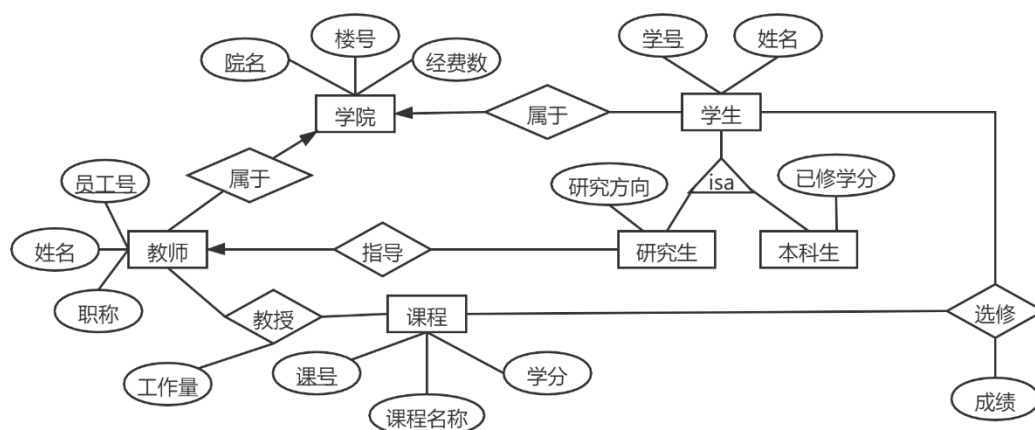
2020—2021 学年第二学期
数据库系统课程期末考试试卷（A 卷）

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]

关系表名	表中含有属性	主键	外键	参照表名及属性
学院				
教师				
学生				
研究生				
本科生				
课程				
学生选课				
教师授课				

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

- 给出研究生和学生选课两个表的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(研究生) ->

On delete(课程) ->

On insert(教师) ->

On delete(学生选课) ->

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	5	7
3	7	4
7	5	6

S:

A	B	D
2	5	2
3	2	4
3	4	4
5	3	3

- 1) SELECT R.B, COUNT(R.A) A个数
FROM R, S
WHERE R.B=5 AND R.B=S.B
GROUP BY R.B
- 2) SELECT R.A, COUNT(R.B) B个数, MAX(S.D) D最大值
FROM R, S
WHERE R.A=3
GROUP BY R.A
- 3) SELECT R.B, SUM(S.D) D求和
FROM R, S
WHERE R.B = S.B
GROUP BY R.B
HAVING COUNT(S.D)>1
- 4) $\sigma_{S.D \leq 3}(R \bowtie_{R.B=S.B} S)$


评分标准：表模式正确1分，结果正确2分

得分

QUESTION 3 [15 points]: Normal Form

草稿区

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

- 1) What is the attribute closure of AC ? [1]
 - 2) Of the following FDs, circle the ones that are implied by the functional dependencies given above: [1]
i. $A \rightarrow DE$ ☒ ii. $C \rightarrow AE$ ☒ iii. $B \rightarrow E$ ☒ iv. $AC \rightarrow E$
 - 3) List all keys for R . [2]
 - 4) Write down two functional dependencies that causes this relation to violate 3NF. [2]
 - 5) Which of the following could occur with the table? [1]
☒ i. Update anomaly ☒ ii. Insertion anomaly
☒ iii. Deletion anomaly
 - 6) Decompose R into two or more relations that are all in 3NF. And make sure your decomposition is (i) dependency preserving, and (ii) lossless join. [2]
- 
- 7) We decompose R into $R_1(B, D, E)$ and $R_2(A, C, E)$. What are the FD's that hold in R_1 and R_2 ? What are the keys of R_1 and R_2 ? [4]
 - 8) We decompose R into $R_1(B, D, E)$ and $R_2(A, C, E)$, is this decomposition (i) dependency preserving, and (ii) lossless join? [2]

得分

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

Consider a database schema with the following relations:

(为帮助同学理解数据库表的含义，文中用中英文做了对照描述，答题可以用英文表名及属性名写查询描述,有下划线的属性为主键)

学生 (学号, 姓名, 学院) ;

社团 (社团号, 社团名称, 负责人) ; --负责人是外键, 参照学生表中的学号
参加 (社团号, 学号, 加入年份) ; --社团号是外键, 参照社团表中的社团号
--学号是外键, 参照学生表中的学号

Student (sno, name, college) ;

Society (sid, sname, leader) ;

JoinS (sid, sno, year)

1) **请用关系代数表达式实现:** 查询在2020年和2021年新加入社团的所有学生信息, 显示信息包括: 学号、姓名。[3]

2) **请用SQL语言实现:** 查询计算机学院在2020年和2021年新加入社团的所有学生信息, 显示信息包括: 学号、姓名。[3]

3) **请用SQL语言实现:** 查询计算机学院参加不同社团的学生人数, 显示信息包括: 社团名称、社团负责人、参加人数。[3]

4) **请用SQL语言实现:** 查询参加社团数超过3个的学生信息, 显示信息包括: 学号、姓名。[3]

评分标准：

每题3分。逻辑表达基本正确，有语法错误扣1分；逻辑表达基本正确，缺少个别逻辑条件扣1分；逻辑表达错误，但查询列基本正确给1分。

得分	QUESTION 5 [16 points]: Concurrency Control

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

Sa= R₁(B) W₁(C) W₃(C) R₁(A) R₄(B) W₂(A) R₁(D) R₅(C) R₄(A) W₅(D) W₅(A)

Sb= R₄(B) W₁(C) R₁(A) W₃(C) W₁(B) W₂(A) R₅(C) R₁(D) W₅(D) R₄(A) W₅(A)

(a) What is the precedence graph for the schedule Sa and Sb? [4]

Sa:

Sb:

(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(C) R₁(A) R₁(B) W₁(C) W₁(D) R₁(B) W₁(A);

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

1) 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]

T1加锁和解锁的顺序: 满足两段锁协议即可

T2加锁和解锁的顺序: 满足两段锁协议即可

评分标准: 加锁和解锁需满足两段锁协议, 未考虑到只读操作加读锁扣1分。

2) 根据上一题T1和T2加锁和解锁的顺序, 给出这两个事务交叉运行时的一个可能的冲突可串行化调度。[2]

冲突可串行化调度示例:

3) 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? [2]

评分标准: 按顺序封锁法加的锁不会出现死锁, 按正常顺序加锁会出现死锁。判断是否死锁给1分, 说明原因给2分。

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, B, 1, 2>
<START, T2>
<T2, A, 1, 2>
<COMMIT T1>
<START CKPT (T2)>
<START T3>
<T2, C, 9, 8>
<START T4>
<T3, C, 8, 7>
<T4, B, 2, 4>
<T3, A, 2, 3>
<COMMIT T3>
```

<END CKPT>

<T4, B, 4, 8>

<T4, C, 7, 6>

<COMMIT T2>

评分标准：每小题错1个扣1分，最多扣2分

- 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) 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？ [2]

A: GRANT SELECT ON R TO B

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

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

B: GRANT SELECT(a) ON R TO D

A: REVOKE SELECT ON R FROM B CASCADE

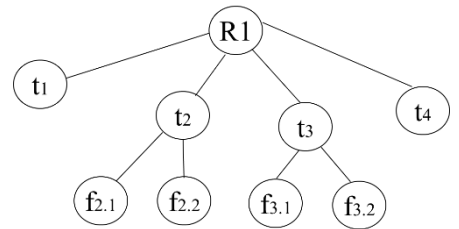
A 具有的权限:

B 具有的权限:

C 具有的权限:

D 具有的权限:

- 2) 如果数据库元素的层次关系如右图所示, 某事务要写 $f_{3.1}$ 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)? 如果另一个事务要写 $f_{3.2}$ 是否可以成功? [3]



- 3) Relation $R(A, B, C)$ satisfies the multi-valued dependency $A \twoheadrightarrow B$, and has (possibly among others) the following tuples in its current instance: (1,1,2), (0,3,6), (1,7,5), (0,1,3) and (2,7,9). Which of the following tuples is necessarily in the current instance of R ? [2] (每个正确选项0.5分)

☒ (1,7,2) ☒ (0,1,6) ☒ (1,1,5) ☒ (0,3,3) ☐ (1,2,5)

- 4) 已知用SQL创建如下模式:

```
CREATE TABLE T(C INT PRIMARY KEY, D INT);
```

```
CREATE TABLE S(B INT PRIMARY KEY, C INT REFERENCES T(C));
```

```
CREATE TABLE R(A INT PRIMARY KEY, B INT REFERENCES S(B));
```

假设上述表R, S和T分别包含 r , s 和 t 行元组, n 是下列查询后的元组数

SELECT * FROM R, S, T WHERE R.B = S.B AND S.C = T.C; 请问 n 的下届是多少? 为什么? [3]

- 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 A, C
```

```
FROM R, S  
WHERE R.A=S.A AND R.B = "b" AND S.D = 5
```

6) 请说明数据库管理系统的三层架构（三级模式）。[2]