

**Final Assessment Test - November 2025**

Course: PAMCA502 - Java Programming

Class NBR(s): 6024 / 6032

Slot: E1+TE1

Max. Marks: 100

Time: Three Hours

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

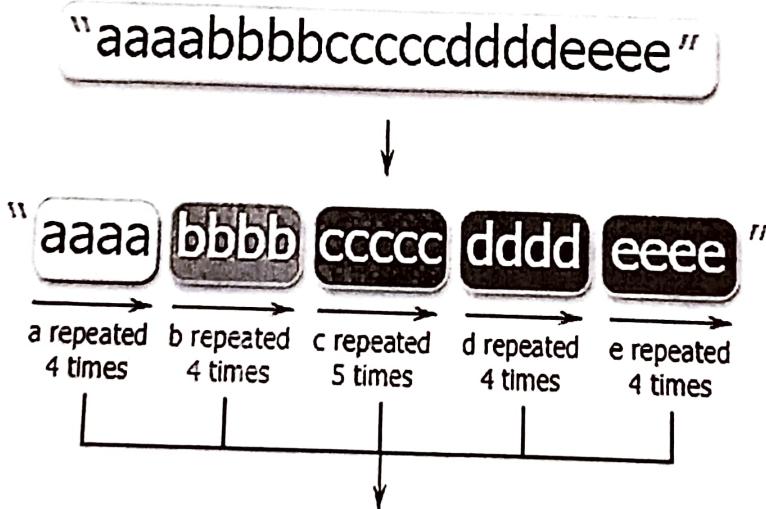
COs	CO Statements
CO1	Apply object-oriented principles to develop Java applications.
CO2	Develop multithreaded and exception-handling features in Java programs.
CO3	Build GUI-based database applications using JavaFX and JDBC.
CO4	Create web applications using Spring Boot and Hibernate.
CO5	Design microservice-based applications for distributed environments.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions

(10 X 10 = 100 Marks)

1. With an appropriate example and description, demonstrate the usage of static blocks, static variables and static functions. CO1 BL2
2. Given below is the pictorial representation of the string compression using the count of repeated characters? CO1 BL3



a4b4c5d4e4

Develop console based java application to implement the above representation.

3. Assume that table named Employee exists with details like Employee ID, Name, Department, Designation and Salary. Develop a Spring boot web app to list out the Employees earning more than 50000. Use microservices wherever necessary. CO5 BL4
4. Design a Library Book Search Portal using Servlet. The application specification is as follows: Maintain the book data (Book_Id, BookName, AuthorName, Price) in Hash table data structure. The Index page of the application should provide the search option of "Search by Book Name Starting with OS". Based on the option the servlet should search the hash table and display the result in formatted HTML Table view. CO4 BL4
5. Assume that you have the persistent class 'Course' with members Course Code, Course Name, School and Credits for the relation named 'Course' maintained in ACADEMIC database. Implement a driver class using hibernate API to insert an Course record. CO4 BL3
6. Create a 2-dimensional jagged array with n rows ('n' denotes the number of customers) to read and store the price details of different products purchased by them. The number of columns in each row depends on the number of products purchased by each customer. Write code to create the above array and display the discounted price (5%) for each item and the total amount to be paid by each customer in a table.
Note: Use enhanced for-loop to traverse the array. CO1 BL3
7. Assume that developer creates the Java Application to let user to feed the Employee ID, Employee Name, Basic Pay and the Project in which the Employee is working. Arrange to store the above information into the HashMap having Employee ID as key. Verify and throw appropriate exception if a map already contains a mapping for the specified key. CO2 BL4
8. Illustrate with appropriate code snippets exchanging the cookies between the client and server using Java Servlets. CO4 BL3
- 9.a) Implement a scenario in which Thread - 1 acquires lock on Math.class and then calls sleep() method which gives Thread - 2. The chance to execute immediately. Now Thread - 2 acquires lock on object.class then calls sleep() method and waits for Thread - 1 to release lock on Math.class.
 What would be the problem on initiating the execution of above scenario? Also provide solution for the problem in terms of appropriate code snippet. CO2 BL3

OR

CO2 BL3

- 9.b) You are requested by a banking concern to develop an application for persisting the details of users of a bank in one serializable file and also facilitate to display the number of admin level users with their contact information. Detail on the approach used for implementation of the above requirement with appropriate code blocks.

CO3 BL3

- 10.a) ~ Implement a batch insert operation using JDBC Prepared Statement to populate the details of newly joined employees of an organization. Assume that the table "Employee" contains the fields Employee Number of Number type, Employee Name of Varchar type, Experience in years of Number type and Employee Salary of Number with decimal values type.

OR

- 10.b) Assume you are developing the internet facing web application that uses a three tier architecture consisting of a physically separate web server, application server and database. Highlight the usage of middle tier application server in the context of security, performance, scalability and maintenance.

CO3 BL3

↔↔↔ BG/K/TY ↔↔↔

**Final Assessment Test – November 2025**

Course: PAMCA501 - Data Structures and Algorithms

Class NBR(s): 6014/6018

Slot: D1+TD1

Time: Three Hours

Max. Marks: 100

- **KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE**
- **DON'T WRITE ANYTHING ON THE QUESTION PAPER**

COs	CO Statements
CO1	Analyze time and space complexity of algorithms using asymptotic notation.
CO2	Compare searching, sorting, and nonlinear data structure techniques.
CO3	Design optimal solutions using graph-based data structures.
CO4	Apply greedy strategies to solve computational problems.
CO5	Apply dynamic programming strategies to solve computational problems.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions

(10 X 10 = 100 Marks)

1. Analyse the time complexity of the following data structures for searching, insertion and deletion operations. Justify with examples: CO2 BL2
 - a) Array [3]
 - b) Linked List [3]
 - c) Hash Table [4]
2. a) Construct a Binary Search Tree (BST) by inserting the following sequence of numbers: [5] CO2 BL3

50, 30, 70, 20, 40, 60, 80

Check whether the resultant tree is balanced or not. Justify your answer with the suitable balance factors of the nodes.

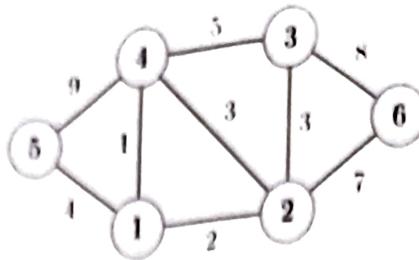
- b) Using Linear Probing, insert the following keys into a hash table of size 10 [5] using the hash function:

$$h(k) = k \bmod 10$$

23, 34, 45, 56, 67, 66, 87, 93, 99

Show the final state of the hash table.

3.



CO3 BL3

- a) For the graph given above, find the Minimum Spanning Tree (MST) using [4]
Kruskal's Algorithm.

- b) Find the MST using Prim's Algorithm, starting from vertex 5. [4]

- c) Compare the two methods and discuss how the choice of starting vertex [2]
affects Prim's Algorithm.

4. A company wants to compress a text file that contains letters with varying frequencies of occurrence. Explain how the company can use the Huffman coding algorithm to assign binary codes to letters based on their frequencies. Describe how to construct the Huffman tree step by step. Elaborate the process for encoding and decoding with the help of the variable length code table.

CO4 BL3

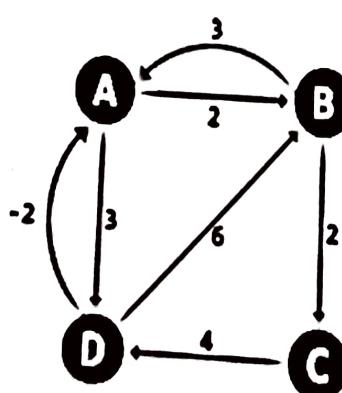
Consider the following message for the demonstration:

AAAAAAABBCCCDDEEEFFFFF

5.

- Explain how the Floyd-Warshall algorithm can be used to compute the shortest paths between all pairs of vertices of a graph. Implement the algorithm on the graph given below and present the distance matrix.

CO5 BL3



6. Design an algorithm to split a singly circular linked list containing n nodes into two equal circular linked lists.

CO1 BL3

If the original list contains an odd number of nodes, the first list should contain one node more than the second. Demonstrate the scenario using suitable example.

7. A company is organizing a coding hackathon where participants' scores are stored in an unsorted list after the event. Explain how the company can use the Heap Sort algorithm to sort the scores in ascending order. Show the step-by-step construction of the max heap from the given list. Demonstrate how elements are swapped and the heap is adjusted during each iteration of the sorting phase in an array. Write the final sorted list after performing Heap Sort.

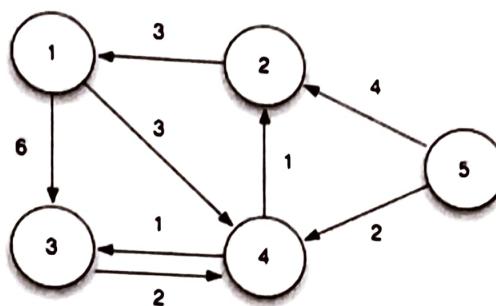
CO2 BL3

Participants scores:

20, 5, 16, 8, 14, 10, 12, 7, 3, 9

8.

CO3 BL3



Using the Dijkstra's algorithm, find the shortest path distances from vertex 1 to all other vertices.

Also, explain how this algorithm is not suitable for graphs with negative edges.

9.a) A data analyst has the following list of elements in an array

CO4 BL3

29, 10, 14, 37, 13, 5, 7, 20, 9, 25, 32

- Use Quicksort (choose the first element as pivot) to sort the array.
- Show the array after each partitioning step till the entire array is sorted.

OR

- 9.b) Explain how Strassen's algorithm reduces the number of multiplications compared to the standard matrix multiplication approach. Using Strassen's method, multiply the following two 2×2 matrices step by step:

$$A = \begin{bmatrix} 1 & 3 \\ 7 & 5 \end{bmatrix}, \quad B = \begin{bmatrix} 6 & 8 \\ 4 & 2 \end{bmatrix}$$

Compute the resulting matrix $C = A \times B$ and verify the result by comparing it with the conventional method.

- 10.a) Explain how backtracking is applied to solve the N-Queens problem. Describe how the algorithm explores possibilities and backtracks when a conflict occurs. Discuss how the algorithm ensures all solutions are found without duplication. Illustrate with a 4×4 board and show one possible solution arrangement.

OR

- 10.b) Explain how Dynamic Programming (DP) can be used to solve the 0/1 Knapsack problem. Describe the construction of the DP table and how it helps in finding the optimal solution. Illustrate the solution using a hypothetical scenario with 5 items having different weights and values (as per the table given below), and a truck with a weight capacity of 20 Kg.

	Weight (kg)	Value (\$)
1	2	3
2	3	4
3	4	5
4	5	8
5	9	10

↔↔↔ Y/K/TY↔↔↔


Final Assessment Test - November 2025

Course: PAMCA601 - Cloud Computing

Class NBR(s): 6367/6368

Slot: C1+TC1+TCC1

Time: Three Hours

Max. Marks: 100

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COs	CO Statements
CO1	Analyze the convergence of computing paradigms and virtualization in cloud environments.
CO2	Design scalable and resilient cloud infrastructures with modern techniques.
CO3	Implement cloud-native applications using DevOps and container orchestration.
CO4	Apply cloud security principles to protect cloud resources.
CO5	Evaluate the integration of edge computing and IoT with cloud services.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions
(10 X 10 = 100 Marks)

1. With reference to modern computational paradigms, Illustrate the evolution of High-performance Computing (HPC) systems and High Throughput Computing (HTC) Systems. Discuss the architectural differences, performance metrics and application domain. Support your answer with suitable examples. CO1 BL2
2. With a neat diagram explain how NIST cloud reference architecture be applied to an automobile company planning to migrate to cloud environment. CO1 BL1
3. Imagine you are the cloud architect, and if you have the responsibility of constructing a data center, what type of topology would you choose and why? Elaborate. CO2 BL3
4. A multinational bank with distributed data storage performs data manipulation with a MapReduce framework. Delineate the phases with sample data. CO3 BL2
5. A company plans to implement human mobility analytics system based on Hadoop Cluster. Elaborate on the architecture and its implementation with the tools. CO3 BL2

6. An internal employee with admin privileges in a hybrid cloud system accesses sensitive HR data without authorization. The company currently relies on role-based IAM policies but lacks behaviour monitoring. Explain how a Zero Trust model integrated with IAM can detect and prevent insider misuse of privileges. CO4 BL3
7. A large agricultural firm wants to deploy Cloud based IoT systems across 5000 acres of farmland to monitor soil moisture, temperature, and crop health in real-time. Explain how would you design the IoT architecture for this system. CO5 BL3
8. A smart city deploys an IoT-based traffic management system, that collects data from cameras, sensors, and GPS devices installed on vehicles and intersections. Explain how edge computing and fog hierarchy can be used to minimize latency in detecting traffic congestion and dynamically controlling traffic signals. CO5 BL5
- 9.a)- For any e-commerce application utilizing the services from the cloud service provider, Identify the possible threats and attacks you could expect; deduce your answer with respect to end user, network and service provider. CO4 BL2

OR

- 9.b) Explore the key cloud security design principles to be followed while setting up a cloud data center and to enable provision the services for a large scale of users. CO4 BL2
- 10.a) Consider you being a Cloud design architect in a large private bank, help them in capacity planning, scaling strategies and global load balancing. CO2 BL2

OR

- 10.b) Propose a Zero Down Time Architecture for any time-sensitive applications like Industrial automation owning its datacenter. CO2 BL2


Final Assessment Test - November 2025

Course: PAMAT501 - Probability and Statistics

Class NBR(s): 5542 / 6330

Slot: A1+TA1+TAA1

Time: Three Hours

Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
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General Instructions: Statistical Tables are permitted.

COs	CO Statements
CO1	Apply probability concepts and random variable distributions to model uncertainties in real-world data.
CO2	Select and apply suitable probability distributions for practical and experimental scenarios.
CO3	Interpret relationships among variables using correlation and regression analysis.
CO4	Perform statistical hypothesis tests using large sample techniques.
CO5	Use parametric and non-parametric methods for hypothesis testing in small or non-normal samples.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions
(10 X 10 = 100 Marks)

1. - A consulting firm rents car from three agencies such that 20% from agency X, 30% from agency Y and 50% from agency Z. If 90% of the cars from X, 80% of cars from Y and 95% of the cars from Z are in good conditions then find
 (i) What is the probability that the firm will get a car in good condition?
 (ii) If a car is in good condition, what is probability that it has come from agency Y?
- 2.a) - For the continuous random variable X with probability density function CO1 BL3

$$f(x) = \begin{cases} kx(1-x); & 0 < x < 1 \\ 0 & \text{otherwise} \end{cases} \quad \text{then}$$

 (i) Find k
 (ii) Find $E(X)$ and $Var(X)$.

OR

- 2.b) The following table represents the joint probability distribution of the two dimensional discrete random variable (X, Y) . CO1 BL2

Y	X		
	1	2	3
1	1/12	1/6	0
2	0	1/9	1/5
3	1/18	1/4	2/15

- (i) Find the marginal distribution functions of X and Y .
 (ii) Find the conditional distribution of X for given $Y = 2$.
 (iii) Find the conditional distribution of Y for given $X = 1$.

3. Out of 800 families with 4 children each, how many families would be expected to have (i) 2 boys and 2 girls, (ii) at least 1 boy, (iii) at most 2 girls. Assume equal probabilities for boys and girls. CO2 BL3
4. The weights of packets of sugar are normally distributed with mean $\mu = 1$ kg and standard deviation $\sigma = 0.05$ kg. CO2 BL2
 (i) Find the percentage of packets weighing less than 0.9 kg.
 (ii) Find the percentage of packets weighing between 0.95 kg and 1.05 kg.
5. In a partially destroyed laboratory record of an analysis of correlation data, the following results only are legible: Variance of $X = 9$, Regression equations: $8X - 10Y + 66 = 0$, $40X - 18Y = 214$. What were CO3 BL3
 (i) the mean values of X and Y ,
 (ii) the correlation coefficient between X and Y ,
 (iii) the standard deviation of Y ?
6. A financial analyst is studying the performance of a certain stock (X_1) based on two market indicators: the company's Price-to-Earnings ratio (X_2) and the overall market volatility (X_3). The simple (zero-order) correlation coefficients are given as $r_{12} = 0.90$ (Stock Price vs. P/E Ratio), $r_{13} = -0.50$ (Stock Price vs. Market Volatility) and $r_{23} = -0.60$ (P/E Ratio vs. Market Volatility). Calculate all partial correlation coefficients ($r_{12.3}$, $r_{13.2}$, $r_{23.1}$) and the multiple correlation coefficients ($R_{1.23}$). CO3 BL1
7. A manufacturer of light bulbs claims that on the average 2 % of the bulbs manufactured by his firm are defective. A random sample of 400 bulbs contained 13 defective bulbs. On the basis of this sample, can you support the manufacturer's claim at 5% LOS? CO4 BL3
8. A manufacturer claims that, the mean breaking strength of safety belts for air passengers produced in his factory is 1275 kilograms. A sample of 100 belts was tested and the mean breaking strength and SD were found to be 1258 kilograms and 90 kilograms respectively. Test the manufacturer's claim at 5% LOS. CO4 BL3
9. Four different drugs have been developed for a certain disease. These drugs are used in 3 different hospitals and the results, given below, show the number of cases of recovery from the disease per 100 people who have taken the drugs. CO5 BL3

		Drugs				
		D1	D2	D3	D4	
Hospitals		H1	29	6	21	7
		H2	10	11	13	8
		H3	15	17	12	6

What conclusion can you draw based on an analysis of variance?

- 10.a) The following data give the number of air-craft accidents that occurred during the various days of a week.

CO5 BL3

Day:	Mon	Tue	Wed	Thu	Fri	Sat
No. of accidents:	15	19	13	12	16	15

Test whether the accidents are uniformly distributed over the week.

OR

- 10.b) A researcher measured blood pressure (mm Hg) of 10 patients before and after a new drug. The readings (Before → After) are:

CO5 BL2

136→130, 142→139, 128→125, 150→152, 145→138, 131→130,
140→135, 148→149, 133→128, 137→133.

Test at 5% significance whether the median change is zero using the Sign Test.
State conclusion.

↔↔↔ Q/K/TY ↔↔↔


Final Assessment Test - November 2025

Course: PAMCA503 - Database Management Systems

Class NBR(s): 6036 / 6041

Slot: B1+TB1

Time: Three Hours

Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

COs	CO Statements
CO1	Design normalized relational schemas using ER and EER modeling.
CO2	Apply relational algebra and normalization techniques for schema optimization.
CO3	Develop complex queries using SQL and PL/SQL for data manipulation.
CO4	Implement transaction and concurrency control strategies.
CO5	Evaluate specialized models like NoSQL, distributed, temporal, and spatial databases.

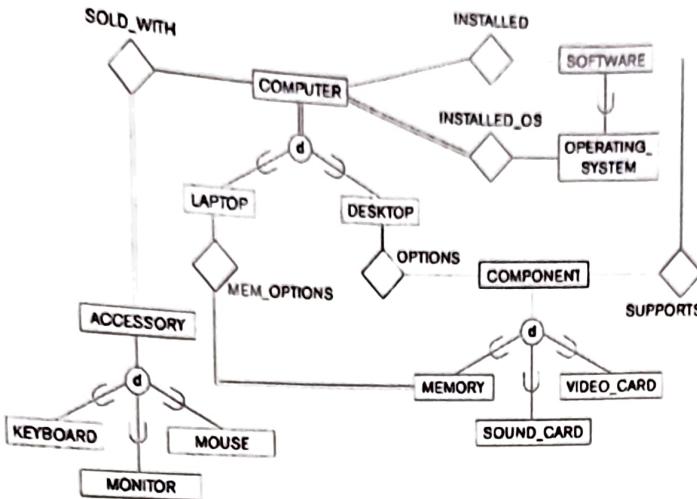
BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions
(10 X 10 = 100 Marks)

1. A multinational company, DataSphere Solutions, is designing an enterprise database system for its global retail operations accessible through web and mobile platforms. As the Database Architect, explain how you would design the system using an appropriate data model, apply the three-schema architecture with necessary mappings, and ensure logical and physical data independence to support scalability, flexibility, and efficient data management in an n-tier client/server environment. CO1 BL3

2. Consider the following EER diagram that describes the computer systems at a company. Provide your own attributes and key for each entity type. Supply min and max cardinality constraints justifying your choice. CO1 BL3
 - a) Write a complete narrative description of what this EER diagram [4] represents.

 - b) Map the EER schema of shown in Figure BELOW into a relational schema. [6]
Specify all primary keys and foreign keys.



Consider the following MAILORDER relational schema describing the data for a mail order company.

CO2 BL2

PARTS(Pno, Pname, Qoh, Price, Olevel)

CUSTOMERS(Cno, Cname, Street, Zip, Phone)

EMPLOYEES(Eno, Ename, Zip, Hdate)

ZIP_CODES(Zip, City)

ORDERS(Ono, Cno, Eno, Received, Shipped)

ODETAILS(Ono, Pno, Qty) Qoh stands for quantity on hand:

Specify and execute the following queries using the Relation Algebra interpreter on the MAILORDER database schema.

- Retrieve the names of parts that price less than \$20.00.
- Retrieve the names and cities of employees who have taken orders for parts pricing more than \$50.00.
- Retrieve the names of customers who have ordered parts from employees living in Wichita.
- Retrieve the names of customers who have not placed an order.
- Retrieve the names of customers who have placed exactly two orders.

4. Consider the relation REFRIG(Model#, Year, Price, Manuf_plant, Color), which is abbreviated as REFRIG(M, Y, P, MP, C), and the following set F of functional dependencies: $F = \{M \rightarrow MP, \{M, Y\} \rightarrow P, MP \rightarrow C\}$

CO2 BL4

- Evaluate each of the following as a candidate key for REFRIG, giving reasons why it can or cannot be a key: {M}, {M, Y}, {M, C}. [3]
- Based on the above key determination, state whether the relation REFRIG is in 3NF and in BCNF, giving proper reasons. [2]
- Consider the decomposition of REFRIG into $D = \{R1(M, Y, P), R2(M, MP, C)\}$. [5] Is this decomposition lossless? Show why.

5. Emp(eid: integer, ename: string, age: integer,
salary: real)

CO3 BL3

Works(eid: integer, did: integer, pct time: integer)
Dept(did: integer, budget: real, managerid: integer)

- Write SQL statements to find the enames of managers who manage the departments with the largest budget. [3]

- ii. Create SQL Triggers for Salary raise for the following requirements whenever an employee is given a raise, the manager's salary must be increased to be at least as much. Further, whenever an employee is given a raise, the department's budget must be increased to be greater than the sum of salaries of all employees in the department. [7]
6. Given a query, apply Heuristic Query Optimization to transform it into an optimized Query Tree and determine the Execution Plan. CO3 BL3
- ```
"SELECT LNAME FROM EMPLOYEE, WORKS_ON, PROJECT WHERE PNAME='Aquarius' AND ESSN=SSN AND PNUMBER=PNO AND BDATE > '1957-12-31';"
```
7. Consider the schedule S1 below. CO4 BL4
- S1: r1 (X); r2 (Z); r1 (Z); r3 (X); r3 (Y); w1 (X); w3 (Y); r2 (Y); w2 (Z); w2 (Y); c1; c2; c3;
- Determine whether the schedule S1 is conflict-serializable. For each schedule that is conflict-serializable, identify the equivalent serial schedule(s). [4]
  - Determine whether the schedule is strict, cascadeless, recoverable, or nonrecoverable. (Determine the strictest recoverability condition that the schedule satisfy.) [6]
8. a) Discuss the timestamp ordering protocol for concurrency control. CO4 BL2 [5]
- b) Figure shows the log corresponding to a particular schedule at the point of a system crash for four transactions, T1, T2, T3, and T4. Suppose that we use the immediate update protocol with checkpointing. Describe the recovery process from the system crash. Specify which transactions are rolled back, which operations in the log are redone and which (if any) are undone, and whether any cascading rollback takes place. [5]

|                                          |
|------------------------------------------|
| [start_transaction, T <sub>1</sub> ]     |
| [read_item, T <sub>1</sub> , A]          |
| [read_item, T <sub>1</sub> , D]          |
| [write_item, T <sub>1</sub> , D, 20, 25] |
| [commit, T <sub>1</sub> ]                |
| [checkpoint]                             |
| [start_transaction, T <sub>2</sub> ]     |
| [read_item, T <sub>2</sub> , B]          |
| [write_item, T <sub>2</sub> , B, 12, 18] |
| [start_transaction, T <sub>4</sub> ]     |
| [read_item, T <sub>4</sub> , D]          |
| [write_item, T <sub>4</sub> , D, 25, 15] |
| [start_transaction, T <sub>3</sub> ]     |
| [write_item, T <sub>3</sub> , C, 30, 40] |
| [read_item, T <sub>4</sub> , A]          |
| [write_item, T <sub>4</sub> , A, 30, 20] |
| [commit, T <sub>4</sub> ]                |
| [read_item, T <sub>2</sub> , D]          |
| [write_item, T <sub>2</sub> , D, 15, 25] |

← System crash

9.a) Consider the following relations:

C05 BL4

BOOKS(Book#, Primary\_author, Topic, Total\_stock, \$price)

BOOKSTORE(Store#, City, State, Zip, Inventory\_value)

STOCK(Store#, Book#, Qty)

Total\_stock is the total number of books in stock and Inventory\_value is the total inventory value for the store in dollars.

- i. Give an example of two simple predicates that would be meaningful for [3] the BOOKSTORE relation for horizontal partitioning.
- ii. How would a derived horizontal partitioning of STOCK be defined based [3] on the partitioning of BOOKSTORE?
- iii. Show predicates by which BOOKS may be horizontally partitioned by [4] topic.

(OR)

9.b) Critically analyse how temporal and spatial database concepts can be integrated to manage dynamic real world applications such as smart city management or health care monitoring systems. Support your answer with the role of valid time, transaction time and bitemporal data, along with spatial data types, operators and Indexing Methods.

C05 BL4

10.a) Explain the key concepts of NoSQL databases. In your answer, discuss:

C05 BL2

- The need for NoSQL systems and how they differ from traditional relational databases.
- The four main categories of NoSQL databases with one example for each category.
- The CAP theorem and its significance in NoSQL system design.
- Two features of a NoSQL database (such as MongoDB or Cassandra) that illustrate NoSQL system behavior.

(OR)

10.b) Explain MongoDB as a distributed NoSQL database. Discuss how UPDATE AND DELETE operations are performed in a distributed environment and describe the concept of sharding for horizontal scaling. Illustrate your answer with an example scenario.

C05 BL2

↔↔↔ S/K/TY ↔↔↔