

King Fahd University of Petroleum and Minerals

Department of Information and Computer Science

ICS 324: Database Systems

Spring 2007-2008

Date: 12-June-2008

Time: 7:30AM.

Final Exam:

Duration: 2 Hours

Total Points: 250

Name:

Student ID #:

Important Notes:

- Please check that you have seven pages containing five questions.
- Please skim through all the questions, make sure that you understand them, and then attempt to answer them with a time-allocation in mind. If any question is not clear, get it clarified during the first twenty minutes.
- If you need to make any reasonable assumptions please document them as part of your answers.
- Make sure that your answers are precise and accurate. Vague answers will be considered as wrong.
- Your handwriting should be clear. Answers that are difficult to read will be considered wrong.

Scores:

<u>Problem</u>	<u>Points</u>	<u>Score</u>
Question 1: ER Design and Relational Model	50	
Question 2: Relational Algebra and SQL	50	
Question 3: Normalization and Practical Database Design	50	
Question 4: Query Processing and Concurrency Control	50	
Question 5: Transaction Processing and Database Recovery	50	
<u>Total</u> →	250	

1. [ER Design and Relational Model] (50 points)

A. Design an ER diagram for the following Bank database. Your diagram should have all the needed details. You may make any reasonable assumptions but you have to state them clearly **(35 points)**

- The bank serve customers. Each customer has a SSN, Name, Address, and Multiple Phones.
- A customer should have one or more accounts, while an account can be shared by more than one customer. An account has an Account-No, Balance and Opening-Date.
- A customer can have one or more loans, while a loan can be given to only one customer. A loan has a Loan-No, Amount and Due-Date.
- It is also desirable to keep track of each account's transactions which include type, amount, date and time.

B. Answer the following parts that are related to Relational Model**(15 points)**

i. Briefly explain what is the Entity Integrity Constraint and why it is important. (5 Points)

ii. List three violations that can be done by an insertion operation and briefly explain one. (10 Points)

2. [Relational Algebra and SQL]**(50 points)**

Consider the following relational database schema.

STUDENT

<u>ID</u>	Name	BDate	Address	Advisor	GPA	Dept
				↘ Faculty		↘ Department

FACULTY

<u>ID</u>	Name	Bdate	Office	Phone	Dept
					↘ DEPARTMENT

DEPARTMENT

<u>Code</u>	Name	Location	Phone	Chairman
				↘ Faculty

A. Write Relational Algebra expressions for the following queries (For Full Marks you should not use Temporary Relations) **(15 points)**

i. Retrieve the name, ID, and GPA of all students whose advisor is "Talal Maghrabi". (6 Points)

ii. Retrieve the number of advisees (students advised) for each faculty in the "Computer Engineering" Department. (9 Points)

B. Write SQL statements to answer the following queries.

(35 points)

i. Retrieve the name, ID, and GPA of all students in the ICS Department with GPA 3.0 or above. Order the result by GPA in descending order and within GPA by ID in ascending order. (10 Points)

ii. Retrieve the number of advisees (students advised) for each faculty in the ICS Department. Sort the result by the number of advisees in descending order. (15 Points)

iii. Find all students with advisors in a department different from the student's department. (10 Points)

3. [Normalization and Practical Database Design]

(50 points)

A. Consider the following relation with its set of functional dependencies:

STU-COURS (Key, Stu-ID, Course-No, Grade, Stu-Name, Course-Name, Instructor, Location, Time)

fd1: Stu-ID, Course-No \rightarrow Key, Grade, Stu-Name, Course-Name, Instructor, Location, Time

fd2: Stu-ID \rightarrow Stu-Name

fd3: Course-No \rightarrow Course-Name, Instructor, Location

fd4: Instructor \rightarrow Location

fd5: Time \rightarrow Course-No

i. Show one example for an insertion, deletion **or** update anomaly on the above relation. (4 points)

ii. In what normal form is this relation and why?

(6 points)

- iii.** Further normalize this relation to BCNF.(Explain your work) (25 points)

B. Answer the following parts that are related to Practical Database Design (15 points)

- i.** Briefly explain the difference between the "Centralized Schema" and "View Integration" design approaches. (8 Points)

- ii.** Briefly explain the "Logical Database Design Process" and list its two stages.. (7 Points)

4. [Query Processing and Concurrency Control] (50 points)

A. Answer the following parts that are related to **Query Processing** (30 points)

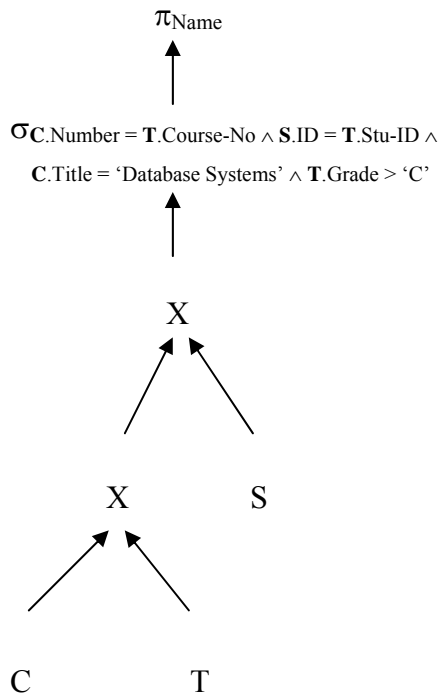
- i.** Briefly explain two of the following concepts of query processing: query scanning, query parsing and query validation. (10 points)

- ii. Given the relational schema and the a relational algebra tree (RAT) below, use heuristic rules to convert this RTA into a more efficient one. Use a maximum of three RATs. (20 points)

STUDENT (S)		
<u>ID</u>	Name	Address

COURSE (C)		
<u>Number</u>	Title	Dept

TAKES (T)		
<u>Stu-ID</u>	<u>Course-No</u>	Grade



B. Answer the following parts that are related to Concurrency Control (20 points)

- i. State two objectives of using a concurrency control mechanism in databas systems. (6 points)

- ii. Briefly explain one of the two phases of the Two-Phase Locking. (5 points)

- iii. What is deadlock? List two methods to handle it and brifly explain one of them. (9 points)

5. [Transaction Processing and Database Recovery] (50 points)**A. Answer the following parts that are related to Transaction Processing (30 points)**

i. What is a transaction? List three of the operations that can be performed by a transaction. (7 points)

ii. Draw a detailed state transition diagram illustrating the states for transaction execution. (15 points)

iii. What are the ACID properties of a transaction? Briefly explain one of them. (8 points)

B. Answer the following parts that are related to Database Recovery (20 points)

i. State two objectives for using a database recovery mechanism. (6 points)

ii. List three types of data update methods and briefly explain one of them. (7 points)

iii. What is checkpoint operation and briefly explain how it is executed. (7 points)