浙江大学 2020－2021 学年 春夏 学期

《数据库系统》课程期末考试试卷

课程号：21121350，　开课学院：计算机学院

考试试卷：√A 卷、B 卷（请在选定项上打√）

考试形式：√闭、开卷（请在选定项上打√），允许带一张 A4 纸笔记入场

考试日期：2021 年 7 月 2 日，考试时间：120 分钟

诚信考试，沉着应考，杜绝违纪。

考生姓名：_____学号：_____所属院系：_____

题序	一	二	三	四	五	六	七	八	总 分
得分									
评卷人									

Problem 1: Relational Model and SQL (18 points)

Following are the relational schemas of a SRTP (Student Research Training Program) project database.

student (sId, sName, dId)
teacher (tId, tName, dId)
department (dId, dName)
project (pId, pName, tId, startTime, endTime)
participate (pId, sId, role)

The underlined attributes are primary keys, and foreign keys are listed as follows:
"dId" in "student" references "department";
"dId" in "teacher" references "department";
"tId" in "project" references "teacher";
"pId" and "sId" in "participate" reference "project" and "student", respectively.
In "participate", only two different roles are permitted: "leader" and "member". Based on the above relational schemas, please answer the following questions:

(1) Write a relational algebra expression to find the names of the projects that are instructed by a teacher from the department "Computer Science". (4 points)
(2) Write SQL statements to create tables project and participate with all the necessary

constraints (Note: Tables student, teacher, and department have already been created and can be referenced). (6 points)

(3) Write a SQL statement to find the names of the teachers that instruct at least one project started in the year 2020. (4 points)

(4) Write a SQL statement to find the names of the students participating more than 2 projects. (4 points)

Answers of Problem 1:

Problem 2: E-R Model (11 points)

Based on the SRTP project management scenario in Problem 1, some new requirements are added as follows:

(1) There are two kinds of SRTP projects, i.e., school-level projects and national-level projects, and a project is either school-level or national-level.

(2) National-level projects have budget information, and school-level projects have mid-term check information.

(3) A school-level project is associated with exactly a department that is in charge of the management of the project.

Please draw an E-R diagram for the scenario.

Answers of Problem 2:

Problem 3: Relational Formalization (12 points)

For relation schema R (A, B, C, D, E, F) with functional dependencies set F = {A->B, A->C, B->C, D->E, D->F, EF->D}. Answer the following questions:

(1) Find all the candidate keys. (3 points)

(2) Find the canonical cover Fc. (3 points)

(3) If R is not in BCNF, decompose it into BCNF schemas. (4 points) Is this decomposition dependency preserving? (2 points)

Answers of Problem 3:

Problem 4: XML (8 points)

The following is a simplified DTD for the SRTP project database given in Problem 1:

```
<!DOCTYPE    SRTP[
    <!ELEMENT    SRTP(department+, teacher+, student+, project*)>
    <!ELEMENT    department (dname)>
    <!ATTLIST    department dId ID #REQUIRED>
    <!ELEMENT    teacher (tname)>
    <!ATTLIST    teacher
            tId ID #REQUIRED
            dId IDREF #REQUIRED>
```

```
    <!ELEMENT     student (sname)>
    <!ATTLIST     student
                  sId ID #REQUIRED
                  dId IDREF #REQUIRED>
    <!ELEMENT     project (pname, starttime, endtime)>
    <!ATTLIST     project
                  pId ID #REQUIRED
                  tId IDREF #REQUIRED
                  sIds IDREFS #REQUIRED >
    <!ELEMENT     dname (#PCDATA)>
    <!ELEMENT     tname (#PCDATA)>
    <!ELEMENT     sname (#PCDATA)>
    <!ELEMENT     pname(#PCDATA)>
    <!ELEMENT     starttime(#PCDATA)>
    <!ELEMENT     endtime(#PCDATA)>
]>
```

Please answer the following questions:

(1) Give an XPath expression to return the names of all the teachers who supervise SRTP projects. (4 points)

(2) Give an XQuery expression to return all the projects and their corresponding instructors, in the form of project_instructor elements that have a project subelement and a teacher subelement. (4 points)

Answers of Problem 4:

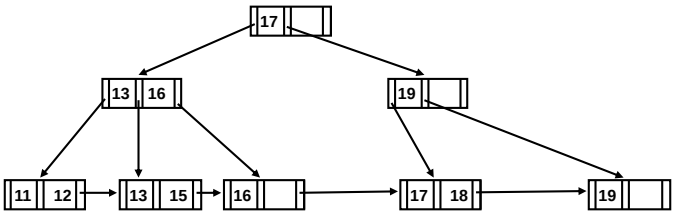
Problem 5: B+ -Tree and Query Processing (10 points)

Table student in Problem 1 is stored sequentially on sId. The following B+-tree is built for the table on attribute dId. Please answer the following questions:

(1) Is the built index a primary index? Why? (2 points)

(2) Draw the B+-tree after inserting entry 14. (4 points)

(3) Draw the B+-tree after deleting entry 19 from the original B+-tree. (4 points)



Answers of Problem 5:

Problem 6: Query Processing (14 points)

There are two relations *r* (100 blocks) and *s* (20 blocks), and hash-join algorithm is used to perform natural join between these two relations (memory size M=6 blocks). Please answer the following questions:

(1) How many partitions can be constructed? Why? (3 points)
(2) Which relation is best to choose as the build relation? Why? (3 points)
(3) Is recursive partition needed? Why? (3 points)
(4) Please compute the cost (numbers of seeks and block transfers) of the hash-join. (5 points)

Answers of Problem 6:

Problem 7: Concurrency Control (13 points)

Given the following schedule, please answer the following questions:

(1) Draw the precedence graph for the schedule. (3 points)

(2) Is the schedule conflict serializable? Why? (2 points)

(3) Is it possible that the schedule is generated by the 2PL protocol with lock conversions? Explain. (5 points)

(4) Which conditions should be satisfied if we want the schedule to be recoverable? (3 points)

T1	T2	T3
	read C	
read B		
	write C	
	read A	
		read C
	write A	
read A		
		write C
write B		
		read B

Answers of Problem 7:

Problem 8: Recovery (14 points)

Given the following log file that supports logical undo, please answer the following questions:

(1) The system crashes just after the last log record. What are the values of B and C in the database after system crash? (3 points)
(2) Which transactions should redo and undo, respectively? (3 points)
(3) What are the start and end points for redo and undo, respectively? (3 points)
(4) What are the log records added during recovery? (5 points)

1 <T_0 start>
2 <T_0, B, 2000, 2050>
3 <T_1 start>
4 <T_1, B, 2050, 2100>
5 <T_1, O_1, operation-begin>
6 <checkpoint {T_0, T_1}>
7 <T_1, C, 700, 400>
8 <T_0 commit>
9 <T_1, O_1, operation-end, (C, +300)>
10 <T_2 start>
11 <T_2, O_2, operation-begin>
12 <T_2, C, 400, 300>
13 <T_2, O_2, operation-end, (C, +100)>
14 <T_2, commit>

Answers of Problem 8: