

Final Assessment Test (FAT) - July/August 2023

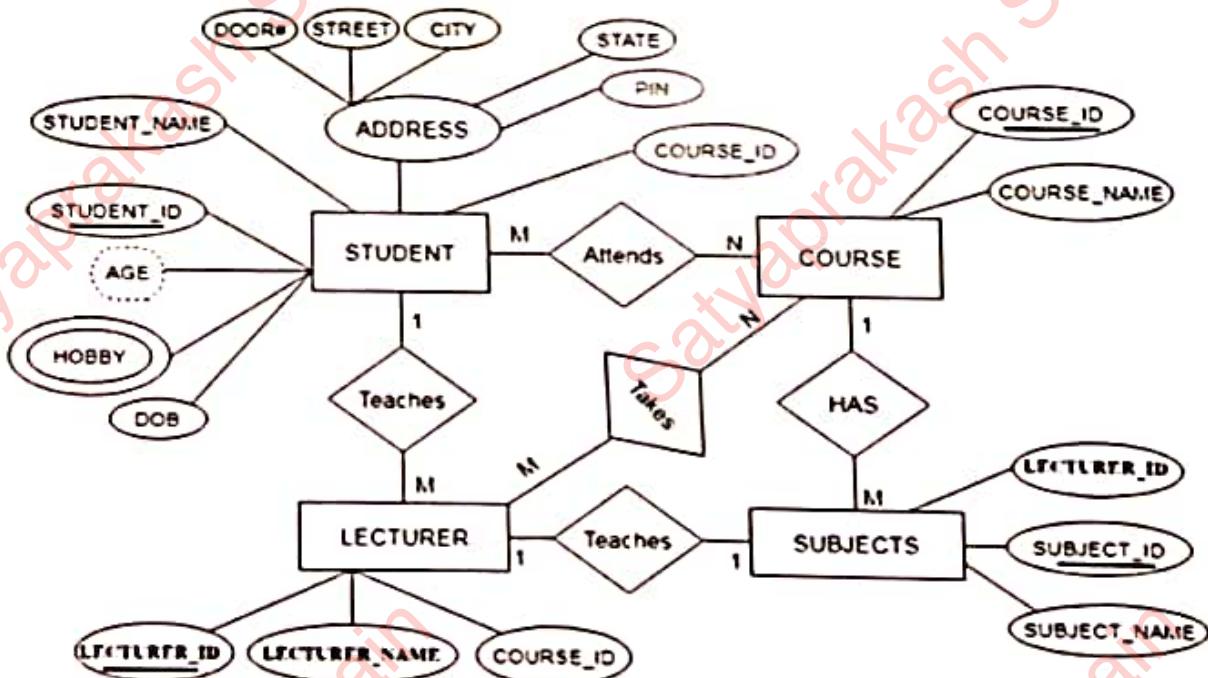
Programme	B.Tech.	Semester	Fall Inter Semester 22-23
Course Title	DATABASE SYSTEMS	Course Code	BCSE302L
Faculty Name	Prof. Reena Roy R	Slot	F2+TF2
Time	3 Hours	Max. Marks	100

Section A (7 X 10 Marks)
Answer all questions

01. Assume that an online retail store called "HappyShoppy" has experienced rapid growth in its [10] customer base and product inventory.
- Identify and elaborate the kind of DBMS architecture needed to manage their operations efficiently with a neat diagram. (8 Marks)
 - Mention the benefits of chosen architecture (2 Marks)

02.

[10]



- Map the above E-R model to appropriate relation schema.(5 Marks)
- Determine the primary key, foreign key, and any other appropriate constraints in the mapped schema and also describe the purpose of each constraints.(5 Marks)

03. Assume that you are the database designer at TeachEasy and you need to maintain the database for easier access and retrieval of records at any time. The database contains the following: [10]

Book ID	Published Date	Tutor ID	Title	Room	Phone Number	Block Numbers
B1	23.02.23	Tut1	PYTHON	AB3310	9940497934, 9940497938	AB3
B2	18.11.23	Tut3	SQL	AB1331	9876123456	AB1
B3	23.02.23	Tut1	MATLAB	AB2310	9940497934, 9940497938	AB2
B5	05.02.23	Tut3	JAVA	AB2332	9876123459	AB2
B4	04.07.23	Tut5	AZURE	DB321	9876543210	DB

Normalize the given table up to the third level normal form with proper justifications for violations in each form.

[10]

04. a. Banking System online application is used to store, manipulate and retrieve the customer's account details. Identify and describe the recovery techniques that can be applied for critical data restoration in case of some transaction failure or data corruptions. (4 Marks)
- b. Write the log records created during Deferred database modification and Immediate database modification for the following schedule. Assume that the initial values of A=1100, B=1200 and C=1000. (6 Marks)

TO: Read(A)
A:=A-550
Write(A)
Read(B)
B:=B+550
Write (B)

T1: Read(C)
C:=C-300
Write(C)

05. a. Consider the Grade Monitoring System that maintains the grade of the students in an institute that enables the faculty to post the grade and students to view their grade. A faculty posts the grade of the student A from the node XYZ and the student A access his/her grade from the node PQR. Illustrate the upholding CAP using the given scenario. (8 Marks)
- b. Comment on the statement : "Achieving CAP is not possible at all times in a distributed system" (2 Marks)

[10]

06.

Consider the following student table

Reg.No.	Name	Physics Marks	Chemistry Marks	Maths Marks	Age	Department	Residential City
1001	Hansh	90	80	98	19	SENSE	Chennai
1002	Ram	50	95	90	20	SENSE	Bangalore
1003	Suresh	80	85	75	19	SENSE	Mumbai
1004	Dhamu	95	95	55	20	SCOPE	Kolkata
1005	Prathik	85	70	85	19	SENSE	Delhi
1006	Gokul	65	52	40	18	SCOPE	Chennai

Write SQL query for the following.

- a. Add a new column "Average" in the above table and find the average of all the students (2 Marks)

[10]

- b. Display the name of all students whose residential city is either Chennai or Bangalore (2 Marks)
- c. List the name of all students in Upper Case those who are in the age 19 and studying in SENSE department (2 Marks)
- d. Display the minimum and maximum age of the students (2 Marks)
- e. Find the student name and department whose average mark above 80 department wise (2 Marks)

07. a. The management team wanted to check whether a particular faculty in the university is employed or not. Write a PL/SQL function to assist the management team so that a message is displayed as "Employed" Otherwise "Not Employed". (5 Marks)
- b. Create an explicit cursor named university_cur and fetch the details of all students in the student table whose department is SENSE. Also, Illustrate the ROWCOUNT using implicit cursor. (5 Marks)

Note: Assume the required tables with data are already existing in the database.

Section B (2 X 15 Marks)
Answer all questions

[15]

08. Consider the following relations of a university database.

Faculty (Empld, Name, Phno, School, DateOfJoining)
Student (RegNo, Name, Phno, School)
Course (CourseCode, CourseName, Credits)
CourseAllocation (ClassNumber, AEmpld, ACourseCode, Venue, MaxStrength, Slot)
StudReg (RegNo, ClassNumber)

- a. Write a relational algebra query and depict a query tree to find Name and Phone numbers of Faculty members who have joined after 01-01-2023 and handling DBMS course. (5 Marks)
- b. Convert the constructed canonical tree into optimized tree using Heuristic technique. (5 Marks)
- c. The Keys 12,18,13,2,3,23,5 and 15 are inserted into an empty hash table of length 8 using open addressing with hash function $h(k) = k \bmod 8$. Show the resultant hash table of each key entries (5 Marks)

09. Consider the Concurrent Transaction and initial values of A, B and C are 200, 200, and 380 respectively

[15]

Time	Transaction T _x	Transaction T _y
T ₁	Read(A)	Read(A)
T ₂	Read(B)	Read(B)
T ₃	Write(B=A+100)	
T ₄	Write(C=C*B ²)	Write(B=A+100)
T ₅	Read(C)	Write(C=C*B ²)
T ₆	Read(A)	Read(A)
T ₇	Read(B)	Read(B)
T ₈		Read(C)

- a. Identify and elaborate the issues on the concurrent transaction as given in the above table (4 Marks)
- b. Illustrate the solution to overcome the problems using lock based protocol (basic, Strict and Rigorous) with proper justification (11 Marks)



Final Assessment Test (FAT) - July/August 2023

Programme	B.Tech.	Semester	Fall Inter Semester 22-23
Course Title	DATABASE SYSTEMS	Course Code	BCSE302L
Faculty Name	Prof. Jani Anbarasi L.	Slot	C2+TC2
Time	3 Hours	Class Nbr	CH2022232501092
		Max. Marks	100

Part A (4 X 10 Marks)

Answer all questions.

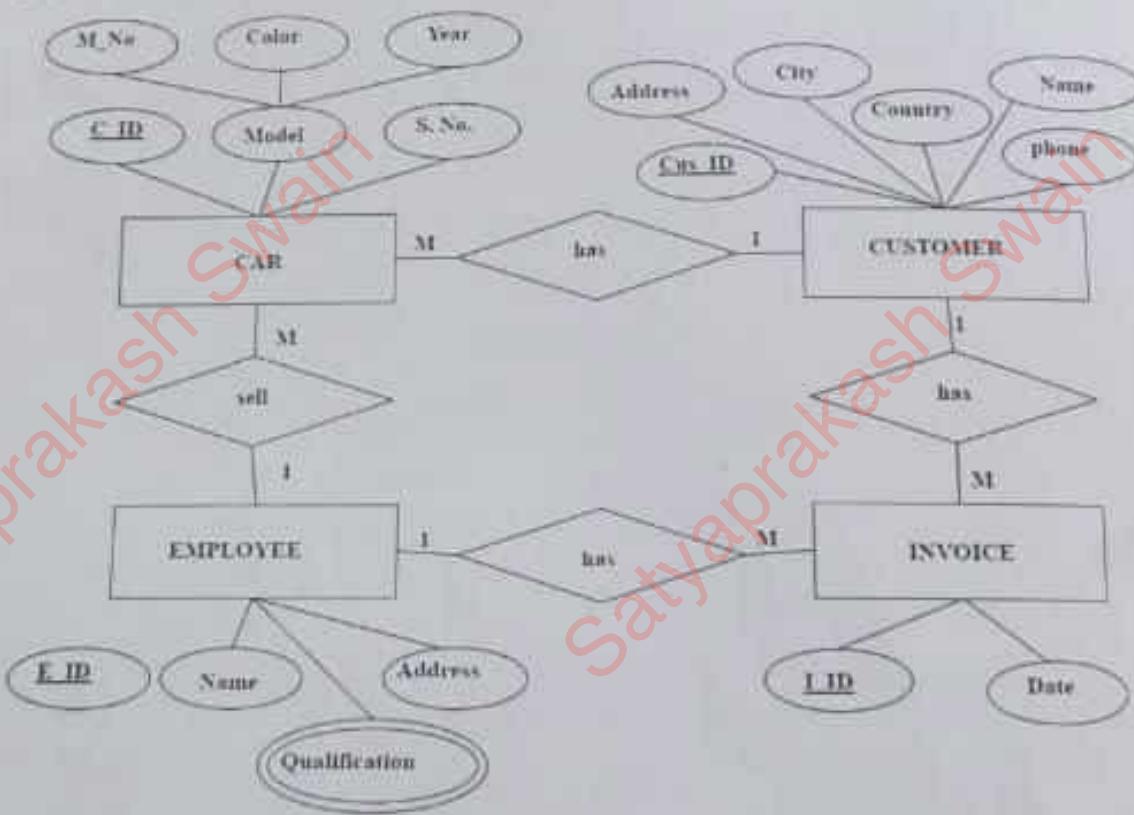
01. a) Consider a food manufacturing company that is managing the supply chain and tracking of production in the factories. List the characteristics of the relational database system maintained by the food manufacturing company (4marks). [10]
 b) Explain the roles of each actor related to food manufacturing database.(6marks)
02. Consider the information about RR Sports Club: [10]
 Registration_Table (Reg_id, Fname, Lname, Education, Age, Location, Gender)
 Sports_Table(Rid, Club, DateOfJoining, Level)
 Write the Relational Algebra expression and SQL query for the following
 a. List the name and location of students enrolled (age above 13) belonging to Football.(3 Marks)
 b. Count the level earned in each club by the student's group by Club.(2 Marks)
 c. List the name and date of joining of all girls in the Volleyball club. (2 Marks)
 d. List the DateOfJoining of the students enrolled whose qualification starts with letter 'B'. (3 Marks)
03. Consider the three transactions T1, T2, and T3, and the schedules S1 and S2 given below. Draw the serializability (precedence) graphs for S1 and S2, and state whether each schedule is serializable or not. If a schedule is serializable, write down the equivalent serial schedule(s) with proper explanation. If not, specify the reason for each schedule. [10]
 T1: r1(X); r1(Z); w1(X); w1(Z)
 T2: r2(Y); r2(Z); w2(Z)
 T3: r3(Y); r3(X); w3(Y)
 S1: r1(X); r3(Y); r3(X); r2(Y); r2(Z); w3(Y); w2(Z); r1(Z); w1(X); w1(Z) [5 marks]
 S2: r1(X); r3(Y); r2(Y); r3(X); r1(Z); r2(Z); w3(Y); w1(X); w2(Z); w1(Z) [5 marks]
04. A premier institute wants to store the research works carried out by its employees and their collaborators permanently. The type of research work can be a Journal publication, patents, Consultancy projects and challenging tasks. Each type of research may have information such as atomic data, multivalued data, numeric data and descriptive data. For example, data that has to be stored are the duration of research, starting and ending date, equipments used, description about the equipments, short biography about the researchers, short description of the research work carried or model description, whether published or not, if published where it is published and so on. Suggest a database to the institute for storing the data and explain how the data can be stored, retrieved and queried with suitable examples. [10]

Part B (4 X 15 Marks)

Answer all questions

Q5. i) A university wants to develop a system to manage its student enrollment process. The university offers multiple courses, and each course has several sections taught by different instructors. Students can enroll in multiple courses and sections. The university also wants to keep track of student grades for each course. Design an entity-relationship diagram (ERD) to represent the entities, relationships, and attributes involved in this scenario. The possible attributes you can use for designing an ERD are: ID, name, Email, credits, phone, time slot, class number, and grade. You can also use some attributes that are necessary to design an ERD for the scenario. This ERD represents the relationships between entities in the university's student enrollment system. It allows for the management of student enrollment, course offerings, instructor assignments, and grade tracking. (10 Marks)

ii) Map the following Entity-Relationship diagram to an equivalent relational schema. Justify the same with proper explanation. (5 Marks)



Q6. i) Show the result of inserting 10, 8, 15, 7, 3, 6, 12, 5, 9, and 17 into an initially empty right-biased B+ tree with the order of the tree (m) is 3. After that, illustrate the deletion of key values 9, 10, and 15. (10marks)

ii) Construct an extensible hashing structure by inserting the following key values into an empty bucket: (5marks)

5, 2, 6, 1, 7, 3, 4, 9.

Consider LSB of each key's binary value for insertion. Assume that each bucket can hold a maximum of two records.

Show the extensible hashing structure after each insertion.

Q7. a) A MRF Company wants to develop a database to keep track of persons, their children and their cars. [15]

For this purpose, they will use the following relation:

$\text{PersonData}(pNbr, pName, pAddress)$

$aMake, email, mobileNumber)$

$pNbr, pName, pAddress$ is the person number, name and address of a person.

$cNbr, cName, cAddress$ is the corresponding information for a child. Each person has exactly one address.

$aMake$ is the license number and make of a car. A car may be owned by more than one person.

Normalize upto 3NF

The functional dependencies hold by the relation as follows (9 marks)

FD1: $pNbr \rightarrow pName, pAddress, cNbr, aLic, email, mobileNumber$

FD2: $cNbr \rightarrow cName, cAddress$

FD3: $aLic \rightarrow aMake$

FD4: $pNbr, cNbr \rightarrow cName, email, mobileNumber$

FD5: $pNbr, aLic \rightarrow aMake$

b. Consider the following Functional Dependencies for the Relation Schema $R = (A, B, C, D, E)$.

Compute the minimal cover.

i) $A \rightarrow B, C \rightarrow B, D \rightarrow ABC, AC \rightarrow D$ (3 Marks)

ii) $AB \rightarrow C, D \rightarrow E, AB \rightarrow E, E \rightarrow C$ (3 Marks)

Q8. a) Consider the following transactions of a schedule:

Add necessary locking-unlocking instructions so that the entire schedule becomes recoverable and cascadeless. [10 Marks]

T1		
Read(P)		
$P=P+10$		
Write(P)		
Read(Q)		
$Q=Q-5$		
Write(Q)		
	T2	
	Read(P)	
	Read(Q)	
	Read(Sum)	
	$Sum = Sum + (P * Q)$	
	Write(Sum)	
		T3
		Read(Sum)
		Read(Q)
		$Sum = Sum + 2$
		Write(Sum)
		$Q = Q + 2$
		Write(Q)

b. Consider the following transaction scenario and check whether there exists any deadlock or not using wait-for graph. Justify your answer. (5marks)

Transactions	Data items requested
T1	A(Exclusive lock), B(Shared lock)
T2	B(Exclusive lock)
T3	B(Shared lock)
T4	A(Shared lock), C(Exclusive lock)

Final Assessment Test (FAT) - APRIL/MAY 202X

Programme	B.Tech	Semester	Winter Semester 202X-2X
Course Title	DATABASE SYSTEMS	Course Code	BCSE302L
Faculty Name	Prof. Jenila Livingston L M	Slot	
Time	3 Hours	Max. Marks	100

Section A (4 X 10 Marks)
Answer All questions

01. a) Assume that you are working as a database administrator for a multinational company. You have decided to organize the records in a hierarchical manner, where the records in a child table must be linked to the records in the parent table. Identify the best-suited data model to store the data and explain your model. (4 marks) [10]
- b) Further, as the DBA, you are supposed to describe the overall workflow of any three database users. illustrate with a diagram. (6 marks)
02. Consider the following tables [10]

EMPLOYEES TABLE:

Name	Null	Type
EMPLOYEE_ID	NOT NULL	NUMBER(6)
FIRST_NAME		VARCHAR2(20)
LAST_NAME	NOT NULL	VARCHAR2(25)
EMAIL	NOT NULL	VARCHAR2(25)
PHONE_NUMBER		VARCHAR2(20)
HIRE_DATE	NOT NULL	DATE
JOB_ID	NOT NULL	VARCHAR2(10)
SALARY		NUMBER(8, 2)
COMMISSION_PCT		NUMBER(2, 2)
MANAGER_ID		NUMBER(6)
DEPARTMENT_ID		NUMBER(4)

DEPARTMENT TABLE:

Name	Null	Type
DEPARTMENT_ID	NOT NULL	NUMBER(4)
DEPARTMENT_NAME	NOT NULL	VARCHAR2(30)
MANAGER_ID		NUMBER(6)
LOCATION_ID		NUMBER(4)

Write SQL statements for the following specifications: (5x2=10 marks)

- Display the last name and salary of employees who earn between 5,000 and 12,000, and are in department 20 or 50. Label the columns “Employee” and “Monthly Salary”, respectively.
- Create a report to display the last name and job id of all employees who do not have a manager.
- Create a report to display the last name, salary, and commission of all employees who earn commissions. Sort data in descending order of salary.

4. Find the highest, lowest, sum, and average salary of all employees for each job id. Round your results to the nearest whole number.
5. The HR department needs to find the names and hire dates of all the employees who were hired before their managers, along with their managers' names and hire dates.
03. Consider the three transactions T1, T2, and T3, and the schedules S1 and S2 given below, and check whether both schedules are equivalent or not. Construct the serializability (precedence) graphs for S1 and S2 and check whether each schedule is conflict serializable or not. [10]
- T1: $r1(X); r1(Z); w1(X); w1(Z);$
- T2: $r2(Y); r2(X); w2(Y);$
- T3: $r3(Y); r3(Z); w3(Z);$
- $S1: r2(Y); r1(X); r2(X); r3(Y); r3(Z); w2(Y); w3(Z); r1(Z); w1(X); w1(Z);$
- $S2: r2(Y); r1(X); r3(Y); r2(X); r1(Z); r3(Z); w2(Y); w1(X); w3(Z); w1(Z);$
04. a) Discuss in detail the relevance of the CAP theorem with respect to NoSQL. (6 marks)
- b) As a database designer, does the nature of the data have a say in the choice of a NoSQL database? Justify when you will opt to use a NoSQL database. (4 marks)

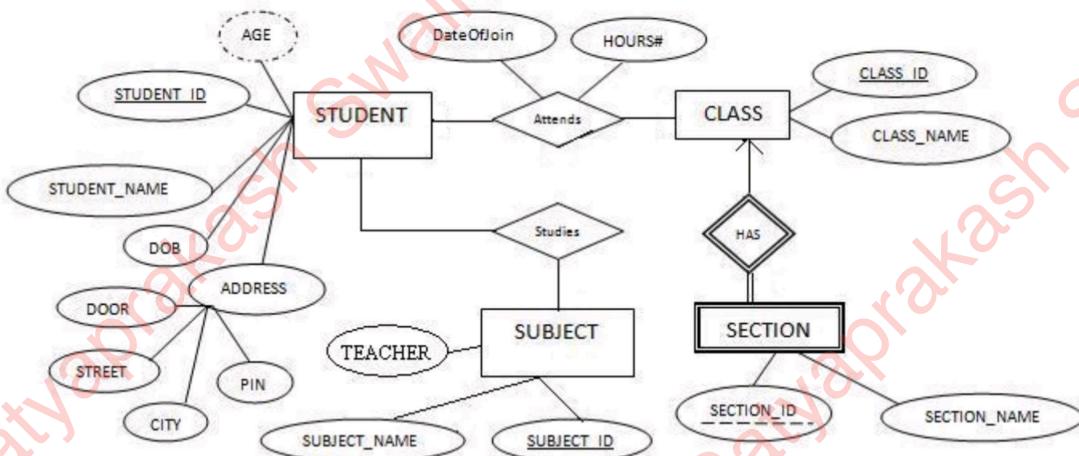
Section B (4 X 15 Marks)

Answer All questions

05. a) Draw an E-R diagram for the banking system based on the following assumptions. (8 marks) [15]

- Banks have customers
- Banks are identified by the name, code, and address of the main office.
- Banks have branches.
- Branches are identified by a branch_no, branch_name, and address.
- Customers are identified by name,cust-id, phone number, and address.
- Customers can have one or more accounts.
- Accounts are identified by account_no,acc_type, and amount.
- Loans are identified by loan_id,loan_type, and amount.
- Accounts and loans are related to the bank's branch.

- b) E-R diagram for the student class allocation system is given below. Convert the given E-R diagram to a relational schema. (7 marks)



06. [15]

a) Consider the relation, R (Doctor_id, Doctor_name, Patient_id, Patient_name, Diagnosis, Treatcode, Amount) with the following functional dependencies:

Doctor_id and Patient_id together determine unique tuples in the relation R.

Patient_id → Patient_name

Doctor_id → Doctor_name

Treatcode → Diagnosis, Amount

Is the relation R in 3NF? Justify your answer. If not, decompose this relation up to 3NF. (8 marks)

b) Consider the following functional dependencies:

FD 1: A → B

FD 2: AB → C

FD 3: D → AC

FD 4: D → E

i) Find any three super keys (3 marks)

ii) Find out the minimal cover corresponding to the given set of functional dependencies.

(4 marks)

07. For the given ‘Employee’ table,

[15]

EmpId	Empname	HoursPerWeek	ContractNo
1022	John Smith	40	C101
1033	Livingstone	42	C102
1042	Sarah White	35	C101
1065	Jafflyn	15	C103
1074	Franklin	45	C103
1092	Louis George	38	C102
1098	Geo Xavier	24	C102
1121	Janet	28	C103
1125	Joice	50	C101

a) Construct a primary dense index for the EmpID attribute (3 marks)

b) Develop a sparse index for the EmpID attribute (3 marks)

c) Apply $h(k) = (k+5) \bmod 11$ hashing function after extracting the '**last two digits of EmpID**' (**k**) and perform linear probing collision resolution technique. Identify the problem that would arise if a linear probing technique had been used. Suggest an alternative index structure to overcome the problem. (6 marks)

d) Write relational algebraic expressions to (1 ½ x 2 = 3 marks)

i) Display the number of employees who worked fewer hours than average hours per week

ii) Display the employee IDs and names of every employee working for ContractID C103

08. a) Consider a database with objects X and Y and assume that there are two transactions, T1 and T2. Transaction T1 reads objects X and Y and then writes object X. Transaction T2 reads objects X and Y and then writes objects X and Y. Write the notation for the given **schedule (S1)**.

[15]

Illustrate S1 for the following conflicts:

i) Read-write conflict. (2 marks)

ii) Write-write conflict. (2 marks)

b) Demonstrate how the strict 2PL protocol allows the above **schedule (S1)**. (6 marks)

c) Create a wait-for graph for the following transaction scenario and determine whether deadlock exists or not: (5 Marks)

Transaction	Data items locked by transaction	Data items transaction is waiting for
T1	X2	X1,X3
T2	X3,X10	X7,X8
T3	X8	X4,X5
T4	X7	X1
T5	X1,X5	X3
T6	X4,X9	X6
T7	X6	X5





KEEPING MOBILE PHONE/SMART WATCH, EVEN IN 'OFF' POSITION, IS EXAM MALPRACTICE

PART – A (8 X 5 = 40 Marks)

Answer ALL Questions

1. Detail the following Architectures for Database Management Systems.

- Centralized
- Two-Tier Client/Server Architecture
- Three-Tier Client/Server Architecture

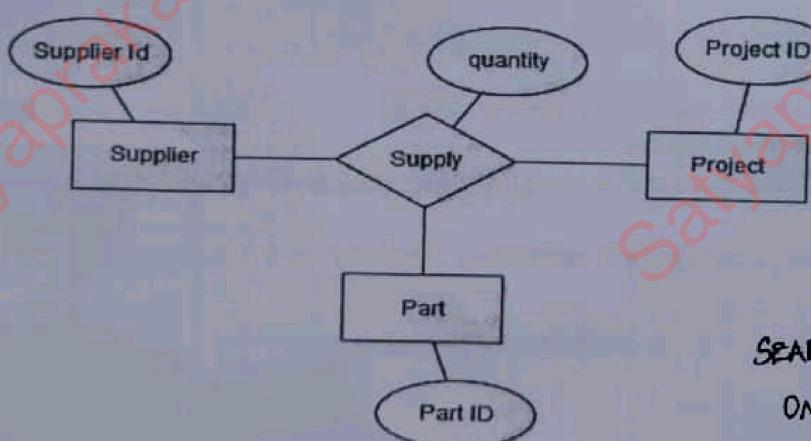
2. Consider the customer schema given below

customer(id, name, phone1, phone2, gender, branchid, income)

Demonstrate with SQL queries how to establish table level constraints on the customer schema for the following

- Combination of phone1 and phone2 should be unique in the customer table.
- Gender column should be allowed to take only 'MALE' or 'FEMALE' values.
- Branchid is a foreign key mapped to the branchid in the branch table.

3. Map the ER model to relation schemas and identify the primary and foreign keys for each relation.



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4. Derive the proof for the following Inference Rules.

- $X \rightarrow YZ$, then $X \rightarrow Y$ and $X \rightarrow Z$
- $X \rightarrow Y$ and $X \rightarrow Z$, then $X \rightarrow YZ$
- $X \rightarrow Y$ and $WY \rightarrow Z$, then $WX \rightarrow Z$



5. Consider the schema given below

Employee_details (EmployeeSSN, ProjectID, DependentID)

An Employee can work on many projects.

An Employee can have many dependents.

- Identify the primary key for the relation.
- Check if there are any non-trivial multivalued dependencies in the relation.
- Apply the tests for Normalization and achieve 4NF for the given relation.

6. Detail the disadvantages of a 2 Phase Locking Protocol and how it is overcome using Rigorous 2 Phase Locking with suitable examples.

7. What do you think are the disadvantages of multi-level indexing? Detail how dynamic multi-level indexes address the issues of multi-level indexes with suitable examples.

8. Construct a graph data model using the relations given below.

Employee

Employee SSN	Name	Department Number
123	Sam	111
124	Ram	222

Department

Department Number	Department Name
111	SCOPE
222	SITE

PART - B (6 X 10 = 60 Marks)

Answer ALL Questions

9. Construct an ER Model for the given Scenario and map the ER Model to relational schemas.
Scenario for a Banking Enterprise

- Every Customer in the bank should be identified by a unique customer number and described by a name, date of birth, street and city
- Customers hold an account in the bank. Every account is identified by a unique account id and account type.
- Customers can borrow loans from the bank. Each loan is identified by a unique loan number and amount fields.
- Customers can make payments on a loan in instalments. Each payment is identified by a payment number, payment date and payment amount.
- Customers can nominate nominees for their account. Every nominee is identified by a name, date of birth, gender, street, city.
- The bank has branches in many locations. Each customer is associated with a bank branch.

10. a) Determine all the keys, Prime and Non-Prime Attributes for the relation T(PQRS) with the following [5]
Functional Dependencies.
 $F=\{PQ \rightarrow R, R \rightarrow S, S \rightarrow Q\}$

b) Identify the Normal Form for the relations R and S given below

• Relation R(ABCD) with set of Functional Dependencies

$$F=\{AB \rightarrow C, B \rightarrow C, A \rightarrow D\}$$

• Relation S(PQR) with set of Functional Dependencies

$$F=\{PQ \rightarrow R, R \rightarrow Q\}$$

Decompose the relations R and S such that they attain Boyce Codd Normal Form.

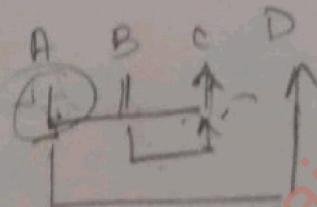
11. A relation R(ABCDE) with the set of Functional Dependencies

$$F = \{A \rightarrow C, B \rightarrow C, C \rightarrow D, DE \rightarrow C, CE \rightarrow A\}$$

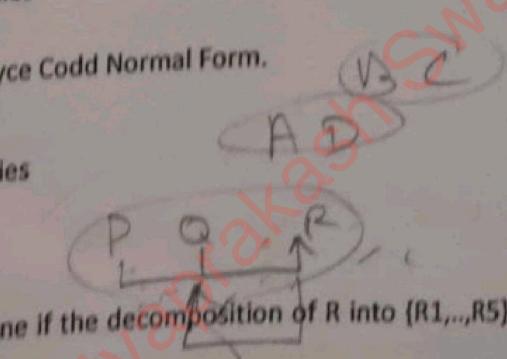
is decomposed as shown below

R1(AD), R2 (AB), R3(BE), R4(CDE), and R5 (AE).

Apply the test for non-additive Join Property and determine if the decomposition of R into {R1,...,R5} is a lossless join decomposition.



[5]



V3 C

12. Consider the following relation schemas.

- Employee(ssn, name, designation, dep_number)
- Department(dep_number, dname, dlocation)
- Workson(ssn, project_id)
- Project(project_id, project_name)

Construct an Initial Query Tree and Optimized Query Tree using Heuristic Query Optimization Techniques for the SQL query given below.

Select e.name, p.project_name from employee e, department d, workson w, project p where e.dep_number=d.dep_number and e.ssn=w.ssn and w.project_id=p.project_id and d.dname='SBST' and p.project_name='OS';

13. a) Detail the following issues with Concurrent Transactions using suitable examples. [5]

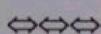
- Lost Update Problem
- Temporary Update Problem
- Incorrect Summary Problem

b) Explain the log based recovery techniques for transactions. [5]

14. a) Detail the differences between the following with suitable examples. [5]

- Primary and Secondary Indices
- Dense and Sparse Indices

b) Compare BASE and ACID Properties of Transactions





Answer ALL Questions

(10 X 10 = 100 Marks)

- a) Compare the characteristics of Database System Approach with File processing systems. List the [5] duties of a Database Administrator who is an actor in database systems.
- b) Define Schema and Subschema in Database Systems. Sketch the three level architecture for Database [5] Management Systems.
2. a) Draw the architectures and explain the components present in the architectures for Centralised [5] Database Systems.
- b) Sketch the architecture of three level client server databases and explain it. [5]
3. Develop an Entity-relationship model for a banking system using the following.
 - Customer Entity with attributes customer-name, social-security_number, customer-street and customer-city where social_security_number is the key attribute.
 - Account entity with attributes account-number and balance where account number is the key attribute
 - Depositor relationship between customer and account entities which itself has an attribute access date.
 - A loan entity with loan_number and loan_amount as attributes which is related to the customer entity through a relationship called borrower.
 - A weak entity called payment with attributes payment_number and payment_amount and payment_date. This entity is related to the loan entity through the relationship
 - For this scenario, draw an E-R diagram by providing suitable mapping cardinalities. [3]
 - Convert this E-R diagram into database tables and explain them. [3]
 - If there are two types of accounts namely savings account and checking account with attributes interest rate for savings account and over draft amount for checking account, extend this E-R diagram to include these entities. [2]
 - d) Explain generalization and specialization using the extended E-R Diagram. [2]
4. Consider the following relation named Hostels

Relation name: Hostels

Student_ID	Hostel_Block	Fee
100	A_Block	20000
150	B_Block	25000
200	D_Block	40000
250	C_Block	30000
300	D_Block	40000
400	B-Block	25000

Key :Student_ID

FDs :

1. Hostel_Block → Fee
 2. Student_Id → Hostel_Block
 3. Student_ID → Fee
- a. (i) Is this relation in First Normal Form? Why? [1]
- (ii) Is this relation in Second Normal Form. If yes, explain. If not, convert into Second [2] Normal Form.

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(iii) Is this relation in Third Normal Form. If yes, explain. If not, convert into Third Normal [2]

- b) Consider the following table named SPJ
SPJ (S#, P#, J#)

S#	P#	J#
S1	P1	J1
S1	P2	J1
S2	P1	J1
S1	P1	J1

- i) Check whether this table has insertion and deletion anomalies. Explain. [1]
- ii) Provide a non-loss decomposition by splitting the table either into two tables namely SP (S#, P#) and PJ (P#, J#) or into three tables namely SP (S#, P#), PJ(P#,J#) and SJ(S#,J#). [2]
- iii) Which one of the above decompositions is non-loss, Explain? [2]
5. a) Is $B \rightarrow G$ in F^+ where [4]
 $R = \{A, B, C, D, E\}$ and
 $F = \{B \rightarrow CD, E \rightarrow F, D \rightarrow E, B \rightarrow A, AD \rightarrow B, F \rightarrow G\}$
- b) Remove any redundant FDs from the following sets of FDs given in F, using the attribute closure algorithm where [6]
 $F = \{AD \rightarrow B, B \rightarrow C, C \rightarrow D, A \rightarrow B\}$
6. a) List the Transformation Rules for Relational Algebra Operations that are used for algebraic query optimization. [5]
- b) You are given the following SQL Query. [5]
- ```
SELECT LNAME
 FROM EMPLOYEE, WORKS_ON, PROJECT
 WHERE PNAME = 'AQUARIUS' AND PNMUBER=PNO AND ESSN=SSN AND BDATE > '1957-12-31';
```
- Write the relational algebra expression that is equivalent to this query. Draw initial query tree for this expression. Find a final query tree that is efficient to execute.
7. a) Write the Properties of a transaction. Explain the need for using locks in concurrent execution of transactions. Draw the compatibility matrix for locks. [5]
- b) Define serializability. Give an example to show the serializability of transactions. How will you check whether a given schedule is serializable? [5]
8. a) Distinguish between immediate modification and deferred modification methods used in log based recovery protocol. Explain them using Redo and Undo operations for making recovery based on commit and abort operations stored in the log records. [5]
- b) State and explain the two phase locking protocol used for concurrency control. [5]
9. Develop a multilevel indexing structure with four keys in each level of the index tree for the key values 2, 35, 55 and 85. Explain the single and multi-level indexing techniques. You must create at least three levels of the tree by considering the first level bases as 2, 8, 15, 24, 35, 39, 44, 51, 55, 63, 71, 80 and 85. The primary key fields are 2, 5, 8, 12, 15, 21, 24, 29, 35, 36, 39, 41, 44, 46, 51, 52, 55, 58, 63, 66, 71, 78, 80, 82, 85 and 89. [5]
10. Compare distributed databases and NOSQL databases based on ACID properties and BASE properties. Also explain the CAP theorem. [5]





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(Deemed to be University under section 3 of the UGC Act, 1956)

Reg. No. :

22BCE1351

### Final Assessment Test (FAT) - May 2024

|              |                       |             |                           |
|--------------|-----------------------|-------------|---------------------------|
| Programme    | B.Tech.               | Semester    | WINTER SEMESTER 2023 - 24 |
| Course Title | DATABASE SYSTEMS      | Course Code | BCSE302L                  |
| Faculty Name | Prof. K P Vijayakumar | Slot        | A1+TA1                    |
| Time         | 3 Hours               | Class Nbr   | CH2023240502441           |
|              |                       | Max. Marks  | 100                       |

#### General Instructions:

- Write only Register Number in the Question Paper where space is provided (right-side at the top) & do not write any other details.

**Answer all questions (10 X 10 Marks = 100 Marks)**

Q1. ABC Car Manufacturing Company is implementing a three-tier architecture for its database management system. The architecture consists of a presentation tier, an application tier, and a data tier. [10]

- a) As a database administrator of the car manufacturing company, explain the responsibilities (3 marks)
- b) Describe the three-tier architecture for the given specification with a neat diagram. (7 marks)

Q2. You are hired to design an Extended Entity-Relationship (EER) diagram for a vehicle management system for a rental company. The system needs to support various types of vehicles, each with unique attributes. Design an EER diagram that incorporates superclasses, subclasses, overlapping, and disjoint attributes to accurately represent the types of vehicles and their characteristics in the system. Make your assumptions wherever necessary. [10]

- Vehicle is identified by VehicleID, Make, Model, Year, Color, etc.
- Car, a type of vehicle, identified by NumDoors, NumPassengers, TransmissionType, etc.
- Truck, another type of vehicle identified by CargoCapacity, TruckType, FuelType, etc.
- Motorcycle, a third type of vehicle identified by EngineSize, FuelCapacity, MotorcycleType, etc.
- Some attributes may apply to more than one subclass. For example, "FuelType" could apply to both trucks and motorcycles.
- Some attributes may be unique to a particular subclass. For example, "NumDoors" would only apply to cars, not to trucks or motorcycles.
- Company is identified by the CompanyID, CompanyName, Location, EstablishedYear
- Customers who purchase vehicles are identified by CustomerID, Name, Address, Contact Information, etc.
- Transaction identified by TransactionID, VehicleID, CustomerID, CompanyID, Sale Date, Total Price, etc.
- Company- Vehicle: Represents the relationship between companies and the vehicles they sell.
- Each company can sell multiple types of vehicles, and each vehicle can be sold by multiple companies.

M : h

- Customer- Transaction: Represents the relationship between customers and transactions.
- Multinational Companies are allowed to sell all types of vehicles
- Small-scale companies are allowed to sell only one type of vehicle
- A company that sells motorcycles, should not sell trucks
- Each customer can participate in multiple transactions, and each transaction involves exactly one customer.
- Company- Transaction: Represents the relationship between companies and transactions.
- Each company can participate in multiple transactions, and each transaction involves exactly one company.

03. Consider the following conference relational schema:

[10]

**Conference Table**

| reg_no | name | college_name | college_address | event_number | event_name          | date |
|--------|------|--------------|-----------------|--------------|---------------------|------|
| 101    | x    | xyz          | abce            | 1            | paper presentation  | xxx  |
| 102    | y    | abc          | cbed            | 2            | poster presentation | yyy  |
| 103    | z    | pqr          | pqrst           | 1            | paper presentation  | yyy  |
| 101    | x    | xyz          | abce            | 2            | poster presentation | yyy  |

a) Find out the type of anomaly for the following cases by considering the Conference Table. (3 Marks)

- The Student 'a' wishes to register for the conference without event details
- Assume that the poster presentation event is canceled due to some unavoidable circumstances
- The student 'x' wishes to change the name of the college since that student had registered his college name wrongly.

b) Normalize the Conference table until you reach the highest normal form. (7 marks)

04. Consider the relation R(A, B, C, D, E, F) and the corresponding functional dependencies of R,

$$FD = \{A \rightarrow C, AB \rightarrow C, C \rightarrow DF, CD \rightarrow F, EC \rightarrow AB, EF \rightarrow C\}$$

a) Find the candidate key(s) of the given relation R (2 marks)

b) Find the minimal cover (6 marks)

c) Find the candidate key from the set of functional dependencies provided after applying minimal cover (2 marks)

05. The keys 10, 16, 11, 25, 3, 21, 8, 18, 15, and 9 are inserted into an empty hash table of length 10 using linear and quadratic open addressing with the hash functions  $h(key) = key \bmod 8$ . Show the resultant hash table of each key entry.

06. Consider a database schema for employee details consisting of the following relations:

employee (employee\_id, name, department\_id, salary)

department (department\_id, department\_name, location\_id)

location (location\_id, city, country)

a) Write the relational algebra expression to retrieve the names of employees who work in the "Finance" department located in "New York" and have a salary greater than \$50,000. (2 Marks)

b) Provide a step-by-step representation in constructing of the optimized query tree. (8 Marks)

07. Consider a database system where multiple concurrent transactions are accessing a shared database.

[10]

- a) While one transaction is accessing a data item, no other transaction can modify that data item. Suggest a solution to implement, and explain this constraint. (3 Marks)
- b) Discuss how a transaction is allowed to grant access to a data item with locks. (3 Marks)
- c) Discuss how the two-phase locking protocol ensures serializability and prevents conflicts among concurrent transactions. (4 Marks)

Q. Consider the following two transactions:

[10]

T13:

```
read(A);
read(B);
if A = 0 then B := B + 1;
write(B)
```

T14:

```
read(B);
read(A);
if B = 0 then A := A + 1;
write(A).
```

Let the consistency requirement be  $A = 0 \vee B = 0$ , with  $A = B = 0$  as the initial value.

- a) Show that every serial execution involving these two transactions preserves the consistency of the database. (2 Marks)
- b) Is there a concurrent execution of T13 and T14 that produces a serializable schedule? Justify your answer (2 Marks)
- c) Convert a serial schedule of T13 and T14 to a non-serial concurrent schedule (2 Marks)
- d) Convert a serial schedule of T13 and T14 to a non-serial concurrent schedule which doesn't preserve the consistency of the database. (2 Marks)
- e) Show a concurrent execution of T13 and T14 that produces a non-serializable schedule. (2 Marks)

Q. Consider the following customer food ordering schema.

[10]

```
customer(custid, custname, mob, address)
restaurant(rid, r_name, location)
food(f_id, item_name, price)
cust_rest_food(custid, rid, fid)
```

Write SQL queries for the following:

- a) Create the table for the cust\_rest\_food relation with key constraints. (4 Marks)
- b) Set a constraint to the price of the food item so that it should not be less than 50 and should not exceed 800 (2 Marks)
- c) Add a not null constraint to 'mob' in customer relation (1 Mark)
- d) List the name of the food items ordered by the customer 'Sai' which costs more than 500. (2 Marks)
- e) Delete the customers who don't reside in 'Chennai' (1 Mark)

Q. Consider the Grade Monitoring System which maintains the grades of the students in an institute that enables the faculty to post the grade and students to view their grades. Consider, that a faculty member posts the grade of the student 'A' from the node XYZ, and the student 'A'

[10]

accesses his/her grade from the node PQR. Illustrate the upholding CAP for the given scenario with suitable diagrams.





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### Final Assessment Test (FAT) - May 2024

|              |                    |             |                           |
|--------------|--------------------|-------------|---------------------------|
| Programme    | B.Tech.            | Semester    | WINTER SEMESTER 2023 - 24 |
| Course Title | DATABASE SYSTEMS   | Course Code | BCSE302L                  |
| Faculty Name | Prof. Premalatha M | Slot        | A2+TA2                    |
| Time         | 3 Hours            | Class Nbr   | CH2023240502443           |

#### General Instructions:

- Write only Register Number in the Question Paper where space is provided (right-side at the top) & do not write any other details.

#### Answer all questions (10 X 10 Marks = 100 Marks)

01. You are hired as a database expert to design a comprehensive database system for a university. [10]

The university requires a robust architecture that can efficiently manage various aspects including student information, course offerings, faculty details, academic records, and administrative functions. The university also desires a scalable and maintainable system that can accommodate future growth and changes in the requirements. Illustrate the importance of the three-tier architecture for the given scenario.

02. You are tasked with designing an Entity-Relationship (ER) diagram for a railway reservation system. The system is intended to facilitate the booking and management of train tickets for the passengers. Design an ER diagram that accurately represents the entities, relationships, different types of attributes, mapping cardinalities, participation constraints involved in the railway reservation system. [10]

- Passenger: Represents individuals who book tickets for train journeys identified with PassengerID (Primary Key), Name(composite attribute), DoB, Age(derived attribute), Gender, Contact Information(multivalued attribute).
- Train: Represents the trains running on different routes identified with TrainID (Primary Key), Train Name, Route, Departure Time, Arrival Time.
- Ticket: Represents the ticket booked by a passenger for a specific journey identified by TicketID (Primary Key), PassengerID, TrainID, Seat Number, Booking Date.
- Station: Represents the stations where trains halt during their journey identified by StationID (Primary Key), Station Name, Location, etc.
- Route: Represents the sequence of stations a train passes through during its journey identified by RouteID (Primary Key), TrainID, StationID, Sequence Number, Distance between Stations, etc.
- One passenger can book multiple tickets for different journeys. One ticket is booked by exactly one passenger.
- One train follows one route. One route is followed by exactly one train.
- One route includes multiple stations. One station is included in multiple routes.

- One ticket is booked for one train journey. One train journey can have multiple tickets booked.

03. Consider the following table representing student course enrollment.

[10]

| Stu_ID | Stu_Name | Course_ID | Course_Name | Instr_ID | Instr_Neme  | Ins_Office |
|--------|----------|-----------|-------------|----------|-------------|------------|
| 101    | Alice    | 1         | Mathematics | 201      | Prof. Smith | SM1        |
| 102    | Bob      | 1         | Mathematics | 201      | Prof. Smith | SM1        |
| 103    | Charlie  | 2         | Physics     | 202      | Prof. John  | JO 2       |
| 104    | David    | 2         | Physics     | 202      | Prof. John  | JO 2       |
| 105    | Eve      | 3         | Chemistry   | 203      | Prof. Lee   | LO3        |
| 106    | Frank    | 4         | Biology     | 204      | Prof. Brown | BO4        |

- Identify and justify the types of anomalies which can occur during insert/update/delete operations for the student course enrollment table (3 Marks)
- Normalize the student course enrollment table till it reaches the highest normal form (7 Marks)

04. Construct a B+ Tree of node size 3 for the set of key values {101, 102, 115, 116, 203, 205, 229, 301, 310, 323, 351} and update and delete the tree for each of the following sub divisions ii), iii) and iv);

- Show the tree after the insertion of all the key values. (4 marks)
- Dynamically update the tree for the insertion of {201} (2 Marks)
- Dynamically update the tree for the insertion of {208} (2 Marks)
- Delete {116, 229, 301} from the recently updated table and show how the tree will shrink after deletion. (2 Marks)

05. i). Imagine you're developing a banking application where users can transfer money between their accounts. One user initiates a transfer of ₹5000 from their current account to their savings account. However, just after initiating the transfer, the server crashes unexpectedly before the transaction completes. Discuss how you would ensure that the system maintains the ACID properties and transaction state integrity in this scenario. What steps would you take to guarantee that the transfer either fully succeeds or fails without leaving the system in an inconsistent state? (7 Marks)

[10]

- Explain the different transaction states with a neat sketch. (3 Marks)

06. i). Consider the initial value of the data items A, B and C as 25000, 12000 and 10000 respectively for the schedule S1. Illustrate the log records for the schedule S1 while applying the deferred database modification and immediate database modification (6 marks)

[10]

Schedule S1

|    |            |
|----|------------|
| T1 | Read (A)   |
|    | A:=A-15000 |
|    | Write(A)   |
|    | Read (B)   |
|    | B:=B+15000 |
|    | Write(B)   |
| T2 | Read (C)   |
|    | C:=C-1500  |
|    | Write(C)   |

ii). Consider the schedule S2, identify and justify whether the schedule is cascadeless schedule or not. If the schedule S2 is not cascadeless then convert it into cascadeless schedule. (4 marks)

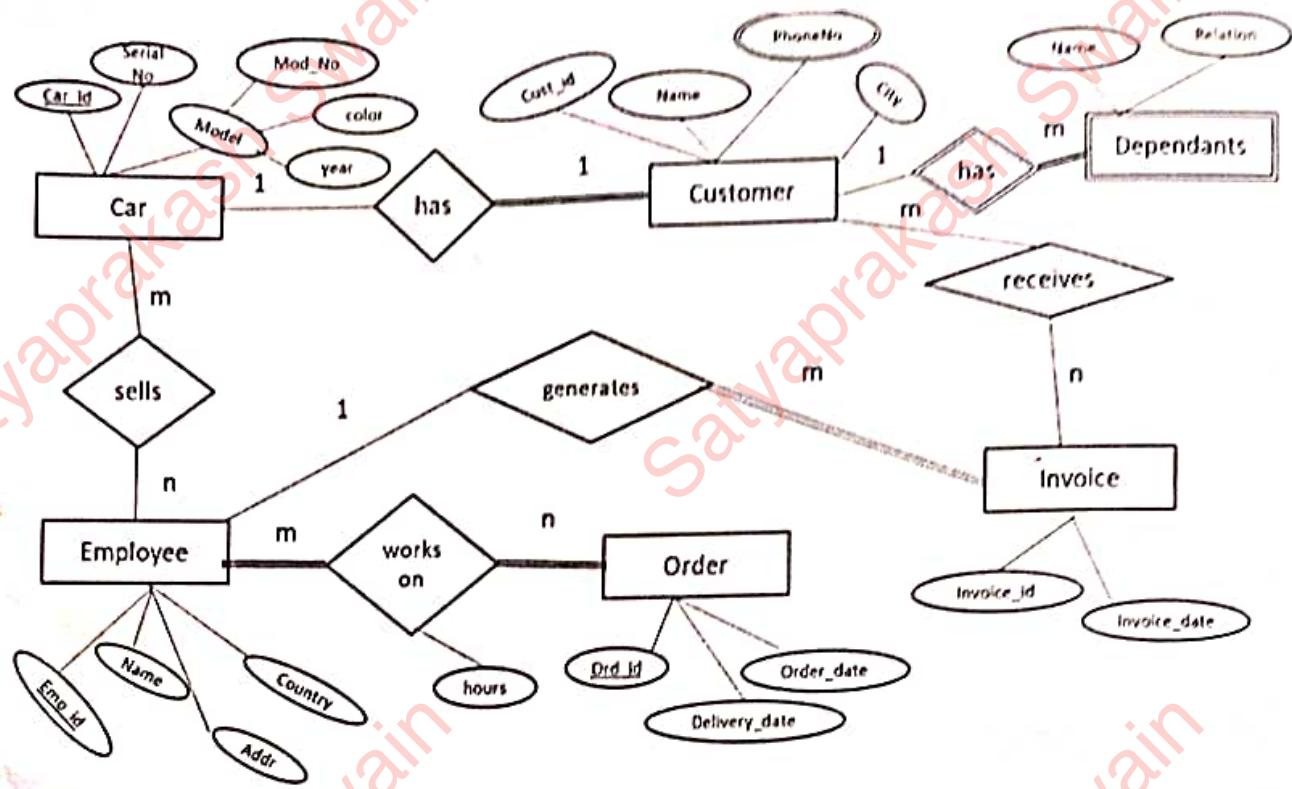
Schedule S2

| T1         | T2        | T3       |
|------------|-----------|----------|
| Read (A)   |           |          |
| A:=A-15000 |           |          |
| Write(A)   |           |          |
| Read (B)   |           |          |
| B:=B+15000 |           |          |
| Write(B)   |           |          |
|            | Read (A)  |          |
|            | A:=A-2000 |          |
|            | Write(A)  |          |
|            |           | Read (A) |

07. Assume that you are asked to design a database system for a large e-commerce platform that experiences high traffic volumes and needs to efficiently handle various types of data. The platform caters to different types of users, including customers, sellers, and administrators. The database needs to support real-time inventory management, user authentication, order processing, and analytics for business insights. [10]

Outline the considerations and decision-making process for choosing between different types of NoSQL databases (document-oriented, key-value, column-oriented, and graph databases) to best suit the requirements of this e-commerce platform. Discuss the specific features, advantages, and potential drawbacks of each type in the context of this scenario. Additionally, explain how the chosen NoSQL database type aligns with the scalability, performance, and data modeling needs of the platform.

08. Convert the given Entity Relationship (ER) diagram into a relational model with step by step illustration. [10]



09. Consider the following relational schema:

Passenger(PName, PId)

BusRoute(RouteNo, Source, Destination)

Drivers(DId, DName)

Travel(PId, RouteNo, DId)

Write the SQL Queries and Relational algebra expression for the following: (5\*2=10 Marks)

- List the name of passengers travel in the route number 151
- Find the number of buses runs from 'Chennai' to 'Bangalore'
- Display the name of drivers who drive in the route number 312 and route number 515
- Find the number of the passengers travelled from Chennai to Delhi and driven by the driver 'Kushal'.
- List the source and the destination of the route number 115 travelled by the passenger 'Ram'.

10. i) For each of the following non serial schedules, transform into serial schedules and state whether it is conflict serializable or not. The actions are listed in the order they are scheduled, and prefixed with the transaction name. (3x2 = 6 marks)

- T1:R(X) T2:R(X) T1:W(X) T2:W(X)
- T1:W(X) T2:R(Y) T1:R(Y) T2:R(X)
- T1:R(X) T2:R(Y) T3:W(X) T2:R(X) T1:R(Y)

ii) For each of the following non serial schedules, transform into serial schedules and state whether it is conflict equivalent or not. The actions are listed in the order they are scheduled, and prefixed with the transaction name. (2x2 = 4 marks)

- T1:R(X) T1:R(Y) T1:W(X) T2:R(Y) T3:W(Y) T1:W(X) T2:R(Y)
- T1:R(X) T2:W(X) T1:W(X) T3:W(X)

