HIT234 Database Concepts

ASSIGNMENT 2

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Group 13

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Hospital Management System Database Design

Part A: ER Diagram

Business Situation Description

The Hospital Management System database is designed for a medium-sized private hospital offering a broad range of medical services, consultations, specialist care, diagnostics, surgeries, inpatient care, and emergency services. The hospital interacts with external entities such as government health agencies, insurance providers, and medical suppliers.

Internally, it employs doctors, nurses, lab technicians, and administrative staff. The hospital needs to manage electronic health records, which include patient details, visit history, diagnoses, prescriptions, lab reports, insurance claims, and billing.

Doctors can treat multiple patients and may work across departments. Patients may have several appointments and can be treated by various doctors. Treatments may involve prescribed medicines and procedures and are sometimes covered by insurance.

A significant challenge lies in handling many-to-many relationships (e.g., patients and doctors) and derived data (e.g., calculating age from date of birth or billing totals from itemized charges). The system must also comply with regulatory requirements that mandate audit data retention..

Assumptions

- Each patient must register before accessing any hospital services.
- Doctors can belong to multiple departments or specializations.
- Appointments are always associated with a patient and at least one doctor.
- A treatment is provided during or after an appointment and may include procedures and medicines.
- External vendors supply medicines with tracked delivery and expiration details.
- Each insurance claim is tied to a specific patient visit or treatment.
- Billing is generated per appointment/visit and can cover multiple components (consultation, medicines, procedures).

- Age is not stored but calculated from date of birth.
- Staff have defined roles and are assigned to departments accordingly.
- Each medicine has a unique batch number and can be traced back to a supplier.

Business Rules

- Each Patient is uniquely identified and can have multiple appointments.
- Each Doctor can treat multiple patients and may belong to one or more departments.
- A Patient can have multiple diagnoses and different treatments over time.
- Each Treatment may involve one or more medicines and/or procedures.
- Each Medicine must have an associated supplier, expiration date, and batch number.
- Insurance claims must be linked to specific patients and treatments.
- Billing is generated per visit, covering consultation, diagnostics, treatments, and medicines.
- Only registered patients are allowed to book appointments.
- The age of a patient is derived from the date of birth.
- All Staff are assigned to departments with designated roles (e.g., Doctor, nurse, admin).

Key Stakeholders of Hospital Management System:

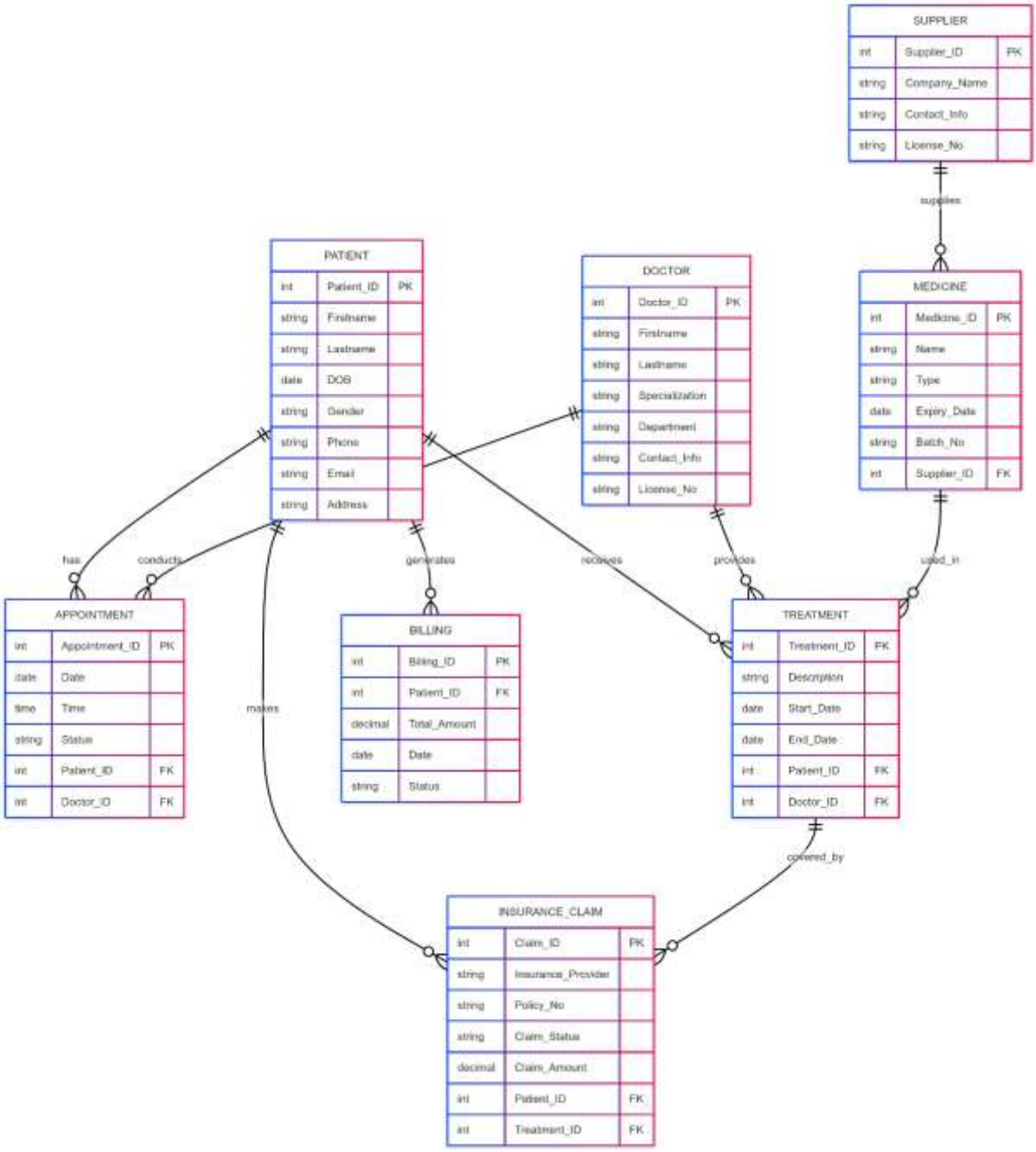
- Hospital Administrator
- Doctors
- Nurses
- Reception Staff
- Patients
- Pharmacy Staff
- Laboratory Technicians
- Suppliers
- Insurance Providers
- IT/System Administrator
- Government Health Agencies

Entities And Attributes of Hospital Management System:

Entity	**Attributes**

Patient	Patient_ID Name (First, Last) DOB Gender Contact_Info (Phone, Email) Address
Doctor	Doctor_ID (PK), Name (First, Last), Specialization, Department, Contact_Info, License_No
Appointment	Appointment_ID (PK), Date, Time, Status, Patient_ID (FK), Doctor_ID (FK)
Treatment	Treatment_ID (PK), Description, Start_Date, End_Date, Patient_ID (FK), Doctor_ID (FK)
Medicine	Medicine_ID (PK), Name, Type, Expiry_Date, S Supplier_ID (FK), Batch_No
Supplier	Supplier_ID (PK), Company_Name, Contact_Info, License_No
Insurance_Claim	Claim_ID (PK), Insurance_Provider, Policy_No, Claim_Status, Claim_Amount, Patient_ID (FK), Treatment_ID (FK)

ER diagram of Hospital Management System



Part B: Map the ER diagram to 3NF & Normalisation

1-Map the ER diagram to 3NF

Step 1:

1. Patient Table (No composite attributes)

Patient_ ID	Firstna me	Lastna me	DO B	Gend er	Pho ne	Ema il	Street_Add ress	Cit y	Sta te	Zip_Co de

2. Doctor Table

Doctor_ID	Firstname	Lastname	Specialization	Department	Phone	Email	License_No

3. Appointment Table

Appointment_ID	Date	Time	Status	Patient_ID (FK)	Doctor_ID (FK)

4. Treatment Table

Treatment_ID	Description	Start_Date	End_Date	Patient_ID (FK)	Doctor_ID (FK)

5. Medicine Table

Medicine_ID	Name	Type	Expiry_Date	Supplier_ID (FK)	Batch_No

6. Supplier Table

Supplier_ID	Company_Name	Phone	Email	License_No

7. Insurance_Claim Table

Claim_ID	Insurance_Provider	Policy_No	Claim_Status	Claim_Amount	Patient_ID (FK)	Treatment_ID (FK)

8. Billing Table

Billing_ID	Patient_ID (FK)	Total_Amount	Date	Status

All composite attributes like Name, Contact_Info, and Address are now separated into individual atomic fields (e.g., Firstname, Lastname, Phone, Email, Street_Address, City, etc.).

The derived attributes :

- Patient's Age (derived from DOB) — removed completely, only DOB remains.
- Billing's Total_Amount (derived from individual costs) — removed, so Billing just stores raw data or could keep a manual total.

1. Patient Table

Patient_ID	Firstname	Lastname	DOB	Gender	Phone	Email	Street_Address	City	State	Zip_Code

2. Doctor Table

Doctor_ID	Firstname	Lastname	Specialization	Department	Phone	Email	License_No

3. Appointment Table

Appointment_ID	Date	Time	Status	Patient_ID (FK)	Doctor_ID (FK)

4. Treatment Table

Treatment_ID	Description	Start_Date	End_Date	Patient_ID (FK)	Doctor_ID (FK)

5. Medicine Table

Medicine_ID	Name	Type	Expiry_Date	Supplier_ID (FK)	Batch_No

6. Supplier Table

Supplier_ID	Company_Name	Phone	Email	License_No

7. Insurance_Claim Table

Claim_ID	Insurance_Provider	Policy_No	Claim_Status	Claim_Amount	Patient_ID (FK)	Treatment_ID (FK)

8. Billing Table

Billing_ID	Patient_ID (FK)	Date	Status

Step 2: Weak Entity

Weak Entities:

- Appointment (depends on Patient and Doctor)

- Possibly Insurance_Claim (if Claim_ID is not unique on its own)

Step 3: Binary Relationship

Relationship Name	Entity 1 (PK)	Entity 2 (PK)
Patient — Appointment	Patient (Patient_ID)	Appointment (Appointment_ID)
Doctor — Appointment	Doctor (Doctor_ID)	Appointment (Appointment_ID)
Patient — Treatment	Patient (Patient_ID)	Treatment (Treatment_ID)
Doctor — Treatment	Doctor (Doctor_ID)	Treatment (Treatment_ID)
Supplier — Medicine	Supplier (Supplier_ID)	Medicine (Medicine_ID)
Patient — Insurance_Claim	Patient (Patient_ID)	Insurance_Claim (Claim_ID)
Treatment — Insurance_Claim	Treatment (Treatment_ID)	Insurance_Claim (Claim_ID)
Patient — Billing	Patient (Patient_ID)	Billing (Billing_ID)

Step 4: Associative Entity

Entity	Foreign Keys
Appointment	Patient_ID (FK), Doctor_ID (FK)
Insurance_Claim	Patient_ID (FK), Treatment_ID (FK)

2-Normalisation

Flat Table:

Patient_ID	Firstname	Lastname	DOB	Gender	Phone	Email	Address
Doctor_ID	Doctor_Firstname	Doctor_Lastname	Specialization	Department	Doctor_Phone	Doctor_Email	License_No
Appointment_ID	Appointment_Date	Appointment_Time	Appointment_Status				
Treatment_ID	Treatment_Description	Treatment_Start_Date	Treatment_End_Date				
Medicine_ID	Medicine_Name	Medicine_Type	Medicine_Expiry	Batch_No	Supplier_ID		

Supplier_Name	Supplier_Phone	Supplier_Email					
Claim_ID	Insurance_Provider	Policy_No	Claim_Status	Claim_Amount			
Billing_ID	Billing_Date	Billing_Status					

First Normal Form (1NF)

- All attribute values must be atomic (indivisible).
- No repeating groups or arrays.
- Each record must be uniquely identified by a primary key.

Second Normal Form (2NF)

- Must be in 1NF.
- No partial dependency: Every non-key attribute must depend on the whole primary key, not just part of it.
- Applies only when the primary key is composite (made of multiple columns).

Third Normal Form (3NF)

- Must be in 2NF.
- No transitive dependency: Non-key attributes must not depend on other non-key attributes.

1. Patient

Step	**Explanation**
1NF	Ensure atomic attributes — no multiple phone numbers or addresses in one field; unique Patient_ID as PK.
2NF	Patient_ID is single PK, so no partial dependency possible. All non-key attributes depend fully on Patient_ID.

3NF	No attribute depends on another non-key attribute; e.g., no attribute like Age derived from DOB is stored.

2. Doctor

Step	**Explanation**
1NF	Atomic values only; Doctor_ID as PK; separate fields for Doctor_Name, Email, Phone, etc.
2NF	Doctor_ID is single PK → no partial dependency.
3NF	Ensure no attribute depends on another non-key attribute; e.g., Department Head info not stored here but in Department entity if needed.

3. Appointment

Step	**Explanation**
1NF	Unique Appointment_ID as PK; atomic values for Date, Time, Status; no repeating groups.
2NF	Single PK → no partial dependency. Patient_ID and Doctor_ID are foreign keys, fully functionally dependent.
3NF	No attribute depends on another non-key attribute (e.g., Status does not depend on Date alone).

4. Treatment

Step	**Explanation**
1NF	Treatment_ID as PK; atomic fields for Description, Start_Date, End_Date; no multi-valued fields.
2NF	No composite key, so no partial dependencies.

3NF	Treatment_Description or dates don't depend on other non-key attributes → no transitive dependency.

5. Medicine

Step	**Explanation**
1NF	Medicine_ID as PK; atomic fields (Name, Type, Expiry, Batch_No); no repeating groups.
2NF	Single PK → no partial dependency.
3NF	Supplier info should **not** be stored here (transitive dependency) → Supplier info moved to Supplier entity; Medicine only stores Supplier_ID as FK.

6. Supplier

Step	**Explanation**
1NF	Supplier_ID as PK; atomic values for Name, Phone, Email.
2NF	Single PK → no partial dependency.
3NF	No transitive dependencies within Supplier attributes.

7. Insurance Claim

Step	**Explanation**
1NF	Claim_ID as PK; atomic fields for Provider, Policy_No, Status, Amount.
2NF	Single PK → no partial dependencies.
3NF	Ensure Insurance Provider info is not duplicated in other fields or dependent on Policy_No only (depends on design).

8. Billing

Step	Explanation
1NF	Billing_ID as PK; atomic fields for Date, Status.
2NF	Single PK → no partial dependencies.
3NF	No transitive dependencies within billing info.

- All entities have atomic attributes and unique primary keys → satisfy 1NF.
- All entities have single-attribute primary keys, so no partial dependencies → satisfy 2NF.
- Removed transitive dependencies by moving Supplier info to Supplier entity → satisfy 3NF.

Final Tables After 3NF

- Patient (Patient_ID, Firstname, Lastname, DOB, Gender, Phone, Email, Address)
- Doctor (Doctor_ID, Doctor_Name, Specialization, Department, Phone, Email)
- Appointment (Appointment_ID, Patient_ID, Doctor_ID, Date, Time, Status)
- Treatment (Treatment_ID, Appointment_ID, Description, Start_Date, End_Date)
- Medicine (Medicine_ID, Name, Type, Expiry, Batch_No, Supplier_ID)
- Supplier (Supplier_ID, Name, Phone, Email)
- Insurance_Claim(Claim_ID, Patient_ID, Treatment_ID, Provider, Policy_No, Status, Amount)
- Billing (Billing_ID, Patient_ID, Date, Status)

Patient_ID	Firstname	Lastname	DOB	Gender	Phone	Email	Address
P002	Jahan	Marjia	1985-07-20	F	0403456789	jahan.marjia@email.com	Wanguri
Doctor_ID	**Doctor_Firstname**	**Doctor_Lastname**	**Specialization**	**Department**	**Doctor_Phone**	**Doctor_Email**	**License_No**
D102	Mehjabin	Chowdhury	General Practitioner	General Medicine	0412123456	mehjabin.chowdhury@hospital.com	523789
Appointment_ID	**Appointment_Date**	**Appointment_Time**	**Appointment_Status**				
A9002	27.05.2025	11:00 AM	Confirmed				
Treatment_ID	**Treatment_Description**	**Treatment_Start_Date**	**Treatment_End_Date**				
T3002	Low Blood Pressure	27.05.2025	27.05.2025				
Medicine_ID	**Medicine_Name**	**Medicine_Type**	**Medicine_Expiry**	**Batch_No**	**Supplier_ID**		
M7002	Panadol	Tablet	2026-12-31	B200	S502		
Supplier_Name	**Supplier_Phone**	**Supplier_Email**					
S502	HealthMed Pty Ltd	0399123344					
Claim_ID	**Insurance_Provider**	**Policy_No**	**Claim_Status**	**Claim_Amount**			
C123	BUPA	BUP123456	Approved	180.00			
Billing_ID	**Billing_Date**	**Billing_Status**					
B645	27.05.2025	Pending					