B.Sc. Engg. / HD CSE 3rd Semester (67)

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

13 May 2016

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION — WINTER SEMESTER, 2015-2016

TIME: 3 HOURS — FULL MARKS: 150

CSE 4307: Database Management Systems

Programmable calculators are not allowed. Do not write anything on the question paper.

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

Question 1.(a) and 2.(a) are based on the following database schema. The underlined attributes are primary keys of relations.

customers (customer_id, customer_name, address, age, sex)
products (product_id, product_name, unit_price)
orders (order_id, product_id, quantity)
transactions (customer_id, order_id, total_amount, date)

The *customers* relation holds customer related information like id, name, address, age and sex of a customer. The *products* relation gives the product id, name and unit price of a product. The *orders* relation holds data about all orders which include products and their quantity in suitable units. The *transactions* relations give further details about an order like who ordered it (customer), when the order was processed (date) and what was the total amount of that order. A database snapshot is shown in Appendix for your convenience.

1. a) Write expressions in **relational algebra** to answer the following queries. 3×5

   i. Find all product names and quantity ordered by customer 'C-001'.
   ii. Find all customer names who live in 'Agargaon' and age is in between 35 and 40.
   iii. Find the total amount paid by each customer.
   iv. Increase unit price of 'Rice' by 15% and update the products relation accordingly.
   v. Find the name of the highest priced product.

   b) Explain how division (÷) operator works using a suitable example. 5

   c) What are the conditions that must be fulfilled to apply set operations over relations in relational algebra? If there are m records in relation r and n records in relation s, how many records can be there at most in relation r ∩ s? 3+2

2. a) Write **SQL statements** to perform the following queries. 3×5

   i. Find all female customers and display their name, address and age.
   ii. Find customers id, name and address who ordered either 'Rice' or 'Flour'. (must use set operation).
   iii. Find the customer ids and names that have placed at most one order. (must use unique keyword).
   iv. Find the customer names and address who ordered the highest quantity of 'Rice'.
   v. Find the quantity in stock for each product.

   b) Suppose there are two relations r (A,B,C) and s (C,D). Write **SQL statements** to perform the following DDL queries. 2×3

   i. Write statement to add a new attribute E that holds date value in relation s.

ii. Write statement to add a foreign key constraint in relation s on attribute C that references attribute C in relation r.

iii. Write statement to rename the attribute A to Z in relation r.

c) Write the equivalent SQL statement for the relational algebra expression $r \bowtie_{r.B=s.b} s$ based on the schema provided in Question 2.(b).

3. a) Construct an E-R diagram for a database recording information about football teams, football players, and their fans, including the following:
Each player has his/her name and playing position. Note that, a player can play at different positions. Each player could play for a team and the database has to maintain the starting and ending date of the contract of a player to a team. A team has its name, year of establishment and color of its jersey. Further, each team has many players and a team captain. A team and a player could have many fans. Each fan has his/her name, gender, date of birth and age.

b) In Question 3.(a), you have designed an E-R diagram. Transform your E-R diagram into a set of relational schemas with appropriate reasoning.

c) What do you understand by the term 'Aggregation' in the context of database design? Explain using an appropriate example. Your example must be different than those discussed in the textbook.

4. a) What is Functional dependency? How is the concept of functional dependency being used to illustrate the definition of super keys and candidate keys?

b) A database schema named PROJECT contains the following relations which are already in INF.
Project (project_code, project_title, project_manager, project_budget)
Project_Employee_Department (project_code, employee_no, employee_name, dept_no, dept_name, hourly_rate)
You have to decompose the following relations in such a way so that the resulting relations are in 3NF. Justify your answer at each step and identify the primary keys as necessary.
A sample dataset is given below for these two relations.

Project Code	Project Title	Project Manager	Project Budget
PC010	Pensions System	M Phillips	24500
PC045	Salaries System	H Martin	17400
PC064	HR System	K Lewis	12250

Project Code	Employee No.	Employee Name	Department No.	Department Name	Hourly Rate
PC010	S10001	A Smith	L004	IT	22.00
PC010	S10030	L Jones	L023	Pensions	18.50
PC010	S21010	P Lewis	L004	IT	21.00
PC045	S10010	B Jones	L004	IT	21.75
PC045	S10001	A Smith	L004	IT	18.00
PC045	S31002	T Gilbert	L028	Database	25.50
PC064	S13210	W Richards	L008	Salary	17.00
PC064	S31002	T Gilbert	L028	Database	23.25
PC064	S21010	P Lewis	L004	IT	17.50
	S10034	B James	L009	HR	18.50

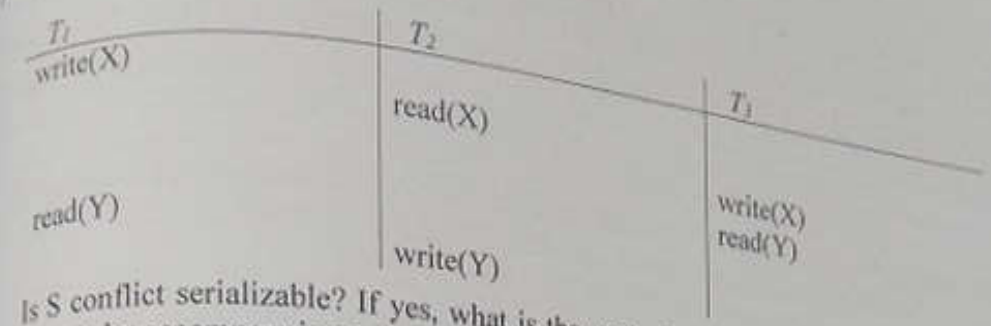
Figure 1: Database snapshot for Question 4.(b)

c) Explain the term 'Multivalued Dependency' using a suitable example. Your example must be different than those which were discussed in the class.

5. a) What are the ACID properties of a transaction? Explain briefly.

b) How do you differentiate between the term 'Serial schedule' and 'Serializable schedule'?

c) Consider the following schedule S.



Is S conflict serializable? If yes, what is the equivalent serial schedule to S? Explain your answer by accompanying a precedence graph for the aforesaid schedule. 8

d) Write the distinction between a 'Recoverable schedule' and a 'Cascadeless schedule'. Which one of them is more preferable? 5

6. a) What is concurrent access anomalies? Explain using a suitable example. 5
b) Explain 2PL protocol for concurrency control. 10
c) What are the deadlock prevention strategies? How can you detect a deadlock? 5+5

7. a) Discuss the different levels of Isolation. 7
b) What are the advantages and disadvantages of graph-based concurrency control protocol? 6
c) How can you transform generation/specialization of an E-R diagram into a set of relational schemas? 6
d) What is the major difference between RAID Level 1 and RAID Level 5? 6

8. a) The following figure shows a B^+ tree with n = 4 (a node can contain at most 4 pointers) where the search-key values are: 2, 3, 5, 7, 11, 17, 19, 23, 29, 31. Show the form of the tree after each of the following operations. Remember that operations are performed sequentially over the result of the previous operation. 10

i. Insert 9
ii. Insert 10
iii. Delete 23
iv. Delete 19

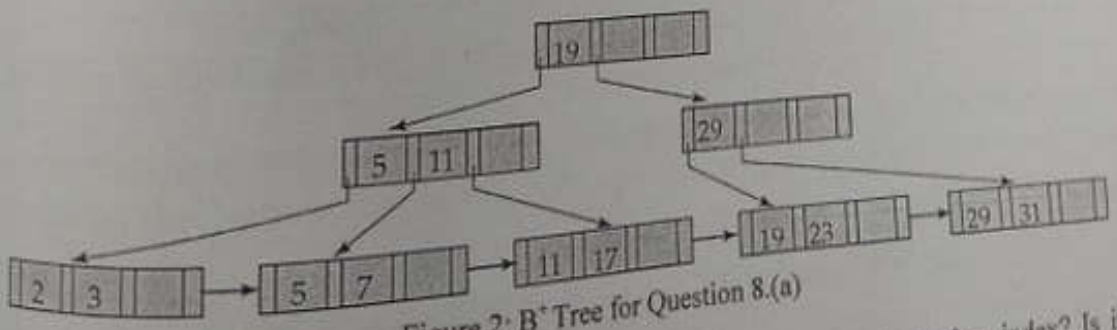


Figure 2: B^+ Tree for Question 8.(a)

b) What is the major difference between clustering index and non-clustering index? Is it possible to create a non-clustering sparse index? Justify your answer. 5+5

c) Assume that you have a relation r that consists of 10000 records and consumes 1000000 bytes of disk space. You want to create a sparse index on r that has an index entry for every block of data of relation r. The given block size is 4 KB and a record cannot be stored in multiple blocks. If each index entry consumes 20 bytes, what is the size of your sparse index? 5

APPENDIX

customers				
customer_id	customer_name	address	age	sex
C-001	Alice	Agargaon	38	F
C-002	Bob	Bashundhara	36	M
C-003	Christina	Chakbazar	42	F

products		
product_id	product_name	unit_price
P-001	Rice	60.50
P-002	Flour	90.50
P-003	Pran Spice	150.75
P-004	Pran Cola	20
P-005	Kitkat	50

orders		
order_id	product_id	quantity
OR-001	P-001	10
OR-001	P-005	20
OR-002	P-002	5
OR-003	P-003	5
OR-003	P-004	25
OR-003	P-001	20
OR-004	P-005	10

transactions			
customer_id	order_id	total_amount	date
C-001	OR-001	1605	15-MAY-2015
C-002	OR-002	452.50	01-JUN-2015
C-003	OR-003	2443.75	02-JUN-2015
C-001	OR-004	500	09-JUN-2015