CS-2005: Database Systems (CS A,B,C,D,E,F,G,H,J,K)

Saturday, 24th February, 2024

Course Instructor

Syed Qaiser Ali Shah, Noor ul Ain, Rabail Zahid, Majid Hussain

Serial No:

Sessional 1
Total Time: 1 Hour
Total Marks: 70

_____
Signature of Invigilator

_____ _____
Student Name   Roll No.   Section   Signature

DO NOT OPEN THE QUESTION BOOK OR START UNTIL INSTRUCTED.

Instructions:

1. Attempt on question paper. Attempt all of them. Read the question carefully, understand the question, and then attempt it. In case of any ambiguity write down your assumption and solve the question.
2. No additional sheet will be provided for rough work. Use the back of the last page for rough work.
3. If you need more space write on the back side of the paper and clearly mark question and part number etc.
4. After asked to commence the exam, please verify that you have Nine (9) different printed pages including this title page. There are a total of Four(4) questions.
5. Calculator sharing is strictly prohibited.
6. Use permanent ink pens only. Any part done using soft pencil will not be marked and cannot be claimed for rechecking.

	Q-1	Q-2	Q-3	Q-4	Total
Marks Obtained					
Total Marks	15	10	17	28	70

Question 1 [10+5=15 Marks]
PART A

Consider a scenario where a company manages employee information in a database. The "Employees" table stores details about employees, including their EmployeeID, Name, DepartmentID, and Position. The "Departments" table contains information about different departments, such as DepartmentID and DepartmentName.

Employees Table:

EmployeeID	Name	DepartmentID	Position
1001	John Doe	5001	Manager
1002	Jane Smith	5002	Developer
1003	Bob Brown	5001	Analyst
1004	Alice Lee	5002	Intern

Departments Tables

DepartmentID	DepartmentName
5001	HR
5002	Marketing
5003	Finance

For the above database, is it safe to perform following operations on the company database. Does it violate any constraints? In case of violation explain what is the violation and how it can be solved? Discuss in terms of database consistency and integrity constraints.

A. **A new employee record with EmployeeID 1005, Name "Sarah Jones", DepartmentID 5004, and Position "Manager" is inserted into the "Employees" table.**
   The insertion of the new employee record with DepartmentID 5003 violates integrity constraints if DepartmentID 5003 does not exist in the "Departments" table.

B. **An update operation is performed on the "Employees" table, updating EmployeeID 1004 position to Developer and updating DepartmentID from 5002 (Marketing) to 5003 (Finance).**
   It will not cause any integrity violation constraints.

C. **A request is made to delete a department record from the "Departments" table. Specifically, the department record with DepartmentID 5002, corresponding to the "Marketing" department, is targeted for deletion.**
   Deleting the department record for the "Marketing" department from the "Departments" table might lead to integrity violations if there are employees in the "Employees" table still assigned to that department. It violates referential integrity constraints and could leave employee records orphaned.

D. **An update operation is executed to change the DepartmentID of an employee in the "Employees" table. EmployeeID 1001's DepartmentID is updated from 5002 to 5010.**

Updating the DepartmentID of EmployeeID 1004 from 5002 to 5003 might violate integrity if DepartmentID 5003 does not exist in the "Departments" table. It could also lead to inconsistency if the department change is not reflected accurately throughout the database.

E. A new employee record with EmployeeID 1006, Name " Alice Lee", and Position "Manager" is inserted into the "Employees" table. [3]

The insertion of the new employee record with DepartmentID 5003 violates integrity constraints if employee is added without Department ID. It could also lead to inconsistency

PART B [5 Marks]

Cardinality ratios often dictate the detailed design of a database. The cardinality ratio depends on the real-world meaning of the entity types involved and is defined by the specific application. For the following binary relationships, suggest cardinality ratios based on the common-sense meaning of the entity types. Clearly state any assumptions you make.

Entity 1 Cardinality Ratio Entity 2	Justification
COUNTRY _____ CURRENT_PRESIDENT	Each country has one current president, and a president can lead only one country at a time. Cardinality Ratio: One-to-One (1:1)
COURSE _____ TEXTBOOK	A course can have multiple textbooks, and a textbook can be used in multiple courses. Cardinality Ratio: Many-to-Many (M:N)
EBAY_AUCTION_ITEM _____ EBAY_BID	Each eBay auction item can have multiple bids, but each bid is for only one eBay auction item. Cardinality Ratio: One-to-Many (1:M)
STUDENT _____ UNIVERSITY	A student attends one university, and a university can have many students. Cardinality Ratio: Many-to-One (M:1)
BOOK _____ AUTHOR	A book can have multiple authors, and an author can write multiple books. Cardinality Ratio: Many-to-Many (M:N)
CUSTOMER _____ PURCHASE	A customer can make multiple purchases, and each purchase is made by one customer. Cardinality Ratio: One-to-Many (1:M)
AIRLINE _____ PASSENGER	An airline can have many passengers, and a passenger can fly with multiple airlines. Cardinality Ratio: Many-to-Many (M:N)
DOCTOR _____ PATIENT	A doctor can have many patients, and a patient can have one or multiple doctors. Cardinality Ratio: Many-to-Many (M:N)
BANK _____ ACCOUNT_HOLDER	A bank can have many account holders, and an account holder can have accounts in multiple banks. Cardinality Ratio: Many-to-Many (M:N)
POLICE_STATION _____ POLICE_OFFICER	A police station can have many police officers, and a police officer works at one police station at a time. Cardinality Ratio: One-to-Many (1:M)

Question 2 [10 Marks]

Answer the following questions with respect to the ER diagram below
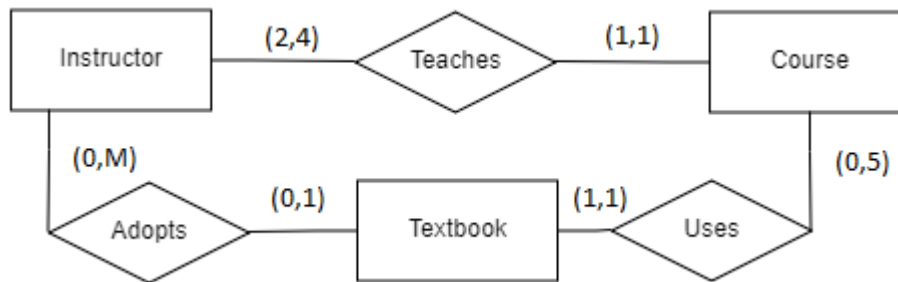
1. How is the relationship between a course and a textbook defined in this scenario?
   The relationship between a course and a textbook is such that a course may or may not use a textbook, but any book used in a course is considered a textbook.
2. What are the limitations on the number of textbooks a course can use?
   A course may not use more than five books.
3. What is the range of courses an instructor can teach?
   Instructors can teach from two to four courses.
4. Can a textbook be used by more than one course?
   No, each textbook is used by one and only one course.
5. How is the adoption of a textbook by an instructor defined?
   An instructor is considered to adopt a textbook if it is used in some course taught by that instructor. An instructor does not have to adopt a textbook for all courses
6. Is it necessary for an instructor to adopt a textbook for all the courses they teach?
   No, an instructor does not have to adopt a textbook for all courses they teach.
7. What is the minimum and maximum number of courses an instructor can teach?
   The minimum number of courses an instructor can teach is two, and the maximum is four.
8. How is the adoption of a textbook related to the instructor teaching a course?
   The adoption of a textbook by an instructor is defined by whether the textbook is used in a course taught by that instructor.
9. Is there any requirement for a course to have a textbook?
   No, a course may or may not have a textbook.
10. How does the existence of a textbook relate to its usage in a course?
    If a textbook exists, it is used in some course, and therefore, it is adopted by some instructor who teaches that course.

Question 3 [7+5+5=17 Marks]
Part A[7 Marks]

Consider the following scenario to answer the question from (1) – (3).

A database is required by the university to keep track of the industrial placement process of the 3rd year students. There is a coordinator who is recruited as a permanent staff member with an *Empid* at the university to manage this process. To this end the coordinator collects student details and he forwards these details to companies. Each student has a unique registration no and a company is identified through its name. One student's details would be sent to many companies and a company may receive many students' details depending on the number of vacancies and the specialty. A student may have several specialties. The coordinator blacklists the companies when they do not provide proper training to students. The companies inform the selected list of students to the coordinator. The coordinator always produces status reports (which are identified through the dates) containing information such as who has been placed to what companies and the number of students placed at each company.

1. In the corresponding conceptual database model of the above scenario, what entities would be represented? [3 marks]

Coordinator ,Student, Company, Specialty, Status Report

2. Which type of relationships could exist between following entities express your answer in term of cardinality? [3 marks]

i) Student and Company   _____M:N_____

ii) Coordinator and Company   _____1:M_____

iii) Student and Specialty   _____M:N_____

3. The coordinator requires to keep track of the date that each student detail was sent to each company. How would this sent_date be represented? [1 marks]

[As a relationship attribues, relationship name is_places]

PART B [5 Marks]

Consider the following scenario to answer questions from (1) – (4)

Cosmetic companies produce cosmetics and trade names identify each cosmetic uniquely with respect to each cosmetic company. Each cosmetic has a fixed price. Shops sell several cosmetics. A cosmetic of a company could be sold at several shops at the same fixed price. A cosmetic company can have contracts with several shops, and a shop can have contracts with several cosmetic companies. Each contract should have a start date, an end date and the details of the contract.
[1 for each+ 2 bonus]

(1) In an Entity Relationship diagram for the above scenario, how could the contract be represented?
  1.As a relationship between shop and cosmetic company entities
(2) Based on the scenario, what is/are the best way(s) to represent the price of a cosmetic?
  2.As an attribute of cosmetic.
  ~~(3) Based on the scenario if it is necessary to maintain the price history of each cosmetic along with the effective date of each price, which of the following statement(s) is/are correct?~~

~~1. Price history could be maintained as a multivalued composite attribute of cosmetic with the component attributes price and effective date.~~
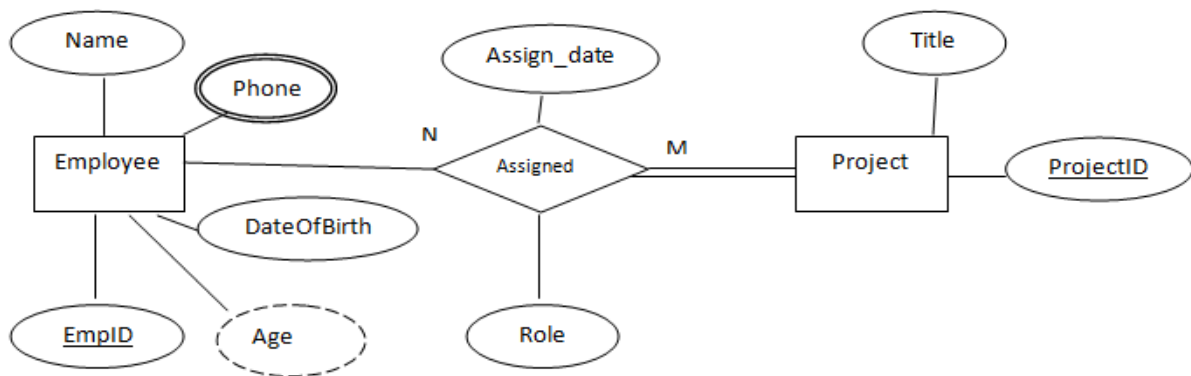~~2. Price history could be represented as a weak entity of the cosmetic entity with attributes price and effective date.~~

(4) If the price of each cosmetic varies from shop to shop, how would the price be represented?
 1. As an attribute of the relationship between shop and cosmetic.

PART C [5 Marks]

Consider the following ER diagram to answer Questions from 1 to 2.

1. Identify the type of attributes from the above entities and fill the table accordingly? [2.5 marks]

	Attribute	Type
A	Age of an employee	**Derive attribute**
B	Phone number of an employee	**Multivalued attribute**
C	ProjectID	**Key attribute**
D	Role	**Relationship attribute**
E	Assign_date	**Ralationship attribute**

2. Identify following terms for the above diagram [2.5 marks]

A	Cardinality Ratio	M:N
B	Participation constraints (Employee)	Partial/optional
C	Participation constraints (Project)	Total/Mandatory
D	Degree of the relationship	Binary
E	Relationship type	Regular

National University of Computer and Emerging Sciences

FAST School of Computing **Spring-2024** **Islamabad Campus**

Question 5[5+5+5+5+3+1+1+3=28 Marks]

A large hospital network wants to revamp its Health Records Management System (HRMS) to improve the security, accessibility, and efficiency of patient data handling. The network comprises multiple hospitals, clinics, and external healthcare providers, all of which need varying levels of access to patient records.

Requirements
1. Each hospital and clinic should have its unique view of patient data relevant to their operations.

2. Specialists and general practitioners require different data about patients.

3. Administrative staff need access to patient demographic and billing information.

4. The system must protect sensitive patient data and comply with healthcare regulations.

5. The HRMS should be scalable and adaptable to future changes in the network.

Task:
You are required to design an External Level architecture diagram for the new HRMS, ensuring that the system is robust, flexible, and secure.

1. **What are the various user's roles in the hospital network, and design the different external views for each user group. Atleast specify 5 external views. What types of interfaces are suitable for presenting views to each user group**

Hospital Administrators:
External View: This view should provide comprehensive access to patient demographic information, billing data, and administrative functionalities such as appointment scheduling, resource management, and facility management.
  Menu-based, popular for browsing on the web
  Justification: easy navigation It allows administrators to easily browse through various options and manage hospital resources efficiently.

Clinic Staff (General Practitioners):
 External View: This view should focus on patient health records relevant to general practice, including medical history, prescription details, lab results, and treatment plans.
 Interface: Forms-based, designed for naïve users
 Justification: A forms-based interface is suitable for general practitioners who may not be familiar with complex database systems. It provides structured forms for entering patient health records, medical history, prescription details, and treatment plans, catering to the needs of less tech-savvy users.

Specialists (e.g., Surgeons, Cardiologists):
  - External View: This view should provide specialized medical data tailored to the specific needs of each specialty, such as diagnostic imaging, surgical notes, and procedure details.

 - Interface: Graphics-based (Point and Click, Drag and Drop, etc.)

   - Justification: Specialists require access to specialized medical data with advanced visualization tools. A graphics-based interface allows them to interactively explore diagnostic imaging, surgical notes, and procedure details. It facilitates efficient navigation and analysis of complex medical information.

External Healthcare Providers (Pharmacies, Laboratories)

  - External View: This view should focus on sharing specific patient data relevant to the services provided by external healthcare entities, such as medication lists, test results, and referral information.
- Interface: Integration via secure APIs (Application Programming Interfaces)

   - Justification: External healthcare providers need seamless data exchange with the HRMS for sharing specific patient data such as medication lists, test results, and referral information. Integration via secure APIs enables automated data transfer while maintaining data security and compliance with regulations

Patients (or Patient Representatives):

  - External View: This view should enable patients to access their own health records, appointment schedules, medication lists, and lab results. It may also include features for appointment booking and communication with healthcare providers.
Interface: Web browser as an interface

   - Justification: Patients require easy access to their own health records, appointment schedules, medication lists, and lab results. A web browser-based interface offers accessibility from various devices and platforms, allowing patients to conveniently manage their healthcare information and communicate with healthcare providers.

Marks distribution:

2=[Entity name (1)+interface identification(1)

Identification of 5 entities, not necessary to have the same name, but similar entities are acceptable (2x5=10 marks)

2. **Identify all the operations that each user can perform within the system.**

1. Hospital Administrators:

  - Access patient demographic information.

  - View billing data and manage financial transactions.

  - Schedule appointments for patients.

  - Manage resources such as staff allocation and medical equipment.

  - Manage facility operations including maintenance and inventory.

  - Generate reports on hospital performance and metrics.

  - Grant and revoke access permissions for other users.

  - Configure system settings and parameters.

2. Clinic Staff (General Practitioners):

  - Access patient health records.

  - Update medical history and treatment plans.

  - Record prescription details and order medications.

  - View and analyze lab results.

  - Schedule appointments for patients.

  - Communicate with patients via secure messaging.

  - Collaborate with specialists or other healthcare professionals.

3. Specialists (e.g., Surgeons, Cardiologists):

  - Access specialized medical data relevant to their specialty.

  - Review diagnostic imaging and surgical notes.

  - Record procedure details and surgical outcomes.

  - Collaborate with other specialists or healthcare providers.

- Participate in multidisciplinary consultations.

- Request additional tests or procedures as needed.

4. External Healthcare Providers (Pharmacies, Laboratories):

- Access specific patient data relevant to the services provided.

- Receive and process medication orders.

- Upload and share test results or referral information.

- Communicate with healthcare providers regarding patient care.

- Participate in care coordination and referral management.

5. Patients (or Patient Representatives):

- Access their own health records and medical history.

- View upcoming appointments and schedule new appointments.

- Manage medication lists and prescription refills.

- View and download lab results and imaging reports.

- Communicate securely with healthcare providers.

- Provide feedback or request changes to personal information.

- Access educational resources and health information.

- Initiate telemedicine consultations if available.

Identification of any two roles for each user[1x5=5 marks]

3. **Identify the possible entities within the system and list their associated attributes.**

1. Patient:

- Patient ID (Primary Key)

- Name

- Date of Birth

- Gender

- Contact Information (Address, Phone Number, Email)

- Medical History

- Allergies

- Current Medications

- Insurance Information

- Emergency Contact Details

2. Hospital:

  - Hospital ID (Primary Key)

  - Name

  - Address

  - Contact Information

  - Number of Beds

  - Specialized Departments

  - Administrative Staff

3. Clinic:

  - Clinic ID (Primary Key)

  - Name

  - Location

  - Contact Information

  - Medical Staff

  - Services Offered

  - Operating Hours

4. Healthcare Provider:

- Provider ID (Primary Key)

- Name

- Type (e.g., Pharmacy, Laboratory)

- Contact Information

- Services Provided

- Accreditation or Certification Information

5. Doctor/Specialist:

- Doctor ID (Primary Key)

- Name

- Specialty

- Contact Information

- Medical Licenses/Certifications

- Appointment Schedule

- Patient Assignments

6. Appointment:

- Appointment ID (Primary Key)

- Patient ID (Foreign Key)

- Doctor ID (Foreign Key)

- Clinic ID (Foreign Key)

- Date and Time

- Reason for Appointment

- Appointment Status

7. Medical Record:

- Record ID (Primary Key)

- Patient ID (Foreign Key)

- Doctor ID (Foreign Key)

- Clinic ID (Foreign Key)

- Date of Visit

- Diagnosis

- Treatment Plan

- Prescriptions

- Lab Results

8. Billing Record:

  - Bill ID (Primary Key)

  - Patient ID (Foreign Key)

  - Services Rendered

  - Charges

  - Insurance Information

  - Payment Status

  - Billing Date

9. Administrative User:

  - Admin ID (Primary Key)

  - Name

  - Role/Position

  - Login Credentials

  - Access Permissions

  - Department/Division

Identification of any 5 entities along with its attributes including primary key

1x5= 5 marks]

4. Identify the unary, binary, and ternary relationships among the entities present in the Health Records Management System (HRMS)? Provide one example for each type of relationship.

Unary Relationship: Doctor Supervises Doctor

Binary Relationship: Patient Visits Clinic

Ternary Relationship: Doctor Prescribes Medication to Patient

Identification of any three relationship[1x3= 3 marks]

5. Will data be stored centrally in a data warehouse or distributed across multiple databases? Justify your answer.

In the context of the scenario described a distributed approach to data storage across multiple databases is more appropriate than centralizing data in a data warehouse.

Distributed data storage aligns with the requirement for each hospital and clinic to have its unique view of patient data relevant to their operations.

It ensures faster access to locally relevant information, reduces data latency, and enhances performance.

Distributed storage enables compliance with healthcare regulations regarding data sovereignty and privacy by allowing data to be stored within specific jurisdictions or regions.

It also offers scalability and flexibility, facilitating the easy onboarding of new facilities and customization based on individual requirements.

Distributed storage enhances fault tolerance and security by reducing the risk of a single point of failure or security breach.

Therefore, given the diverse needs and requirements of the hospital network, a distributed approach to data storage across multiple databases ensures robustness, flexibility, and security in the new HRMS architecture.

[Both are acceptable, just dependent on the justification =1 mark]

6. What type of data dictionary is best suited for managing external schemas?

Active data dictionaries due to its accessibility to both DBMS software and users/DBAs

[1 mark]

7. What type of tier architecture does this description refer to? Draw its diagram and also justify your answer?

Three their Architecture
[diagram= 3 marks, 1 mark per layer]