UNIVERSITY OF MANAGEMENT AND TECHNOLOGY

Estd. 1990

Syed Muhammad Waiz Rizvi	F2023376117
Section:	D2
subject:	DBMS
submitted to:	Sir Usama Amjad

Scenario 1:

Entities and Attributes

Entity	Attributes
Book	BookID (PK), Title, Edition (multi-valued), ISBN, Publisher, Year
Author	AuthorID (PK), Name
Member	MemberID (PK), Name, Email, Phone, Address
Staff	StaffID (PK), Name, Role (Admin, Librarian), Email, Phone
Borrowing	BorrowingID (PK), BorrowDate, DueDate, ReturnDate, Fine
Reservation	ReservationID (PK), ReservationDate
Login	UserID (PK), Username, Password, Role

Relationships

- **Writes**: Book ⇄ Author (many-to-many)
- **Borrows**: Member ⇄ Borrowing ⇄ Book (M:N with attributes)
- **Reserves**: Member ⇄ Reservation ⇄ Book (M:N)
- **Manages**: Staff ⇄ Borrowing / Reservation / Fine
- **Has_Login**: Each Member or Staff has one Login (weak entity — requires ID from Member/Staff)

Multivalued Attribute

- **Book → Edition**

Weak Entity

- **Login** (depends on Member/Staff)

Role-Based Relationships

- Staff Role defines whether they can Manage Fines, Reservations, etc.

---

2. Normalized Relational Schema (3NF)

Here's a **3NF** version of the schema:

Book(BookID, Title, ISBN, Publisher, Year)

Edition(BookID, EditionNo)

(Multi-valued attribute → separate table)

Author(AuthorID, Name)

BookAuthor(BookID, AuthorID)

(Many-to-many)

Member(MemberID, Name, Email, Phone, Address)

Staff(StaffID, Name, Role, Email, Phone)

Login(UserID, Username, Password, Role, LinkedID, LinkedType)

(Weak entity, references either MemberID or StaffID based on LinkedType)

Borrowing(BorrowingID, MemberID, BookID, StaffID, BorrowDate, DueDate, ReturnDate, Fine)

Reservation(ReservationID, MemberID, BookID, ReservationDate, IsFulfilled)

---

3. Candidate Keys and Foreign Keys

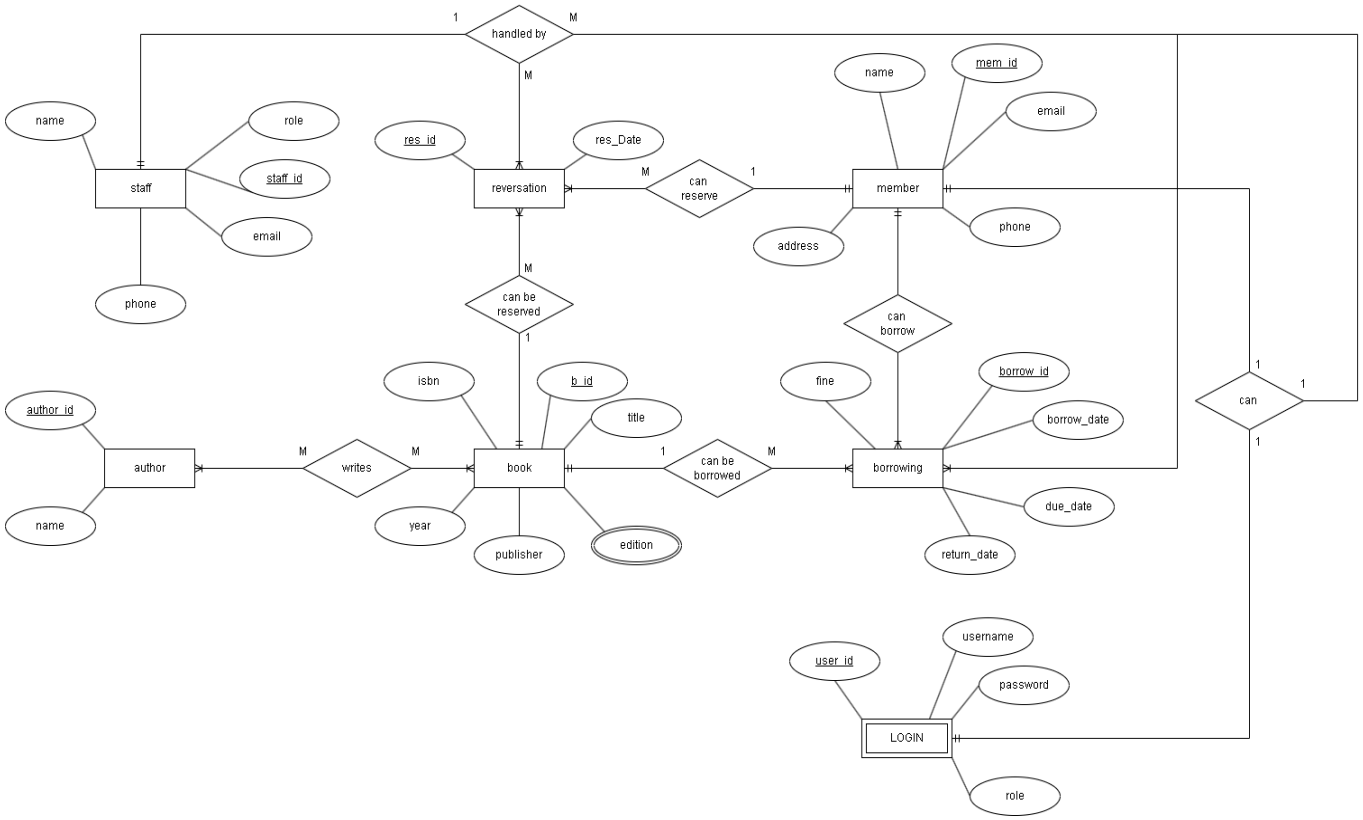
Candidate Keys

- **Book**: BookID
- **Author**: AuthorID
- **Member**: MemberID
- **Staff**: StaffID
- **Login**: UserID
- **Borrowing**: BorrowingID
- **Reservation**: ReservationID

Foreign Keys

- **Edition.BookID → Book.BookID**
- **BookAuthor.BookID → Book.BookID**
- **BookAuthor.AuthorID → Author.AuthorID**
- **Borrowing.MemberID → Member.MemberID**
- **Borrowing.BookID → Book.BookID**
- **Borrowing.StaffID → Staff.StaffID**
- **Reservation.MemberID → Member.MemberID**
- **Reservation.BookID → Book.BookID**
- **Login.LinkedID → Member.MemberID or Staff.StaffID (conditional)**

Extended ERD:



Scenario 2:

1. ER Diagram Design

Entities and Attributes

Entity	Attributes
Student	StudentID (PK), Name, Email, Phone, Gender
Department	DeptID (PK), DeptName
Course	CourseID (PK), CourseName, CreditHours
Instructor	InstructorID (PK), Name, Email, Phone
Login	UserID (PK), Username, Password (for instructors)
Assessment	AssessmentID (PK), Type (Midterm, Final, Quiz, Assignment), Weight (%)
Grade	GradeID (PK), MarksObtained
Attendance	AttendanceID (PK), TotalClasses, ClassesAttended, Percentage, WarningFlag

---

Relationships

- **Student belongs to → Department** (M:1)
- **Student enrolls in → Course** (M:N)
- **Course is taught by → Instructor** (M:N)
- **Instructor has → Login** (1:1)
- **Course has → Assessments** (1:M)
- **Student receives → Grades** for each (Student, Course, Assessment) tuple
- **Student has → Attendance** per course

ER Diagram Features

- **Weak Entity**: Login (dependent on Instructor)
- **Multivalued**: Grades per Assessment
- **Role-based**: Instructors manage grades/attendance only for their courses

---

2. Normalized Relational Schema (3NF)

Student(StudentID, Name, Email, Phone, Gender, DeptID)

- FK: DeptID → Department

Department(DeptID, DeptName)

Course(CourseID, CourseName, CreditHours)

Instructor(InstructorID, Name, Email, Phone)

Login(UserID, Username, Password, InstructorID)

- FK: InstructorID → Instructor

Enrollment(StudentID, CourseID)

- Composite PK: (StudentID, CourseID)
- FK: StudentID → Student
- FK: CourseID → Course

CourseInstructor(CourseID, InstructorID)

- Composite PK: (CourseID, InstructorID)
- FK: CourseID → Course
- FK: InstructorID → Instructor

Assessment(AssessmentID, CourseID, Type, Weight)

- FK: CourseID → Course

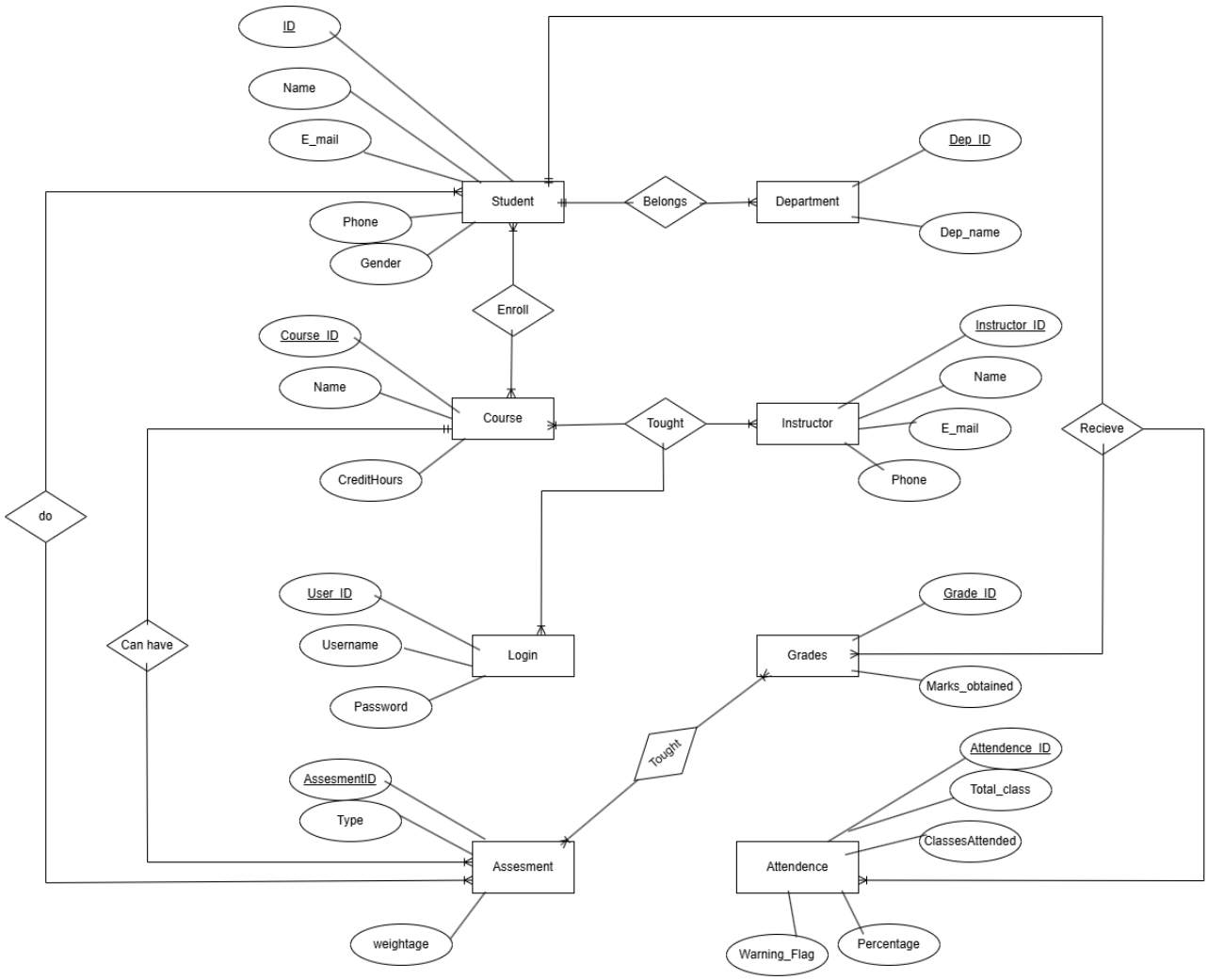
Grade(GradeID, StudentID, AssessmentID, MarksObtained)

- FK: StudentID → Student
- FK: AssessmentID → Assessment

Attendance(AttendanceID, StudentID, CourseID, TotalClasses, ClassesAttended, Percentage, WarningFlag)

- FK: StudentID → Student
- FK: CourseID → Course

Detailed ERD:



Scenario 3:

1. Comprehensive ER Diagram Design

Entities and Attributes

Entity	Attributes
Patient	PatientID (PK), Name, DOB, Gender, Contact, Address
Doctor	DoctorID (PK), Name, Specialization, Contact
Staff	StaffID (PK), Name, Role (Admin, Nurse, Receptionist, Doctor), Contact
Department	DeptID (PK), DeptName
Appointment	AppointmentID (PK), PatientID (FK), DoctorID (FK), Date, Time, Purpose
MedicalRecord	RecordID (PK), PatientID (FK), Diagnosis, Procedure, Prescription, Date
Room	RoomID (PK), RoomType, ChargesPerDay
Admission	AdmissionID (PK), PatientID (FK), RoomID (FK), AdmitDate, DischargeDate
Bill	BillID (PK), PatientID (FK), TotalAmount, BillDate
BillItem	BillItemID (PK), BillID (FK), ItemType (Consultation, Lab Test, Medicine, Room), Cost
DischargeSummary	SummaryID (PK), AdmissionID (FK), Diagnosis, Procedure, FollowUp

---

Relationships

- **Patient → Appointments, Admissions, Bills, Medical Records**
- **Doctor → Appointments, Medical Records**
- **Room → Admissions**

- **Admission → DischargeSummary**
- **Staff → Department** (Many-to-One)
- **Staff can assist in → Appointments/Admissions/Billing** based on roles

---

Special ER Features

- **Multivalued Attributes**: None (handled via tables like BillItems)
- **Weak Entities**: BillItem (dependent on Bill)
- **Role-based Relationships**: Staff role defines authority

2. Normalized Relational Schema (3NF)

Patient(PatientID, Name, DOB, Gender, Contact, Address)

Doctor(DoctorID, Name, Specialization, Contact)

Staff(StaffID, Name, Role, Contact, DeptID)

Department(DeptID, DeptName)

Appointment(AppointmentID, PatientID, DoctorID, Date, Time, Purpose)

- FK: PatientID → Patient
- FK: DoctorID → Doctor

MedicalRecord(RecordID, PatientID, DoctorID, Diagnosis, Procedure, Prescription, Date)

- FK: PatientID → Patient
- FK: DoctorID → Doctor

Room(RoomID, RoomType, ChargesPerDay)

Admission(AdmissionID, PatientID, RoomID, AdmitDate, DischargeDate)

- FK: PatientID → Patient
- FK: RoomID → Room

DischargeSummary(SummaryID, AdmissionID, Diagnosis, Procedure, FollowUp)

- FK: AdmissionID → Admission

Bill(BillID, PatientID, BillDate, TotalAmount)

- FK: PatientID → Patient

BillItem(BillItemID, BillID, ItemType, Cost)

- FK: BillID → Bill

---

3. Key Relationships

- **Staff.DeptID → Department.DeptID**
- **Doctor is a specialized role under Staff** (Can model via Staff.Role = 'Doctor')
- **Patient admitted to Room** via Admission
- **Bill can have multiple BillItems**
- **Discharge linked to Admission**
- **Medical Records linked to both Patient and Doctor**

---

4. SQL Queries

Generate a Bill for a Patient

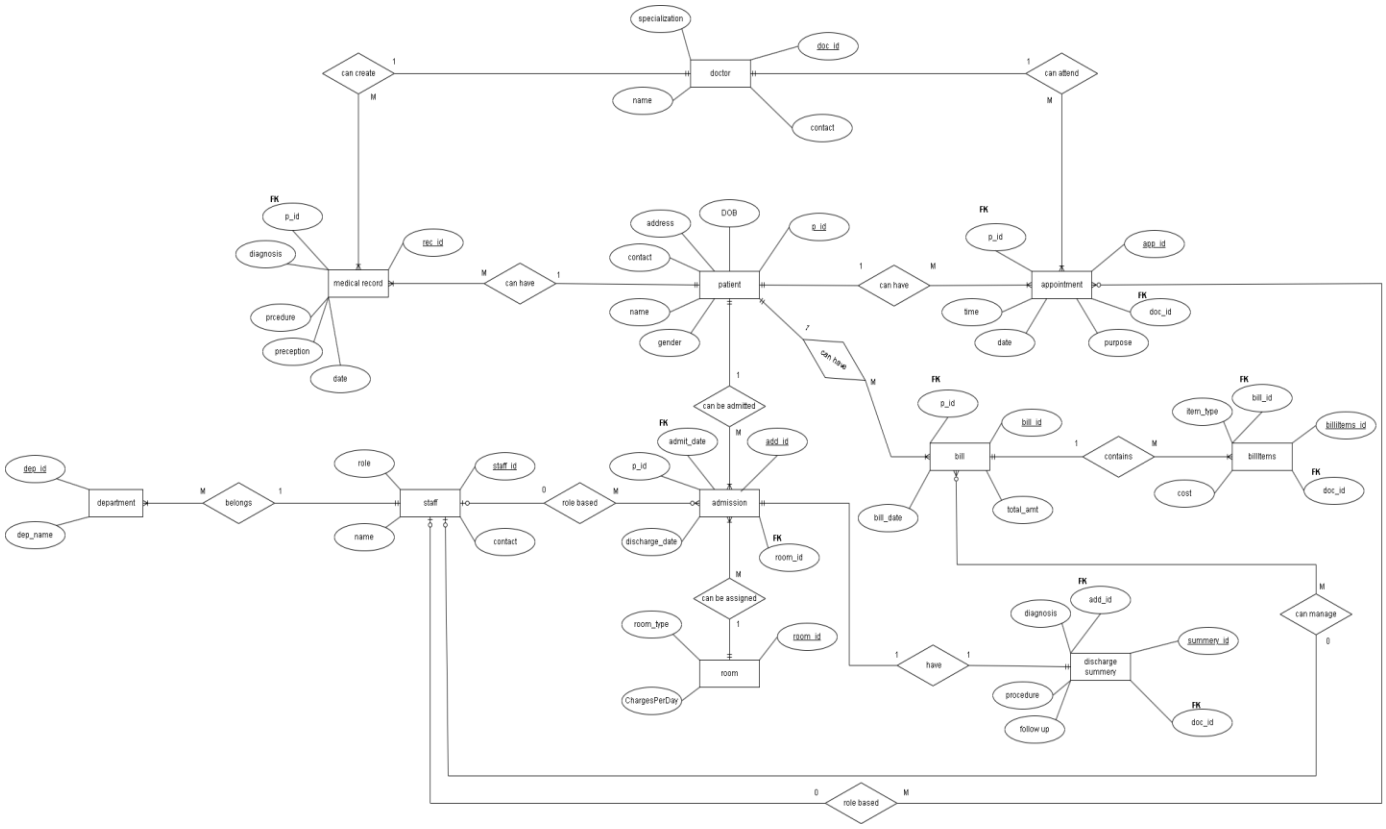
```
SELECT
  B.BillID,
  B.BillDate,
  BI.ItemType,
  BI.Cost,
  SUM(BI.Cost) AS TotalAmount
FROM
  Bill B
JOIN
  BillItem BI ON B.BillID = BI.BillID
WHERE
  B.PatientID = 'P001'
GROUP BY
  B.BillID, B.BillDate, BI.ItemType, BI.Cost;
```

List Doctors with Most Admitted Patients

```
SELECT
  D.DoctorID,
  D.Name,
  COUNT(DISTINCT A.PatientID) AS TotalPatients
FROM
  Doctor D
JOIN
  Appointment Ap ON D.DoctorID = Ap.DoctorID
```

```
JOIN
  Admission A ON A.PatientID = Ap.PatientID
GROUP BY
  D.DoctorID, D.Name
ORDER BY
  TotalPatients DESC
LIMIT 5;
```

Comprehensive ERD:



Scenario 4:

1. ER Diagram (Described Textually)

Entities and Attributes

Entity	Key Attributes
Customer	CustomerID (PK), Name, Email, Phone, Address
Product	ProductID (PK), Name, Price, Description, StockLevel, ReorderThreshold, CategoryID (FK), VendorID (FK)
Order	OrderID (PK), CustomerID (FK), OrderDate, Status, ShippingAddress, PaymentMethod, TotalAmount
OrderItem	OrderID (FK), ProductID (FK), Quantity, PriceAtOrderTime *(Composite PK: OrderID + ProductID)*
Category	CategoryID (PK), Name, Description
Vendor	VendorID (PK), Name, Contact, Address
Review	ReviewID (PK), CustomerID (FK), ProductID (FK), Rating (1–5), Comment, ReviewDate
Admin	AdminID (PK), Username, Password
Payment	PaymentID (PK), OrderID (FK), PaymentDate, Amount, PaymentMode, Status
Refund	RefundID (PK), OrderID (FK), RefundDate, Amount, Reason

---

Relationships

- **Customer → Order** (1:M)
- **Order → OrderItem** (1:M) ⬅️ **(Many-to-Many with attributes)**
- **Product → OrderItem** (1:M)
- **Product → Category** (M:1)
- **Product → Vendor** (M:1)

- **Product → Review (Customer)** (M:M with Rating, Comment)
- **Order → Payment** (1:1 or 1:M)
- **Order → Refund** (0:1)

Special Notes:

- **Many-to-Many with Attributes**: OrderItem is the M:N relation with attributes like quantity, price.
- **Product reviews** also form a many-to-many relationship with Customer, with attributes Rating, Comment.

---

2. Normalized Relational Schema (3NF)

Customer(CustomerID, Name, Email, Phone, Address)

Product(ProductID, Name, Price, Description, StockLevel, ReorderThreshold, CategoryID, VendorID)

- FK → Category(CategoryID)
- FK → Vendor(VendorID)

Order(OrderID, CustomerID, OrderDate, Status, ShippingAddress, PaymentMethod, TotalAmount)

- FK → Customer(CustomerID)

OrderItem(OrderID, ProductID, Quantity, PriceAtOrderTime)

- PK → (OrderID, ProductID)
- FK → Order(OrderID)
- FK → Product(ProductID)

Category(CategoryID, Name, Description)

Vendor(VendorID, Name, Contact, Address)

Admin(AdminID, Username, Password)

Review(ReviewID, CustomerID, ProductID, Rating, Comment, ReviewDate)

- FK → Customer(CustomerID)
- FK → Product(ProductID)

Payment(PaymentID, OrderID, PaymentDate, Amount, PaymentMode, Status)

- FK → Order(OrderID)

Refund(RefundID, OrderID, RefundDate, Amount, Reason)

- FK → Order(OrderID)

---

3. Integrity Constraints

```
-- Quantity in OrderItem must be positive
CHECK (Quantity > 0)

-- StockLevel must be non-negative
CHECK (StockLevel >= 0)

-- Rating between 1 and 5
CHECK (Rating >= 1 AND Rating <= 5)

-- Refunds must not exceed total order amount (logic constraint)
CHECK (Amount >= 0)
```

Detailed erd: