Experiment 1: Database Creation with Constraints, Relationships & User Access Control

1. Aim of the Session

The purpose of this practical is to provide hands-on experience in designing and implementing a comprehensive database system for a library management scenario. Students will learn to create tables with various constraints, establish relationships between tables, and manage user access through roles and permissions in a Database Management System (DBMS).

Purpose of the practical:

- To understand how to create databases and tables with proper structure
- To implement data integrity through constraints and relationships
- To manage user access and permissions in a DBMS

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2. Objective of the Session

The specific goals of this session are:

- **Learn Table Creation**: Understand how to create tables with various data types and constraints
- **Implement Data Integrity**: Apply PRIMARY KEY, FOREIGN KEY, NOT NULL, UNIQUE, and CHECK constraints to ensure data quality
- **Establish Relationships**: Create relationships between multiple tables using foreign keys (one-to-many relationships)
- **Manage Roles & Permissions**: Create user roles and grant/revoke database permissions
- **Data Manipulation**: Insert, retrieve, and manage data using SQL queries
- **Database Security**: Understand role-based access control and permission management

Upon completion, students will be able to:

- Design normalized database schemas with proper relationships
- Implement constraints to maintain data integrity

- Manage user access and database security
- Write SQL DDL (Data Definition Language) statements confidently

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3. Practical / Experiment Steps

The experiment involves creating a Library Management System database with the following components:

Step 1: Create the BOOKS Table

- Define a table to store book information
- Implement PRIMARY KEY constraint on BOOKS_ID
- Use VARCHAR for text fields and NOT NULL constraint for mandatory fields

Step 2: Create the LIBRARY_VISITORS Table

- Define a table for library members
- Implement PRIMARY KEY on USER_ID
- Apply CHECK constraint to ensure visitors are at least 17 years old
- Apply UNIQUE constraint on EMAIL to prevent duplicate email registrations
- Use NOT NULL constraints for mandatory fields

Step 3: Create the BOOK_ISSUE Table

- Define a table to track which books are issued to which visitors
- Implement PRIMARY KEY on BOOK_ISSUE_ID
- Use FOREIGN KEY constraints to establish relationships with BOOKS and LIBRARY_VISITORS tables

Step 4: Insert Sample Data

- Insert book records into the BOOKS table
- Insert visitor records into the LIBRARY_VISITORS table with valid data
- Insert book issue records linking books to visitors

Step 5: Create Database Roles and Manage Permissions

- Create a LIBRARIAN role with login credentials

- Grant permissions (SELECT, INSERT, UPDATE, DELETE) on specific tables
- Revoke permissions to demonstrate access control

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4. Procedure of the Practical

Follow these sequential steps to execute the experiment:

(i) Start the System and Open Database Management System

- Power on the computer and log in
- Open the Database Management System (SQL Server / MySQL / Oracle)
- Ensure you have administrative access to create databases and roles

(ii) Create or Select the Required Database

- Create a new database or select an existing one for the library management system
- Verify the database is active before proceeding

(iii) Drop Existing Tables (Optional)

- Execute DROP TABLE IF EXISTS BOOKS to remove any existing tables and start fresh
- This ensures a clean state for the experiment

(iv) Create the BOOKS Table

```
CREATE TABLE BOOKS(
  BOOKS_ID INT PRIMARY KEY,
  BOOK_NAME VARCHAR(50) NOT NULL,
  AUTHOR_NAME VARCHAR(50) NOT NULL
)
```

- Execute the command to create the table
- Verify successful creation

(v) Create the LIBRARY_VISITORS Table

```
CREATE TABLE LIBRARY_VISITORS(
  USER_ID INT PRIMARY KEY,
  NAME VARCHAR(50) NOT NULL,
  AGE INT CHECK(AGE>=18) NOT NULL,
  EMAIL VARCHAR(20) NOT NULL UNIQUE
)
```

- Execute the command with constraints
- Note the CHECK constraint for age validation

(vi) Create the BOOK_ISSUE Table with Foreign Keys

```
CREATE TABLE BOOK_ISSUE(
  BOOK_ISSUE_ID INT PRIMARY KEY,
  USER_ID INT REFERENCES LIBRARY_VISITORS(USER_ID),
  BOOK_ID INT NOT NULL,
  FOREIGN KEY(BOOK_ID) REFERENCES BOOKS(BOOKS_ID)
)
```

- Execute to establish relationships between tables
- Verify foreign key constraints are properly set

(vii) Insert Data into BOOKS Table

```
INSERT INTO BOOKS VALUES(101, 'HARRY POTTER', 'DAVID')
```

- Execute to insert book records
- Verify insertion using SELECT query

(viii) Insert Data into LIBRARY_VISITORS Table

```
INSERT INTO LIBRARY_VISITORS(USER_ID,NAME,AGE,EMAIL)
VALUES(501, 'ARNAV PRAJAPATI’, 20, 'arnav@.com')


INSERT INTO LIBRARY_VISITORS VALUES(502, 'Anshu Sharma', 19, 'anshu@gmail.com')
```

- Execute both insert statements
- Ensure data satisfies all constraints (AGE >= 18, unique EMAIL, etc.)

(ix) Insert Data into BOOK_ISSUE Table

```
INSERT INTO BOOK_ISSUE VALUES(1001, 501, 101)
```

- Execute to create an issue record linking visitor to book
- Verify foreign key relationships are maintained

(x) Verify Data Retrieval

- Execute SELECT * FROM BOOKS
- Execute SELECT * FROM LIBRARY_VISITORS
- Execute SELECT * FROM BOOK_ISSUE
- Verify all records are correctly inserted and retrieved

(xi) Create a Database Role

```
CREATE ROLE LIBRARIAN

WITH LOGIN PASSWORD 'arnav0211'
```

- Execute to create a new role with login credentials
- Verify role creation

(xii) Grant Permissions to Role

```
GRANT SELECT,INSERT,DELETE,UPDATE ON BOOKS TO LIBRARIAN
```

- Execute to grant specific permissions
- Verify permissions are assigned

(xiii) Revoke Permissions from Role

```
REVOKE SELECT,INSERT,DELETE,UPDATE ON BOOKS FROM LIBRARIAN
```

- Execute to demonstrate permission revocation
- Verify permissions are removed

(xiv) Document Results

- Note down all outputs and observations
- Take screenshots of each successful execution
- Record any errors and how they were resolved

5. Input / Output Analysis

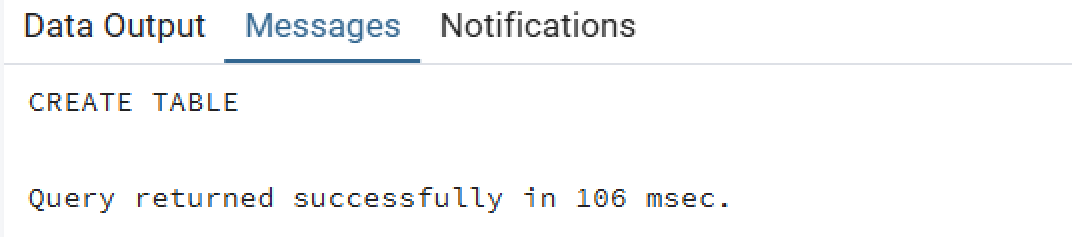
Inputs Provided:

1. **BOOKS Table**: Book records with ID, name, and author
2. **LIBRARY_VISITORS Table**: Visitor information with ID, name, age (minimum 18), and unique email
3. **BOOK_ISSUE Table**: Issue records linking visitors to books through foreign keys
4. **User Role**: LIBRARIAN role with specific permissions

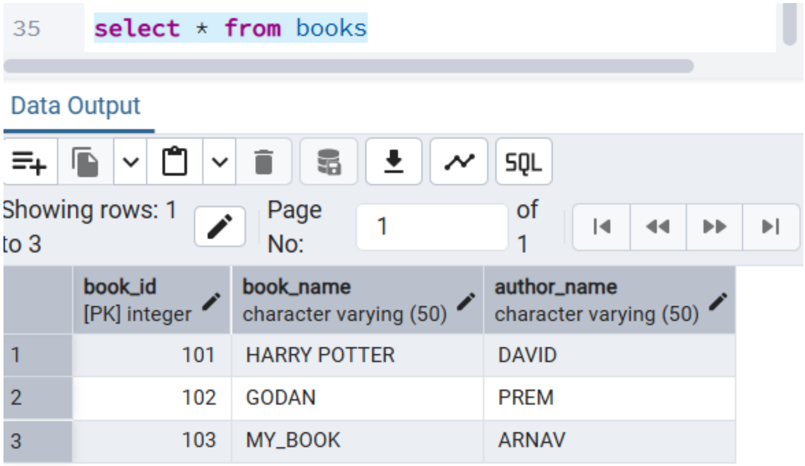
Expected Outputs:

1. **Successful Table Creation**: All three tables created with proper constraints and relationships
2. **Data Insertion Success**: Records inserted without constraint violations
3. **SELECT Query Results**: All records displayed with proper structure and data types
4. **Role Management**: LIBRARIAN role created and permissions granted/revoked successfully

Sample Screenshots Should Show:

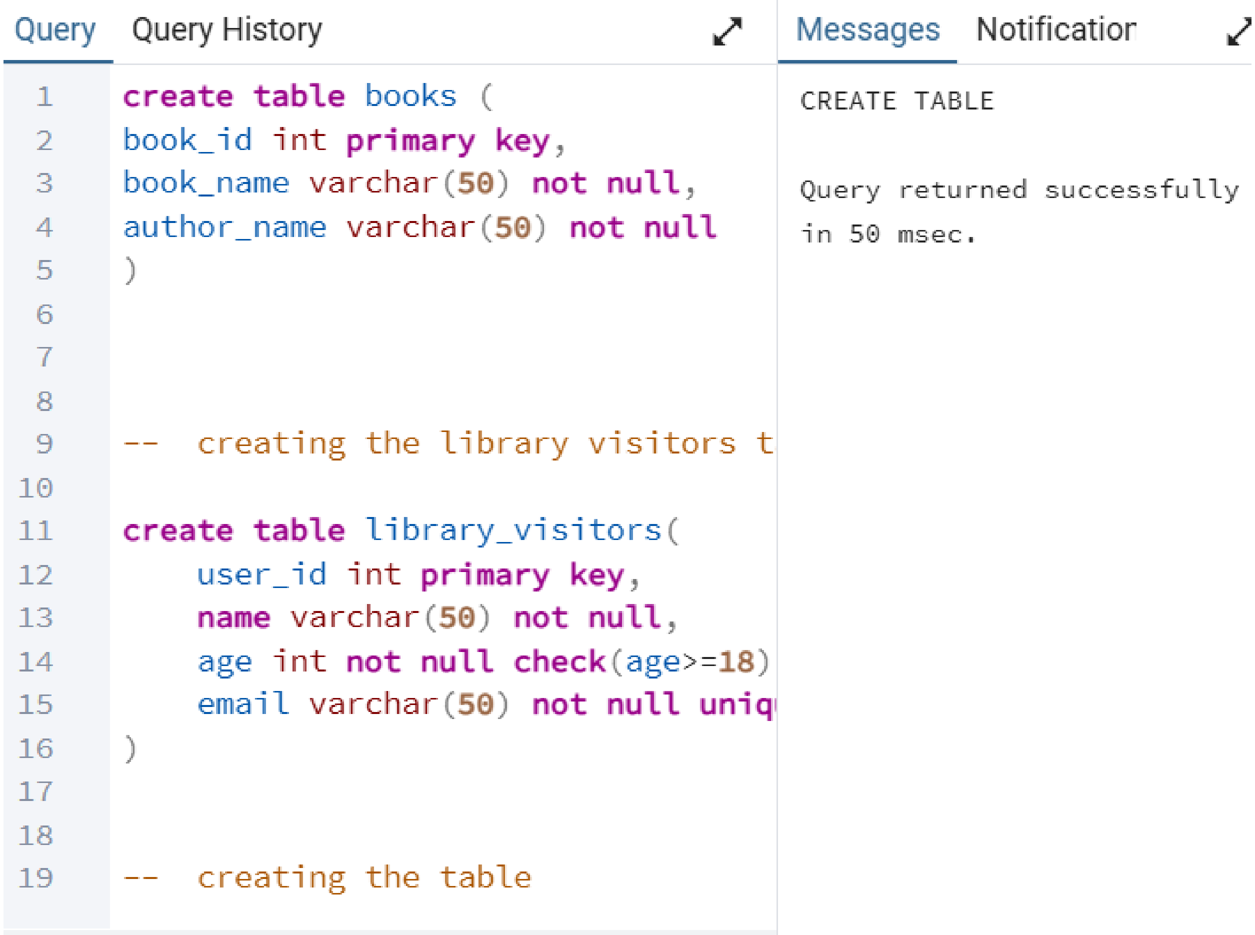


```
CREATE TABLE

Query returned successfully in 106 msec.
```



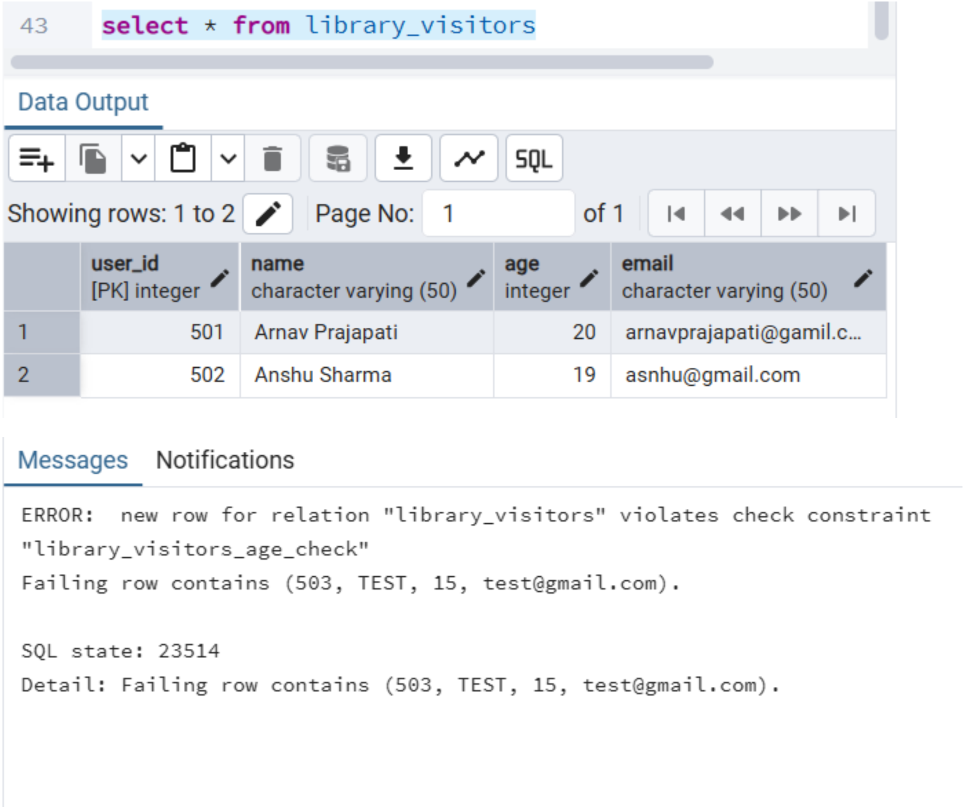
```
select * from books
```

	book_id [PK] integer	book_name character varying (50)	author_name character varying (50)
1	101	HARRY POTTER	DAVID
2	102	GODAN	PREM
3	103	MY_BOOK	ARNAV



```
create table books (
book_id int primary key,
book_name varchar(50) not null,
author_name varchar(50) not null
)



--  creating the library visitors t

create table library_visitors(
    user_id int primary key,
    name varchar(50) not null,
    age int not null check(age>=18)
    email varchar(50) not null uniq
)


--  creating the table
```

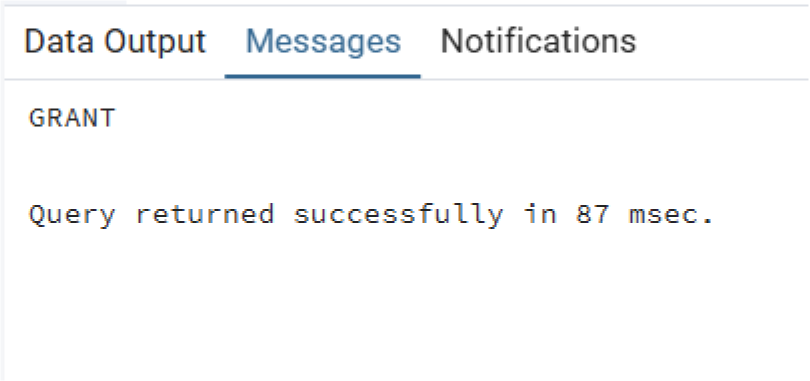
```
CREATE TABLE

Query returned successfully
in 50 msec.
```



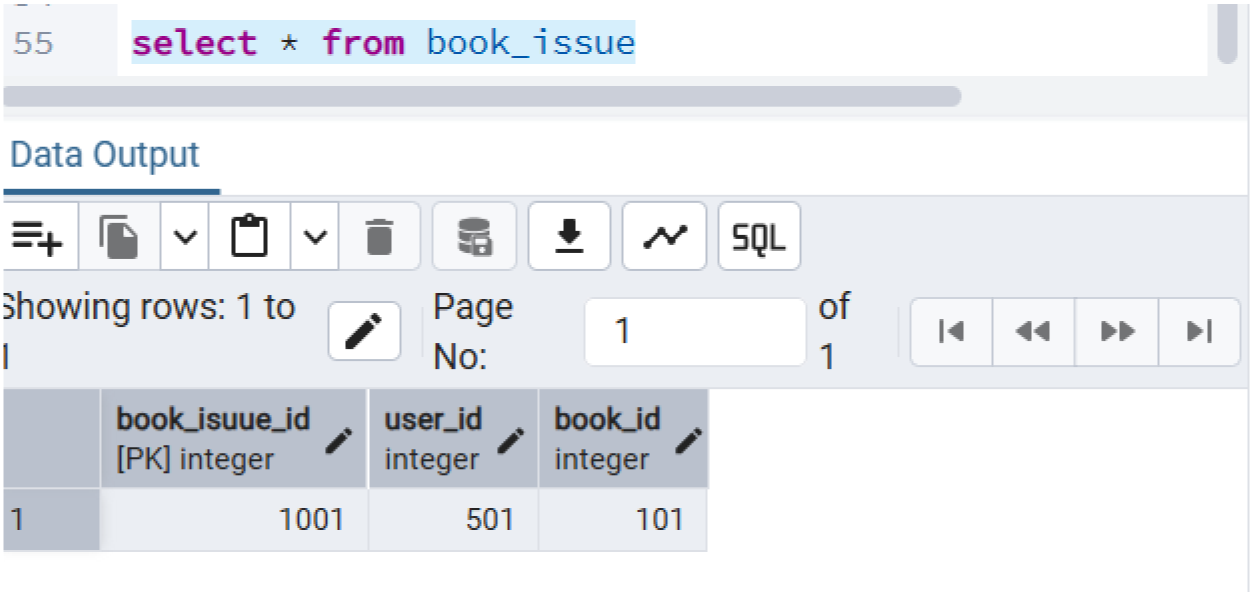
```
43  select * from library_visitors
```

	user_id [PK] integer	name character varying (50)	age integer	email character varying (50)
1	501	Arnav Prajapati	20	arnavprajapati@gamil.c...
2	502	Anshu Sharma	19	asnhu@gmail.com

```
ERROR:  new row for relation "library_visitors" violates check constraint
"library_visitors_age_check"
Failing row contains (503, TEST, 15, test@gmail.com).

SQL state: 23514
Detail: Failing row contains (503, TEST, 15, test@gmail.com).
```



```
GRANT

Query returned successfully in 87 msec.
```



```sql
select * from book_issue
```

Showing rows: 1 to 1 Page No: 1 of 1

	book_isuue_id [PK] integer	user_id integer	book_id integer
1	1001	501	101

6. Learning Outcomes

Concepts Understood:

- **Database Design**: How to structure data using normalized tables
- **Data Integrity**: Implementation of constraints (PRIMARY KEY, FOREIGN KEY, NOT NULL, UNIQUE, CHECK)
- **Table Relationships**: One-to-many relationships using foreign keys
- **Data Manipulation**: INSERT and SELECT operations
- **Access Control**: Role-based security and permission management
- **Data Validation**: Using CHECK constraints for business rule enforcement

Skills Developed:

- Ability to write DDL (Data Definition Language) statements
- Capability to design relationships between multiple tables
- Understanding of constraint implementation and enforcement
- Proficiency in user role creation and permission management
- Data insertion and retrieval skills
- SQL debugging and error resolution

Practical Exposure Gained:

- Real-world database design for a library management system
- Practical experience with relational database concepts
- Understanding of how DBMS maintains data integrity
- Hands-on experience with SQL DML and DDL operations
- Knowledge of role-based security in enterprise databases
- Appreciation for database normalization and constraint usage

Key Takeaways:

Students will have practical knowledge of building a complete database system with proper structure, integrity, security, and relationships—skills essential for database administration and application development.