Hospital and Research Management System

Scenario: You are tasked with designing the database for a **multi-specialty hospital** which also includes a **clinical research wing**. The hospital offers inpatient and outpatient services, runs specialized units like ICU, handles surgeries, billing, insurance, and even manages clinical trials for new drugs.

Your ER diagram must model the following requirements:

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1. Hospital Staff

- Staff includes doctors, nurses, administrative staff, lab technicians, pharmacists.
- Every staff member has a name, ID, contact info, joining date, and department.
- Doctors have specialization(s), consultation hours, and can supervise junior doctors.
- A doctor can work in **multiple departments** (e.g., Oncology, Radiology).
- Nurses can be assigned to specific wards or ICUs.

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2. Patients

- Patients can be **inpatients** (admitted) or **outpatients** (visit and leave).
- Every patient has a unique ID, demographic details (age, gender, address, contact).
- Inpatients are assigned **rooms and beds**, and each room has a type (ICU, Private, Shared) and a daily charge.
- Outpatients are linked to a **consultation record** (date, doctor, diagnosis).

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3. Appointments and Visits

- Patients can make appointments with doctors.
- Appointment details: date, time, status (booked, completed, canceled).
- Each visit results in a **prescription**, **lab tests ordered**, and **billing**.

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4. Prescriptions and Pharmacy

- Doctors prescribe **medicines** (name, dosage, duration).
- Medicines are managed by the pharmacy — inventory must be tracked (stock level, reorder threshold, supplier).

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5. Lab Tests

- Lab tests can be blood tests, imaging (MRI, CT), etc.
- Each test has a type, description, and cost.
- Lab technicians perform tests and generate **reports** linked to patients.

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6. Insurance and Billing

- Patients can optionally have **insurance** (company name, policy number, coverage details).
- Bills include consultation fees, lab tests, medicines, hospital stay charges (if admitted).
- Insurance may cover partial or full bill amounts.

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7. Clinical Trials (Research Wing)

- Clinical trials are conducted for new drugs.
- Each trial has a name, start date, end date, responsible doctor.
- Selected patients can **enroll** voluntarily after signing consent forms.
- Trials require periodic **monitoring** — visits, vital signs, adverse events must be recorded.
- Trials have phases (Phase I, II, III), and drugs under trial are stored and dispensed separately.

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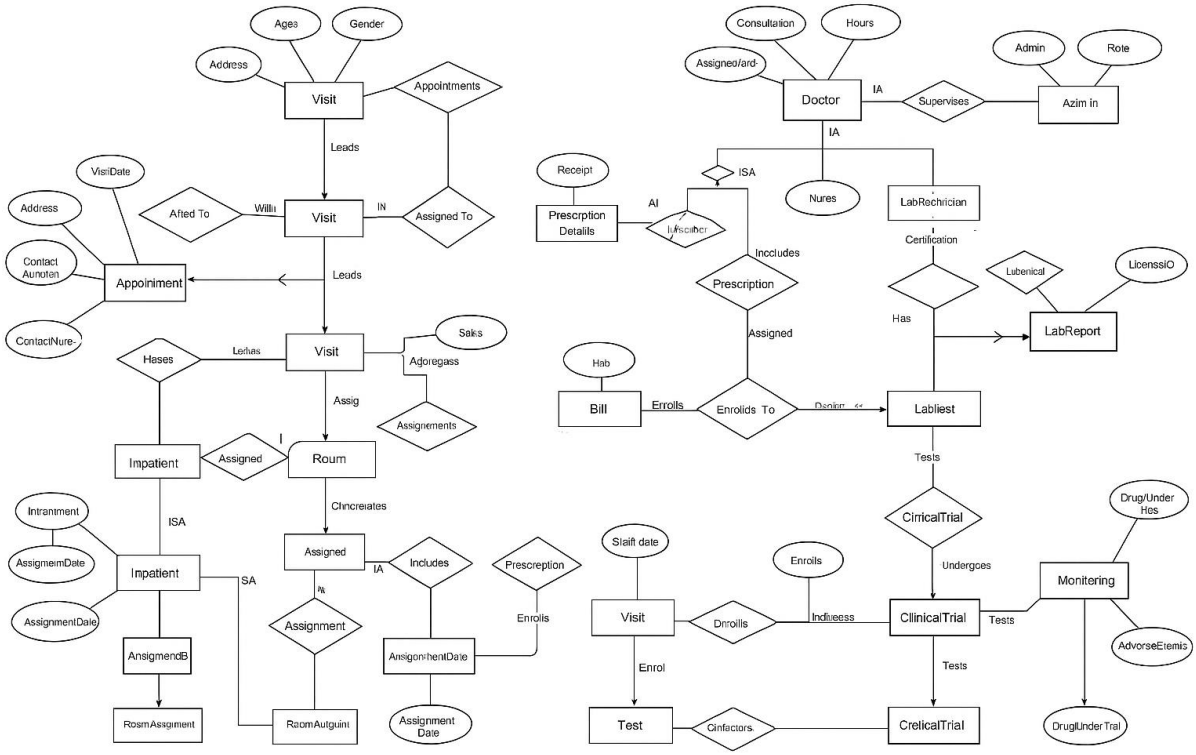
8. Other Complexities to be Modeled:

- **Multi-valued attributes**: (e.g., doctor can have multiple specializations).
- **Weak entities**: (e.g., Room assignment for inpatients — depends on patient existence).
- **Ternary relationships**: (e.g., Clinical trial involves doctor, patient, and drug).
- **ISA hierarchies**: (Staff can be generalized, ISA relationship between Doctor, Nurse, Admin).
- **Aggregation**: For example, Prescription includes (medicine, dosage) and links to Visit.
- **Participation constraints** (total/partial) and cardinality (one-to-many, many-to-many).

Deliverables:

- Draw a **full ER diagram** with:
    - Entities, attributes, keys clearly shown.
    - All relationships with cardinalities.
    - Specialization/generalization if needed.
    - Indicate weak entities properly.
    - Handle multi-valued and composite attributes where required.

ER Diagram



Complete ER Solution

Entities

1. **Patient**
    - PatientID (PK)
    - Name
    - Age
    - Gender
    - Address
    - ContactNumber
    - PatientType {Inpatient, Outpatient}
2. **Staff** *(Generalized Entity)*
    - StaffID (PK)
    - Name
    - ContactNumber
    - JoiningDate
    - Department
    - **Doctor** (ISA Staff)
        - Specializations (multi-valued attribute)
        - ConsultationHours
        - SeniorDoctorID (for supervision)
    - **Nurse** (ISA Staff)
        - AssignedWard (ICU/Ward number)
    - **Admin** (ISA Staff)
        - Role
    - **LabTechnician** (ISA Staff)
        - Certification
    - **Pharmacist** (ISA Staff)
        - LicenseID

3. **Room** *(for Inpatients)*
    - RoomNumber (PK)
    - RoomType {ICU, Private, Shared}
    - DailyCharge
4. **Appointment**
    - AppointmentID (PK)
    - Date
    - Time
    - Status {Booked, Completed, Canceled}
5. **Visit**
    - VisitID (PK)
    - VisitDate
    - Diagnosis
6. **Prescription**
    - PrescriptionID (PK)
    - Date
    - DoctorID (FK)
    - PatientID (FK)
7. **Medicine**
    - MedicineID (PK)
    - Name
    - DosageForm (Tablet, Injection)
    - StockLevel
    - ReorderThreshold
    - SupplierName
8. **Insurance**
    - InsuranceID (PK)
    - CompanyName
    - PolicyNumber

- CoverageDetails

9. **Bill**
    - BillID (PK)
    - TotalAmount
    - PaidAmount
    - BillingDate
10. **LabTest**
    - TestID (PK)
    - TestName
    - Description
    - Cost
11. **LabReport**
    - ReportID (PK)
    - ResultDetails
    - DateGenerated
12. **ClinicalTrial**
    - TrialID (PK)
    - TrialName
    - StartDate
    - EndDate
    - Phase (I/II/III)
13. **DrugUnderTrial**
    - DrugID (PK)
    - Name
    - Manufacturer
14. **Monitoring**
    - MonitoringID (PK)
    - Date
    - VitalSigns

- AdverseEvents

Relationships

- **Patient - Appointment - Doctor**
  - Patient books **Appointments** with Doctor.
  - (M:1 from Appointment to Patient)
  - (M:1 from Appointment to Doctor)
- **Appointment - Visit**
  - One Appointment **leads to** one Visit (1:1).
- **Visit - Prescription**
  - One Visit results in **zero or many** Prescriptions (1:M).
- **Prescription - Medicine**
  - A Prescription **lists multiple Medicines** (M:N).
- **Patient - Insurance**
  - A Patient **may have** zero or one Insurance (0:1).
- **Patient - Bill**
  - Each Bill is generated for a Patient (1:M).
- **Room - Inpatient (Patient)**
  - Each Inpatient **occupies** one Room.
  - (1:1 relationship but patient could leave and room be reassigned)
- **LabTest - LabReport**
  - A Lab Test leads to a Lab Report (1:1).
- **LabTechnician - LabTest**
  - A Lab Technician **performs** multiple LabTests (1:M).
- **Patient - ClinicalTrial - Doctor**
  - Patients **enroll** in ClinicalTrials (ternary relationship with Doctor supervising).
- **DrugUnderTrial - ClinicalTrial**
  - A ClinicalTrial **tests** multiple Drugs (1:M).
- **Patient - Monitoring - ClinicalTrial**

- Monitoring data is recorded for a Patient during a ClinicalTrial (M:N via Monitoring entity).

Specializations and Weak Entities

- **Staff ISA {Doctor, Nurse, Admin, LabTechnician, Pharmacist}**
- **RoomAssignment** *(Weak Entity dependent on Patient and Room)*
  - BedNumber
  - AssignmentDate
- **Prescription Details** *(weak inside Prescription)*
  - MedicineID
  - Dosage
  - Duration

Complex Features Modelled

Feature	**How Modelled**
Multi-valued attributes	Doctor has multiple Specializations
Weak entity	RoomAssignment for inpatient
Aggregation	Prescription aggregates Medicines with dosages
Ternary relationship	Patient-Doctor-ClinicalTrial
Generalization	Staff → {Doctor, Nurse, Admin, Pharmacist, Technician}