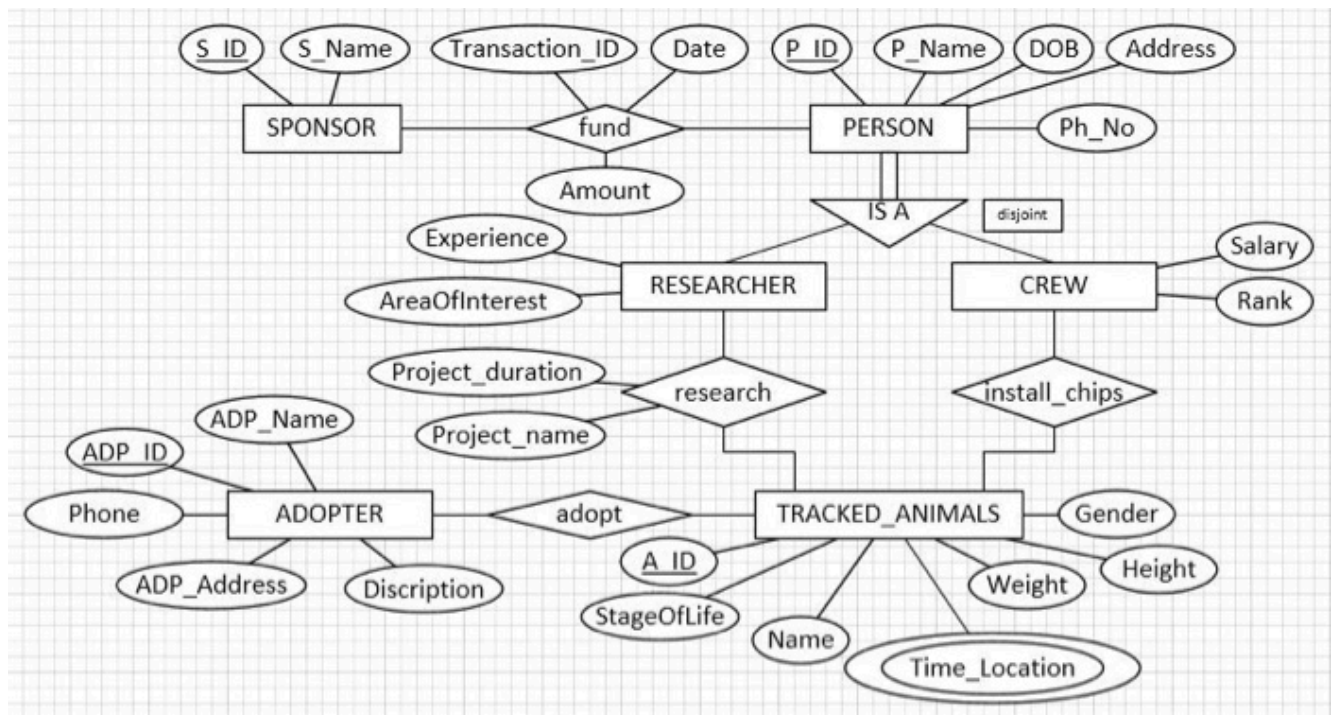Homework assignment 4

Exercise

4.16:-
Design an EER schema for a database application that you are interested in. Specify all constraints that should hold on the database. Make sure that the schema has at least five entity types, four relationship types, a weak entity type, a superclass/subclass relationship, a category, and an n-ary (n > 2) relationship type.
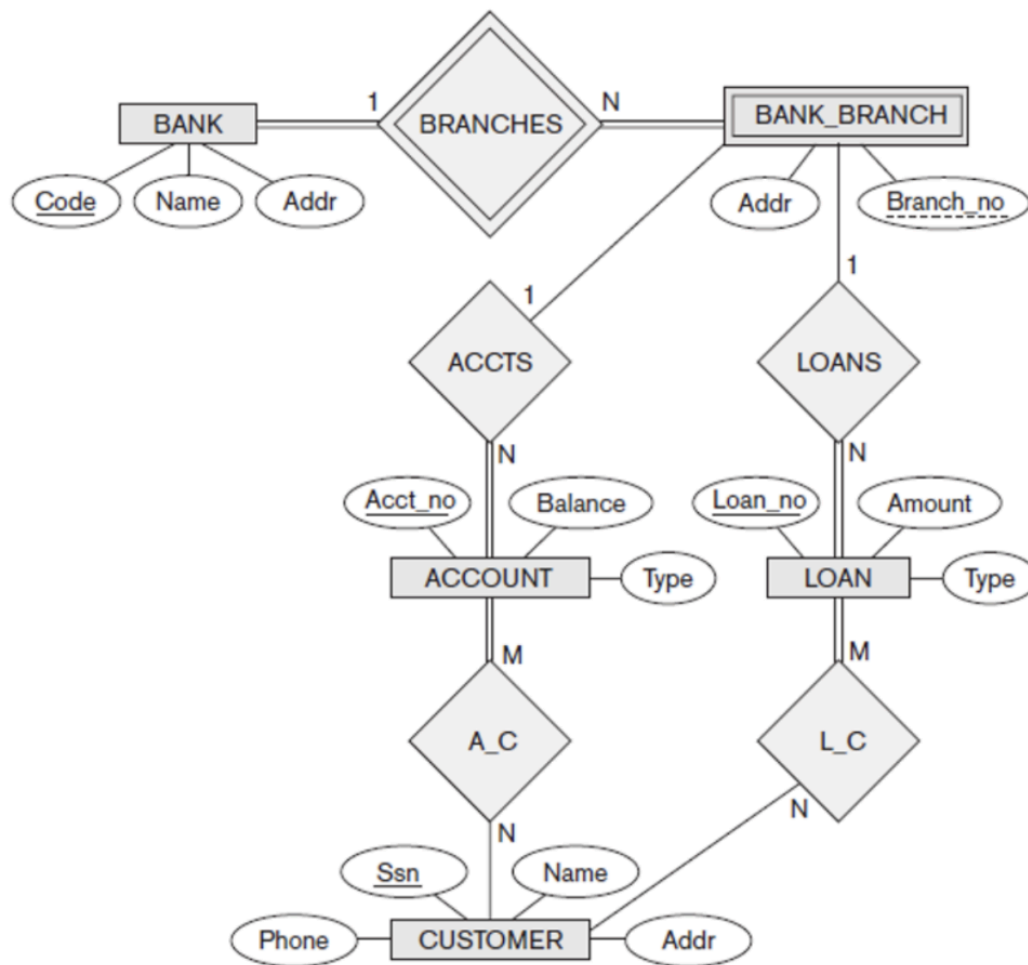
=> Answer:-

4.17:-

Consider the BANK ER schema in Figure 3.21, and suppose that it is necessary to keep track of different types of ACCOUNTS (SAVINGS_ACCTS, CHECKING_ACCTS, ...) and LOANS (CAR_LOANS, HOME_LOANS, ...).
Suppose that it is also desirable to keep track of each ACCOUNT's TRANSACTIONS (deposits, withdrawals, checks,...) and each LOAN's PAYMENTS; both of these include the amount, date, and time. Modify the BANK schema, using ER and EER concepts of specialization and generalization. State any assumptions you make about the additional requirements.

=> Answer:-

❖ **Understanding the Current Schema**

The given BANK ER schema represents a simplified banking system. It includes entities for BANK, BRANCHES, ACCOUNTS, LOANS, and CUSTOMERS. The relationships between these entities depict basic associations, such as a bank having multiple branches, accounts belonging to customers, and loans being associated with accounts.

❖ **Identifying New Requirements and Modifications**

Based on the requirement to track different account and loan types, as well as transactions and payments, we can introduce specialization and generalization into the schema.

→ **Assumptions:**
● Each transaction and payment will have a unique identifier.
● Transactions can be associated with both savings and checking accounts.
● Loans can have multiple payments.
● A customer can have multiple accounts and loans.

→ **Proposed Modifications:**

1. **Specialization of ACCOUNTS and LOANS:**
● Create two subtypes of ACCOUNTS: SAVINGS_ACCT and CHECKING_ACCT.
● Create two subtypes of LOANS: CAR_LOAN and HOME_LOAN.
● The specialization relationships should be total and disjoint, meaning each account and loan must belong to one and only one subtype.

2. **New Entity: TRANSACTIONS:**
   - Introduce a new entity, TRANSACTIONS, to store details about account transactions.
   - Attributes: transaction_id, amount, date, time, transaction_type (deposit, withdrawal, check).
   - Create a many-to-many relationship between ACCOUNTS and TRANSACTIONS to allow for multiple transactions per account.

3. **New Entity: PAYMENTS:**
   - Introduce a new entity, PAYMENTS, to store details about loan payments.
   - Attributes: payment_id, amount, date, time.
   - Create a many-to-many relationship between LOANS and PAYMENTS to allow for multiple payments per loan.

4.19:-
Identify all the important concepts represented in the library database case study described below. In particular, identify the abstractions of classification (entity types and relationship types), aggregation, identification, and specialization/generalization. Specify (min, max) cardinality constraints whenever possible. List details that will affect the eventual design but that have no bearing on the conceptual design. List the semantic constraints separately. Draw an EER diagram of the library database.

Case Study:
The Georgia Tech Library (GTL) has approximately 16,000 members, 100,000 titles, and 250,000 volumes (an average of 2.5 copies per book). About 10% of the volumes are out on loan at any one time. The librarians ensure that the books that members want to borrow are available when the members want to borrow them.

Also, the librarians must know how many copies of each book are in the library or out on loan at any given time. A catalog of books is available online that lists books by author, title, and subject area. For each title in the library, a book description is kept in the catalog; the description ranges from one sentence to several pages. The reference librarians want to be able to access this description when members request information about a book. Library staff includes chief librarian, departmental associate librarians, reference librarians, check-out staff, and library assistants.

Books can be checked out for 21 days. Members are allowed to have only five books out at a time. Members usually return books within three to four weeks. Most members know that they have one week of grace before a notice is sent to them, so they try to return books before the grace period ends. About 5% of the members have to be sent reminders to return books. Most overdue books are returned within a month of the due date. Approximately 5% of the overdue books are either kept or never returned. The most active members of the library are defined as those who borrow books at least ten times during the year. The top 1% of membership does 15% of the borrowing, and the top 10% of the membership does 40% of the borrowing. About 20% of the members are totally inactive in that they are members who never borrow.

To become a member of the library, applicants fill out a form including their SSN, campus and home mailing addresses, and phone numbers. The librari ans issue a numbered, machine-readable card with the member's photo on it. This card is good for four years. A month before a card expires, a notice is sent to a member for renewal. Professors at the institute are considered automatic members. When a new faculty member joins the institute, his or her information is pulled from the employee records and a library card is mailed to his or her campus address.

Professors are allowed to check out books for three-month intervals and have a two-week grace period. Renewal notices to professors are sent to their campus address.

The library does not lend some books, such as reference books, rare books, and maps. The librarians must differentiate between books that can be lent and those that cannot be lent. In addition, the librarians have a list of some books they are interested in acquiring but cannot obtain, such as rare or out-of-print books and books that were lost or destroyed but have not been replaced. The librarians must have a system that keeps track of books that cannot be lent as well as books that they are interested in acquiring. Some books may have the same title; therefore, the title cannot be used as a means of identification. Every book is identified by its International Standard Book Number (ISBN), a unique international code assigned to all books. Two books with the same title can have different ISBNs if they are in different languages or have different bindings (hardcover or softcover). Editions of the same book have different ISBNs. The proposed database system must be designed to keep track of the members, the books, the catalog, and the borrowing activity.

=> Answer:-

Identified Concepts in the Library Database Case Study:

i. **Entity Types and Attributes (Classification Abstractions)**
   ➔ **Member**: Includes `MemberID`, `SSN`, `CampusAddress`, `HomeAddress`, `PhoneNumber`, `CardID`, `ExpirationDate`, `BorrowLimit`, `GracePeriod`, `ReminderSent`, and `ActivityStatus`.
   ➔ **Book**: Includes `ISBN`, `Title`, `Author`, `SubjectArea`, `Binding`, `Edition`, `Description`, `LendingStatus`, and `Availability`.

➔ **Volume**: Represents copies of books; includes `VolumeID`, `ISBN`, `Availability`, `LoanStatus`.

➔ **Loan**: Represents borrowing transactions; includes `LoanID`, `VolumeID`, `MemberID`, `LoanDate`, `DueDate`, `ReturnDate`, `ReminderSent`.

➔ **Librarian**: Subtypes include `ChiefLibrarian`, `ReferenceLibrarian`, `CheckoutStaff`, `LibraryAssistant`; common attributes include `LibrarianID`, `Name`, and `Role`.

ii. Relationship Types (Classification Abstractions)

➔ **Borrows**: Relationship between `Member` and `Loan` with attributes like `LoanDate`, `DueDate`, `ReturnDate`, etc.

➔ **Manages**: Relationship between `Librarian` and `Volume`, showing management or responsibility over books.

➔ **Maintains**: Relationship between `Librarian` and `Catalog`, indicating that librarians keep the catalog up to date.

➔ **Reserves**: A potential future relationship where `Members` may reserve `Books` for borrowing.

iii. Aggregation

➔ **Book-Volume**: Aggregation to represent multiple volumes belonging to a single book (`Title`), allowing tracking of individual copies.

➔ **Member-Loan**: Aggregation of loans associated with a particular member.

iv. Identification

- **Book** is identified by its **ISBN,** ensuring uniqueness despite the title or author overlaps.
- **Member** is identified by their **MemberID** or **SSN**.
- **Loan** is identified by **LoanID**.

v. **Specialization/Generalization**
  ➔ **Librarian**: Subtypes of librarians include `ChiefLibrarian`, `ReferenceLibrarian`, `CheckoutStaff`, and `LibraryAssistant`. Each subtype has distinct responsibilities, but they share common attributes like `LibrarianID` and `Name`.

vi. **Cardinality Constraints**
  ➔ **Borrows (Member-Loan)**: Each member can borrow **(0, 5)** books at a time.
  ➔ **Manages (Librarian-Volume)**: One librarian can manage **(0, N)** books, but each book copy (volume) is managed by **(1)** librarian.
  ➔ **Contains (Book-Volume)**: A book can have **(1, N)** volumes (copies).
  ➔ **Describes (Catalog-Book)**: Each catalog entry describes **(1)** book, but a book can appear in **(0, N)** catalog entries (e.g., by title, author, subject).

vii. **Semantic Constraints**
  ➔ **Non-Lending Books**: Books like rare books, reference books, and maps cannot be borrowed, tracked via the `LendingStatus` attribute.
  ➔ **Automatic Membership for Professors**: Faculty members automatically receive membership cards without needing to apply.
  ➔ **Renewal Policy**: Regular members renew their membership every four years, while professors' loans can be extended for three-month intervals.
  ➔ **Book Return Grace Period**: Members have a one-week grace period for returning books.

viii. **Details Affecting Eventual Design**
  ➔ **Borrow Limits**: Members can borrow up to five books simultaneously, and professors have extended loan periods.
  ➔ **Catalog**: Detailed descriptions are kept for each book in a digital catalog.
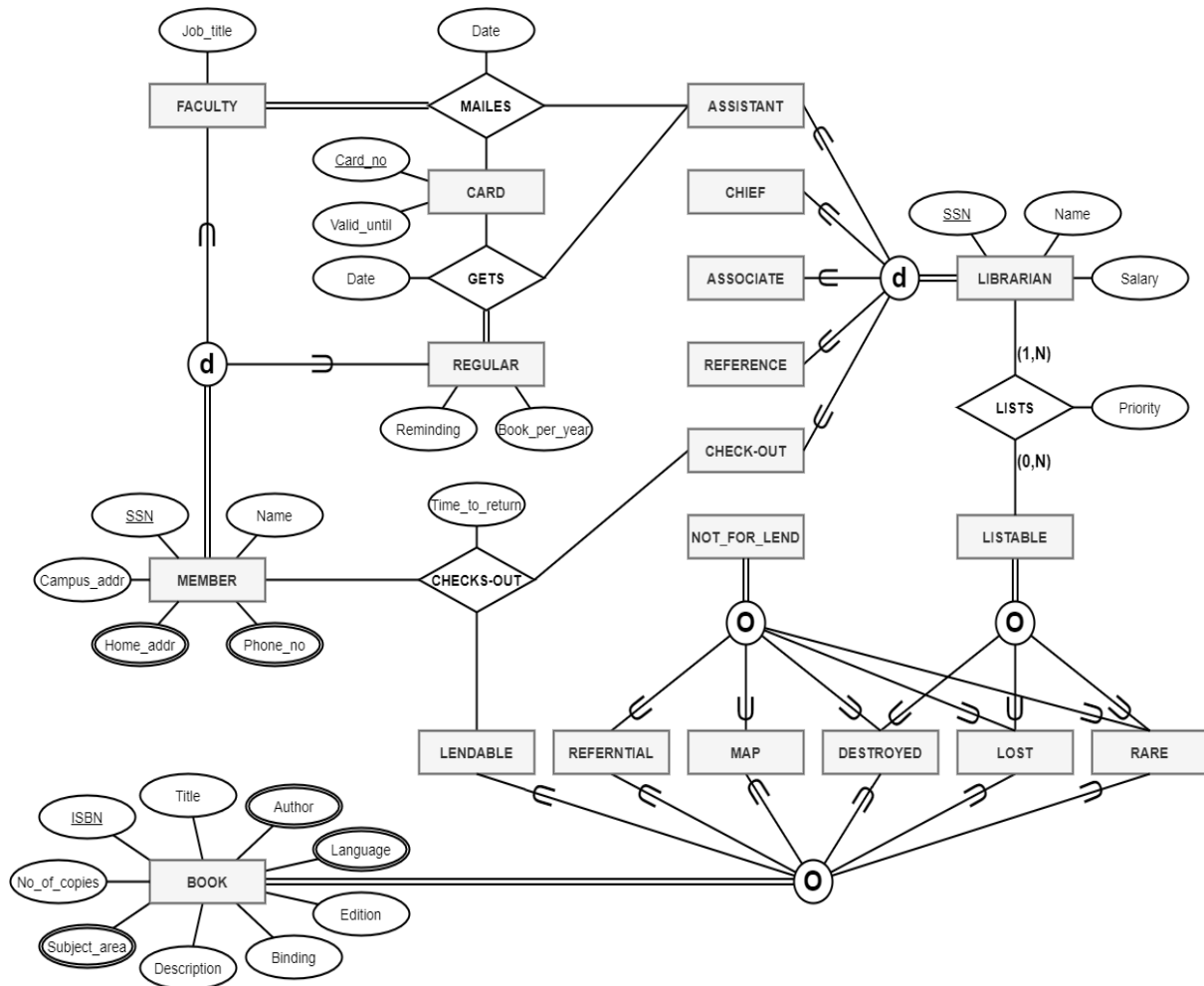
4.20:-

Design a database to keep track of information for an art museum. Assume that the following requirements were collected:

● The museum has a collection of ART_OBJECTS. Each ART_OBJECT has A unique Id_no, an Artist (if known), a Year (when it was created, if known), a Title, and a Description. The art objects are categorized in several ways, as discussed below.

- ART_OBJECTS are categorized based on their type. There are three main types—PAINTING, SCULPTURE, and STATUE—plus another type called OTHER to accommodate objects that do not fall into one of the three main types.
- A PAINTING has a Paint_type (oil, watercolor, etc.), material on which it is Drawn_on (paper, canvas, wood, etc.), and Style (modern, abstract, etc.).
- A SCULPTURE or a statue has a Material from which it was created (wood, stone, etc.), Height, Weight, and Style.
- An art object in the OTHER category has a Type (print, photo, etc.) and Style.
- ART_OBJECTs are categorized as either PERMANENT_COLLECTION (objects that are owned by the museum) and BORROWED. Information captured about objects in the PERMANENT_COLLECTION includes Date_acquired, Status (on display, on loan, or stored), and Cost. Information captured about BORROWED objects includes the Collection from which it was borrowed, Date_borrowed, and Date_returned.
- Information describing the country or culture of Origin (Italian, Egyptian, American, Indian, and so forth) and Epoch (Renaissance, Modern,
- Ancient, and so forth) is captured for each ART_OBJECT.
- The museum keeps track of ARTIST information, if known: Name, DateBorn (if known), Date_died (if not living), Country_of_origin, Epoch, Main_style, and Description. The Name is assumed to be unique.
- Different EXHIBITIONS occur, each having a Name, Start_date, and End_date.

- EXHIBITIONS are related to all the art objects that were on display during the exhibition.
- Information is kept on other COLLECTIONS with which the museum interacts; this information includes Name (unique), Type (museum, personal, etc.), Description, Address, Phone, and current Contact_person.

Draw an **EER** schema diagram for this application. Discuss any assumptions you make, and then justify your EER design choices

=> Answer:-