

2. Develop a logical data model based on the following requirements:

a. Derive relations from the conceptual model

Entity 1	M ₁	Relationship	M ₂	E ₂	Type of Relationship
Clinic	1..1	employs	1..*	Staff	1:* (give rise to foreign key) clinicNo
Staff	1..1	manages	0..1	Clinic	1:1 (give rise to foreign key) staffNo
Clinic	1..1	registers	0..*	Pet	1:* (give rise to foreign key) clinicNo
PetOwner	1..1	owns	1..*	Pet	1:* (give rise to foreign key) ownerNo
Pet	1..1	undergoes	0..*	Examination	1:* (give rise to foreign key) petNo
Staff	1..1	performs	0..*	Examination	1:* (give rise to foreign key) staffNo

1. Clinic (clinicNo, name, address, telephone, ManagerStaffNo) **staffNo= (ManagerStaffNo) (FK)**
2. Staff (staffNo, name, address, telephone, DOB, position, salary, clinicNo) **clinicNo (FK)**
3. Owner (ownerNo, name, address, telephone)
4. Pet (petNo, name, DOB, species, breed, color, ownerNo, clinicNo) **clinicNo (FK) ownerNo (FK)**
5. Examination (examNo, complaint, description, date, actions, petNo, staffNo) **staffNo (FK) petNo(FK)**

Assumptions:

1. **Clinic - Staff:** Each clinic employs multiple staff members. A staff member can manage at most one clinic, and a clinic can be managed by at most one staff member. However, not every staff member manages a clinic.
1. **Clinic - Pet:** Each pet is registered at one clinic. A pet's medical records cannot be shared across different clinics.
2. **PetOwner - Pet:** An owner can own multiple pets, but a pet has only one owner.
3. **Pet - Examination:** Each pet can undergo multiple examinations.

4. **Staff - Examination:** A staff member can perform multiple examinations. The pet undergoes an examination by a staff member. This implies that every examination is conducted by a staff member, and each examination is associated with a specific pet.
 5. **Unique Identifiers:** Each clinic, staff member, owner, pet, and examination have a unique identifier. Thus, there is no duplication in these entities.
 6. **Current Management:** Database will store the current manager at the clinic at the present time.
- b. Validate the logical model using normalization to 3NF.
1. **First Normal Form (1NF):** Each relation is in 1NF because it has a primary key and each attribute contains only indivisible values.
 2. **Second Normal Form (2NF):** Each relation is in 2NF because it is in 1NF and every non-primary-key attribute is fully functionally dependent on the primary key. For example, in the Staff relation, all attributes are fully dependent on staffNo.
 3. **Third Normal Form (3NF):** Each relation is in 3NF because it is in 2NF and there are no transitive dependencies. A transitive dependency occurs when one attribute depends on another attribute through a third one. In this case, non-key attributes don't depend on other non-key attributes.
- c. Validate the logical model against 5 user transactions.
1. **Add a new pet:** This would involve inserting a new record into the 'Owner' table. The model supports this as all necessary fields (ownerNo, name, address, telephone) are present in the 'Owner' table.
 2. **Update staff information:** This could involve changing a staff member's address or telephone number in the Staff table. Therefore, the staffNo exists to update the required fields.
 3. **Register a new owner:** This would involve adding a new row in 'Pet' table, with references to the correct 'ownerNo' and 'clinicNo'. The ownerNo will contain unique combinations to ensure there are no duplicates. The model supports this as all necessary fields are present in the 'Pet' table.
 4. **Record a new examination:** This would involve adding a new row to the Examination table. Thus, petNo and staffNo exist in the Pet and Staff tables, respectively.
 5. **Change a pet's clinic:** This would involve updating the clinicNo for a pet in the Pet table. The new clinicNo will exist in the Clinic table.
- d. Define integrity constraints:
- i. **Primary Key Constraints:** Each table has a unique primary key that cannot be NULL.
 - Clinic: clinicNo
 - Staff: staffNo
 - Owner: ownerNo
 - Pet: petNo
 - Examination: examNo

ii. **Referential Integrity/Foreign Key Constraints:** Foreign keys in a table must match the primary key of another table or be NULL.

- Clinic.ManagerStaffNo references Staff.StaffNo
- Staff.clinicNo references Clinic.clinicNo
- Pet.ownerNo references Owner.ownerNo
- Pet.clinicNo references Clinic.clinicNo
- Examination.petNo references Pet.petNo
- Examination.staffNo references Staff.staffNo

iii. **Alternate Key Constraints:** There are no alternate keys in this model. An alternate key is a candidate key not chosen as the primary key.

iv. **Required Data:** All attributes are required (cannot be NULL) except for Clinic.ManagerStaffNo because not all staff manage a clinic.

v. **Attribute Domain Constraints:** These define the valid values for a column. For example:

- Staff.position could be restricted to values like 'Vet', 'Nurse', 'Receptionist', etc.
- Pet.species could be restricted to 'Dog', 'Cat', 'Bird', etc.
- Pet.color, Examination.date, and other attributes should have appropriate data types and formats.

vi. **General Constraints:** There are business rules that don't fall into other categories.

- A member of staff manages at most one clinic.
- Not every staff member manages a clinic.
- A pet can be registered at only one clinic.

e. E- R Diagram

