CC-215

Database System

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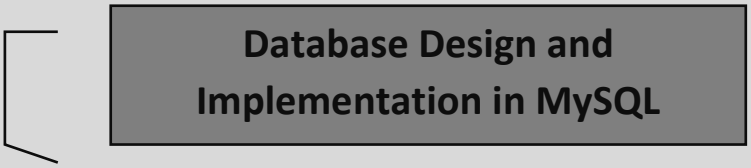
May 2,2025



Entity Relationship Diagram

Relational schema\table schema

Normalization

Implementation in MySQL

Question:

Hospital System with Shifts and Medical History Logs

Doctors, nurses, and administrative staff are assigned shifts based on availability and department load. Patient histories include lab reports, prescriptions, allergies, surgeries, and emergency visits. Each ward has capacity rules. The billing system integrates lab, pharmacy, and consultation charges and generates receipts. Insurance claims are digitally filed and tracked through the portal.

Entity Relationship Diagram:

Notations used in ERD:

Chen and Crow’s Foot are two different notations used in ERDs (Entity-Relationship Diagrams).

They both represent the same concepts (entities, attributes, relationships), but in different styles:

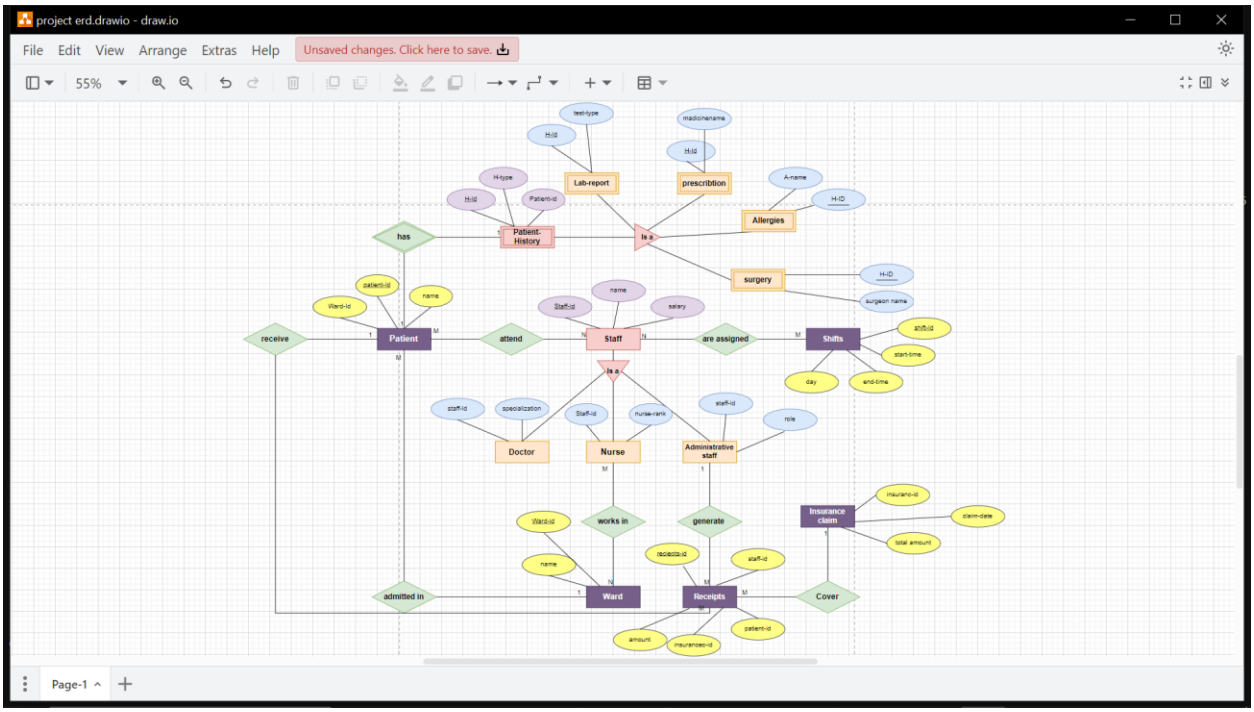
Chen Model:

Uses rectangles for entities, ellipses for attributes, and diamonds for relationships. It's simple and used in conceptual design.

Crow’s Foot Model:

Uses boxes for entities and lines with symbols (like a crow’s foot) for relationships. It’s more detailed and used in logical/physical design.

ER Diagram using Chen Model



Specialization is orange here

Attributes of specialization is blue

Superclass is red

Attributes of superclass is light purple

Relationships are green

Simple entities are dark purple

Attributes of Simple entities are yellow

Weak entity is represented by a double rectangle

Relational schema\table schema from ERD

Staff (Staff-Id, name, salary)

Specialization:

- **Doctor** (Staff-Id, specialization)
- **Nurse** (Staff-Id, nurse-rank)
- **Administrative staff** (Staff-Id, role)

Shift (Shift-Id, start-time, end-time, day)

Staffshift (Staff-Id, shift-Id) (3rd table of staff and shift)

Patient (Patient-Id, Ward-id, name)

Patientstaff (patient-Id, Staff-id) (3rd table of staff and patient)

Ward (Ward-id, name)

wardNurse (Ward-Id, staff-id) (3rd table of Ward and nurse)

Receipts (Receipts-id, staff-id, patient-id, insurance-id, amount)

Insurance claim (insurance-id, total-amount, claim-date)

Patient history (H-id, patient-id, H-type)

Specialization:

- **Lab report** (H-id, test-type)
- **Surgery** (H-id, surgeon-name)
- **Prescription** (H-id, medicine-name)

Normalization

First Normal Form (1NF)

Definition:

- No multivalued attributes (each attribute holds atomic values).
- Each field contains only one value.
- Each record is unique.

As all entities have atomic attributes, no multivalued attributes. Each record in every table is unique with a clear primary key. Therefore, the above table schema First Normal Form (1NF).

Second Normal Form (2NF)

Definition:

- Must be in 1NF.
- No partial dependency (non-prime attributes depend on the whole primary key, not part of it).
- If the table has a composite primary key, each non-key attribute must depend on the whole composite key, not just a part of it.

- **Tables with Primary Key and Attributes Dependent on It:** These tables have single primary keys and their attributes fully depend on the primary key, such as

Staff, Doctor, Nurse, Administrative staff, Shift, Ward (satisfy the 2NF)

In Doctor, Nurse, Administrative staff the staff-Id act as Primary key and foreign key at the same time

- **Tables with Composite Primary Key:** These tables use composite keys to handle many-to-many relationships such as **StaffShift, PatientStaff, WardNurse**

(satisfy the 2NF)

- **Tables with Attributes Dependent on Primary Key, with Foreign Keys:** These tables have single primary keys, and their attributes depend on the primary key, but they also include foreign keys referencing other tables such as **Patient, Receipt, Patient history. (satisfy the 2NF)**

  - **Lab Report(Patient-Id, Test-Type)**

Primary Key: (H-Id) (Foreign key) at the same time.
Test-Type depends on H-Id . (satisfy the 2NF)

  - **Surgery(H-Id, Surgeon-Name)**

Primary Key: (H-Id) (Foreign key) at the same time.
Surgeon-Name depends on H-Id . (satisfy the 2NF)

  - **Prescription(H-Id, Medicine-Name)**

Primary Key: (H-Id) (Foreign key) at the same time.
Medicine-Name depends on H-Id . (satisfy the 2NF)

So all the tables are in 2NF as there is no partial dependency

Third Normal Form (3NF)

Definition:

- Must be in 2NF.
- No transitive dependency (non-prime attribute should not depend on another non-prime attribute).

Staff table: Name and Salary depend directly on Staff-Id.

Doctor/Nurse/Admin: specialization, nurse-rank, and role depend directly on Staff-Id.

Receipts: Amount depends directly on Receipts-id.

Insurance claim: total-amount, claim-date depend on Insurance-id.

PatientHistory specialization (Lab Report, Surgery, Prescription) are separated correctly.

No non-key attribute depends on another non-key attribute.

As there are no transitive dependencies, and non-prime attributes depend only on the primary key,

the database satisfies Third Normal Form (3NF).

So the tables are in normal form as it satisfies all the conditions of normalization

Common commands

1. To see existing databases:

```
show databases;
```

2.To Create a database:

```
CREATE DATABASE database_name;
```

3.To use the database:

```
USE database_name;
```

4.To create table:

```
CREATE TABLE table_name (
  column1_name DATA_TYPE CONSTRAINT,
```

column2_name DATA_TYPE CONSTRAINT,

…);

5.To see tables in database:

show tables;

6.to insert data in tables:

insert into table_name values('value1','value2',…);

6.to describe table:

desc table_name;

7.To see the table with values;

SELECT * FROM table_name;

8.To update the existing values:

UPDATE table_name SET column_name = new_value

WHERE condition;

9.To add new column:

alter table table_name add new_column_name datatype(domain);

10.To add foreign key to existing table:

alter table table_name add new_column_name datatype(domain);

alter table table_name add constraint constraint_name foreign key (column_name) references referenced_table (referenced_column);

11.To see specific column from table:

select column_name from table_name;

12.To see specific cell from table:

select column_name from table_name where condition;

13.To Rename column in output temporarily:

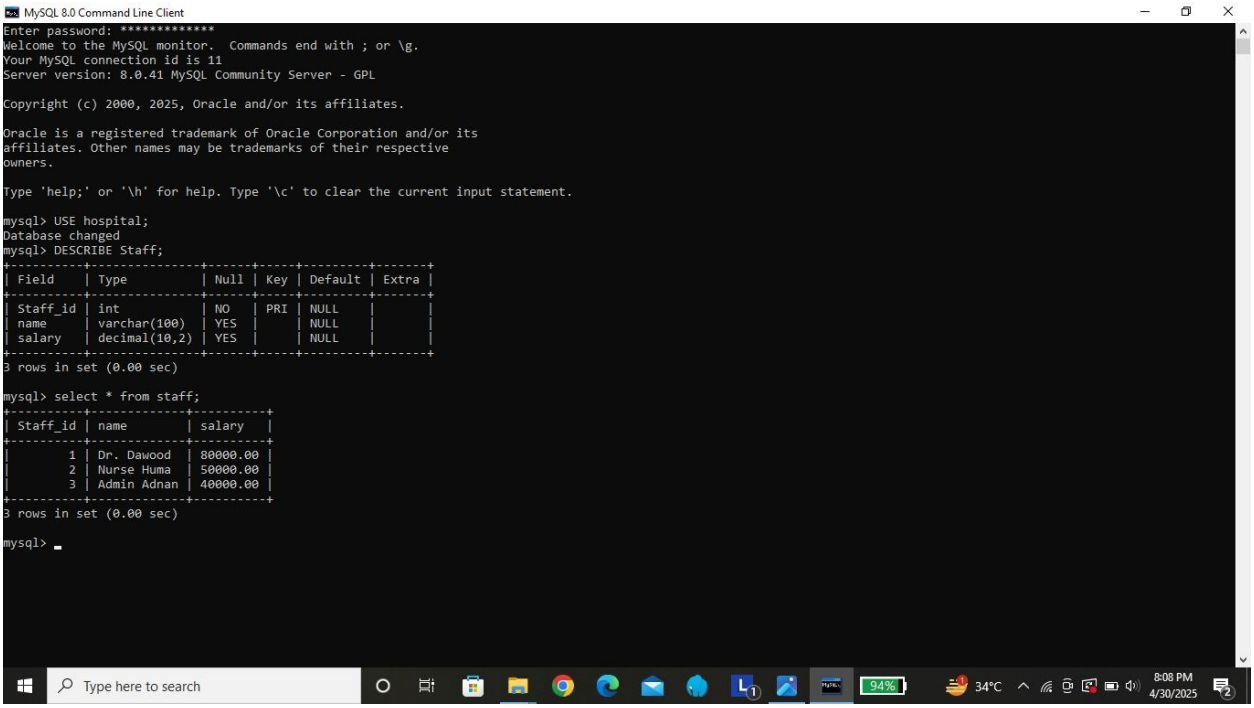
select column_name as new_column_name from table_name;

14.To add foreign key at the time of table creation:

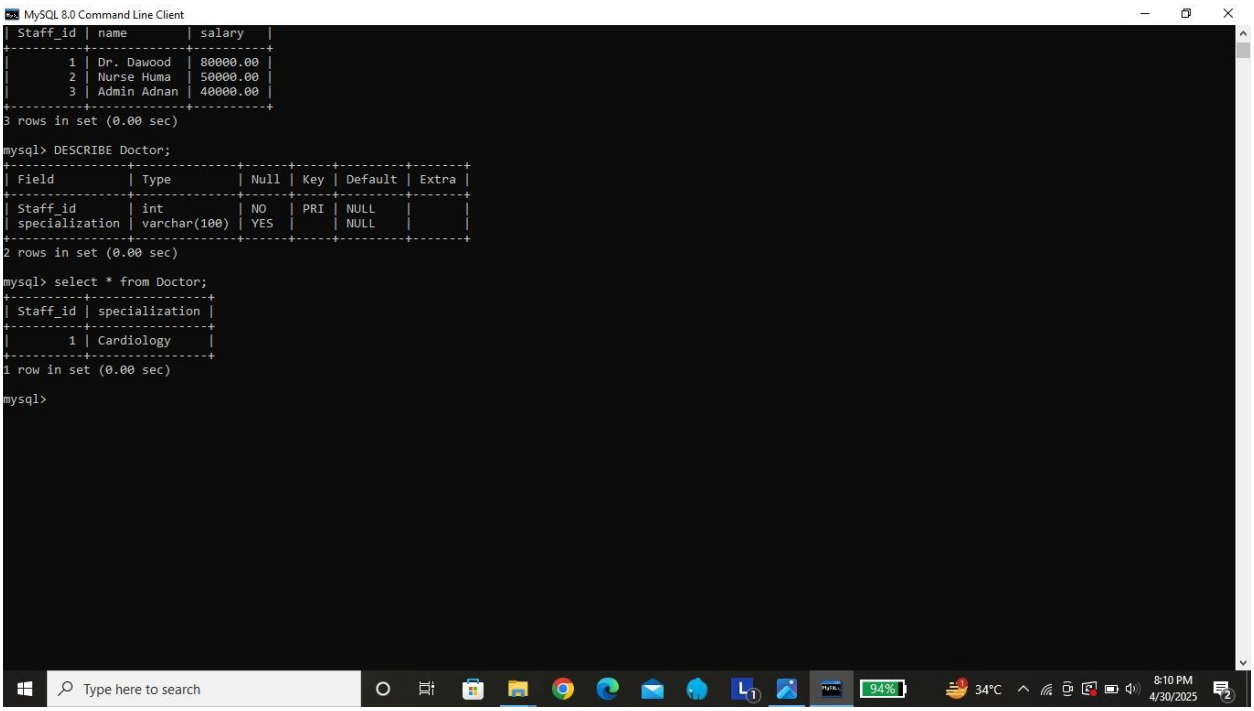
CREATE TABLE table_name (Column_name datatype constraint, FOREIGN KEY (column_name) REFERENCES referenced_table (referenced_column);

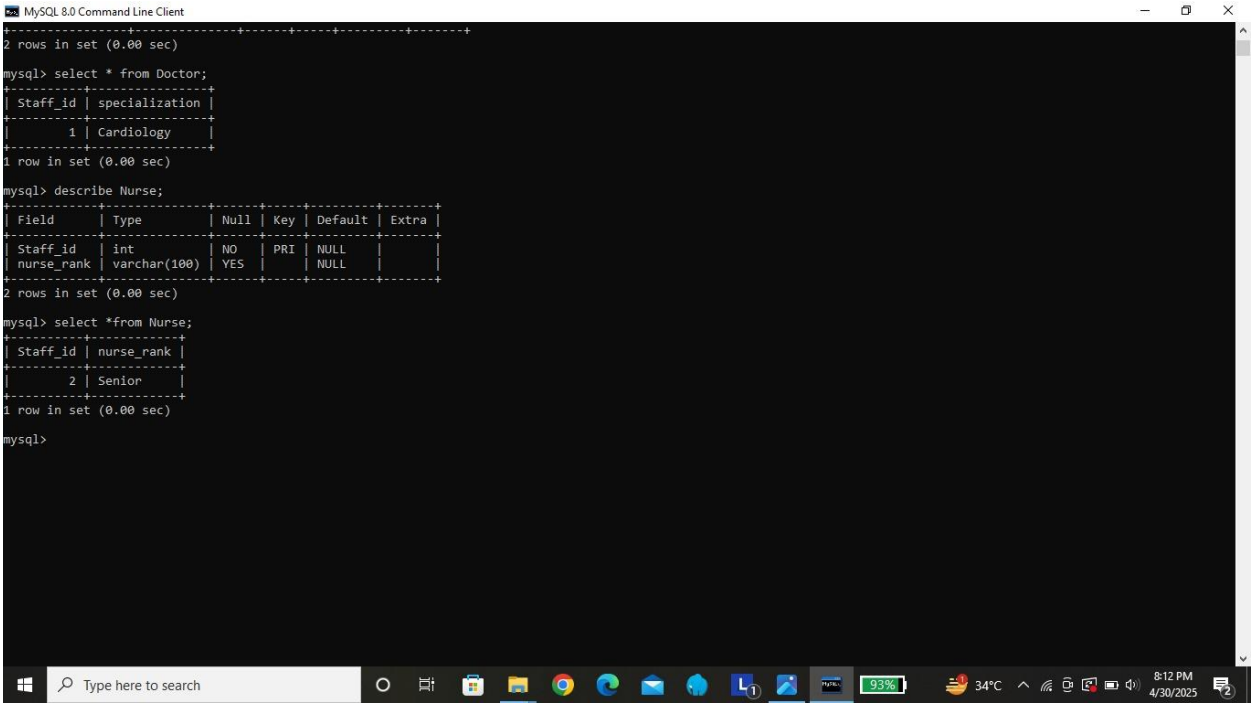
Implementation in MySQL

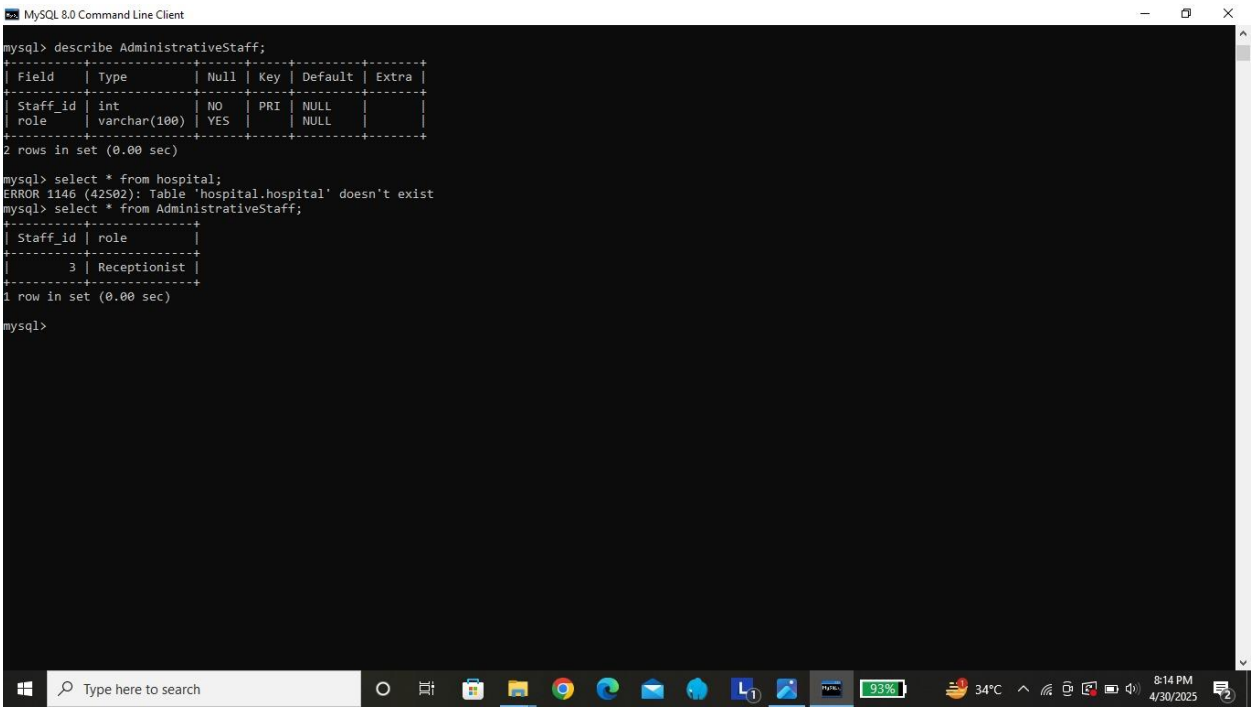
- show databases;
- create database hospital;
- use hospital;
- creatr table Staff(Staff_id int(3) primary key,name varchar(100),salary decimal(10,2));
- desc staff;
- insert into Staff values('1','Dr.dawood','80000.00');
- insert into Staff values('2','nurse Huma','50000.00'),('3','Admin Adnan','40000.00');
- select * from Staff;



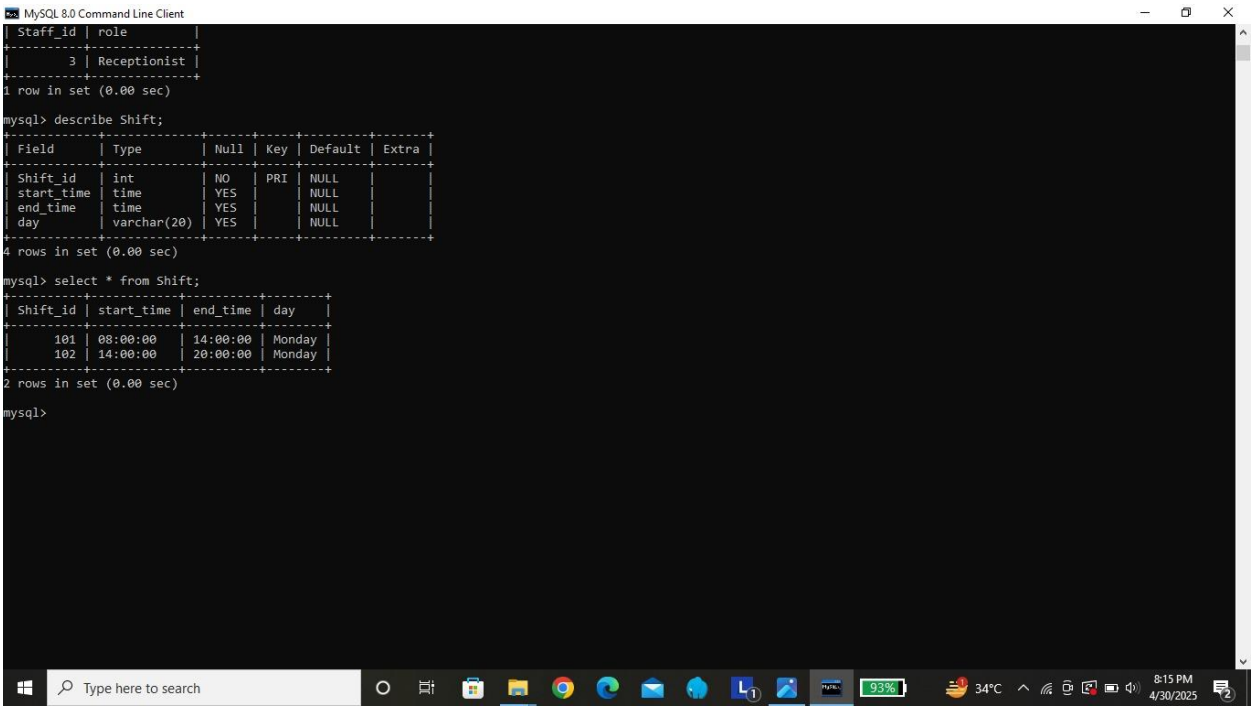
- CREATE TABLE Doctor (Staff_Id INT PRIMARY KEY, specialization VARCHAR(100), CONSTRAINT fk_Staff FOREIGN KEY (Staff_Id) REFERENCES Staff(Staff_Id));
- CREATE TABLE Nurse (Staff_Id INT PRIMARY KEY,nurse_rank VARCHAR(100), CONSTRAINT fk_Staff FOREIGN KEY (Staff_Id) REFERENCES Staff(Staff_Id));
- CREATE TABLE AdministrativeStaff (Staff_Id INT PRIMARY KEY, role VARCHAR(100), CONSTRAINT fk_Staff FOREIGN KEY (Staff_Id) REFERENCES Staff(Staff_Id));
- INSERT INTO Doctor VALUES (1, 'Cardiology');
- INSERT INTO Nurse VALUES (2, 'Senior');
- INSERT INTO AdministrativeStaff VALUES (3, 'Receptionist');
- desc Doctor;
- desc Nurse;
- desc AdministrativeStaff;
- select * from Doctor;
- select * from Nurse;
- select * from AdministrativeStaff;


MySQL 8.0 Command Line Client
Staff_id	name	salary
1	Dr. Dawood	80000.00
2	Nurse Huma	50000.00
3	Admin Adnan	40000.00
3 rows in set (0.00 sec)
mysql> DESCRIBE Doctor;
Field	Type	Null	Key	Default	Extra
Staff_id	int	NO	PRI	NULL	
specialization	varchar(100)	YES		NULL	
2 rows in set (0.00 sec)
mysql> select * from Doctor;
Staff_id	specialization
1	Cardiology
1 row in set (0.00 sec)
mysql>
Type here to search
94%
34°C
8:10 PM
4/30/2025


MySQL 8.0 Command Line Client
2 rows in set (0.00 sec)
mysql> select * from Doctor;
| Staff_id | specialization |
| 1 | Cardiology |
1 row in set (0.00 sec)
mysql> describe Nurse;
Field	Type	Null	Key	Default	Extra
Staff_id	int	NO	PRI	NULL	
nurse_rank	varchar(100)	YES		NULL	
2 rows in set (0.00 sec)
mysql> select *from Nurse;
Staff_id	nurse_rank
2	Senior
1 row in set (0.00 sec)
mysql>
Type here to search
93%
34°C
8:12 PM
4/30/2025

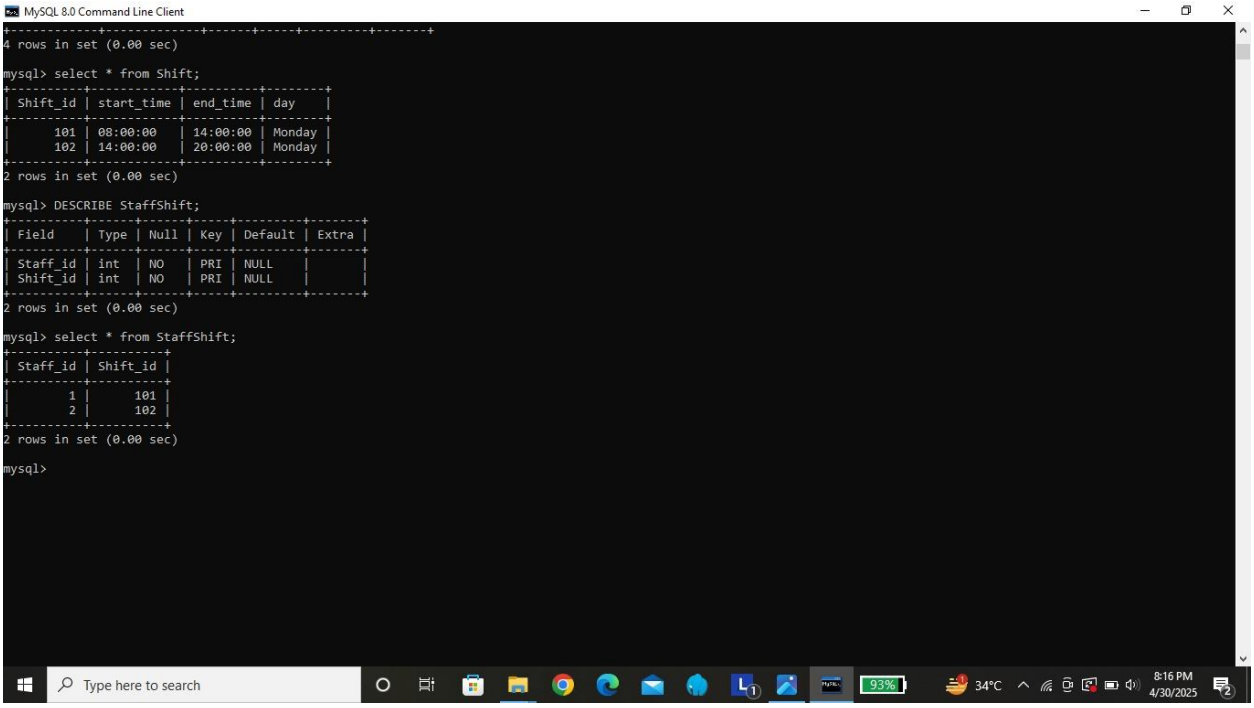


- CREATE TABLE Shift (Shift_Id INT PRIMARY KEY, start_time TIME,end_time TIME, day VARCHAR(20));
- INSERT INTO Shift VALUES (101, '08:00:00', '14:00:00', 'Monday');
- INSERT INTO Shift VALUES (102, '14:00:00', '20:00:00', 'Monday');

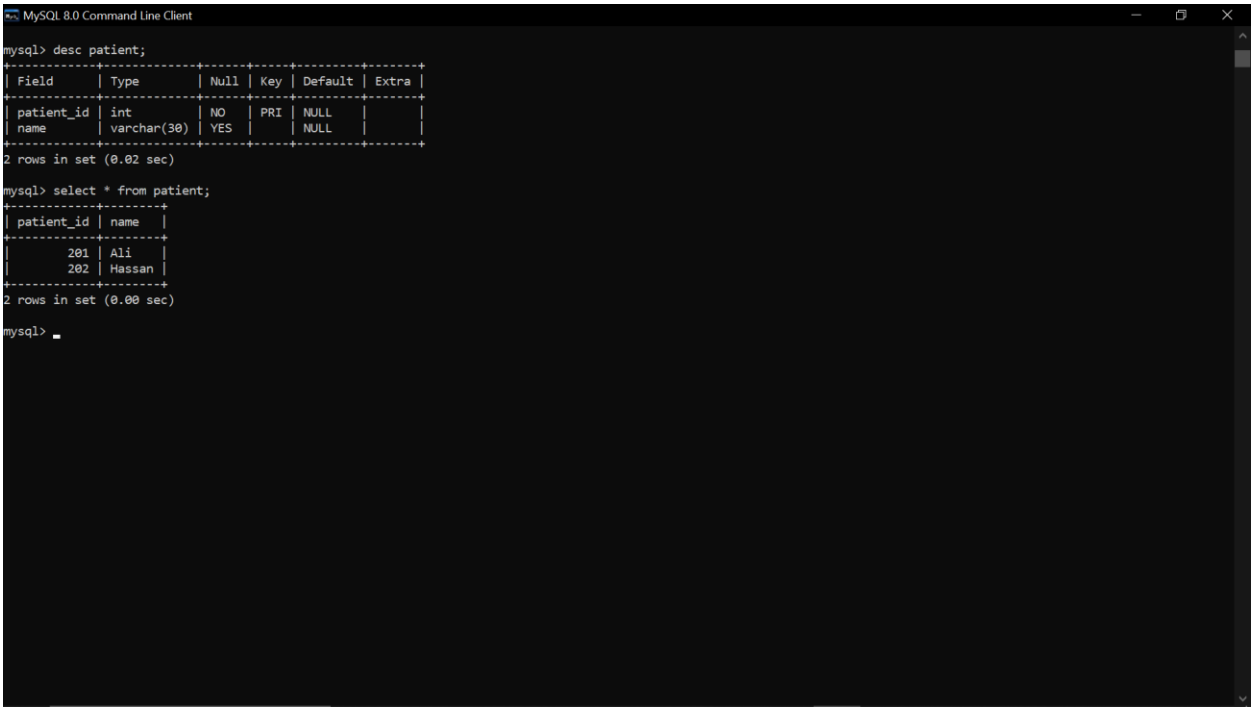


- CREATE TABLE StaffShift (Staff_Id INT,Shift_Id INT, PRIMARY KEY (Staff_Id, Shift_Id), CONSTRAINT fk_StaffShift_Staff FOREIGN KEY (Staff_Id) REFERENCES Staff(Staff_Id), CONSTRAINT fk_StaffShift_Shift FOREIGN KEY (Shift_Id) REFERENCES Shift(Shift_Id));

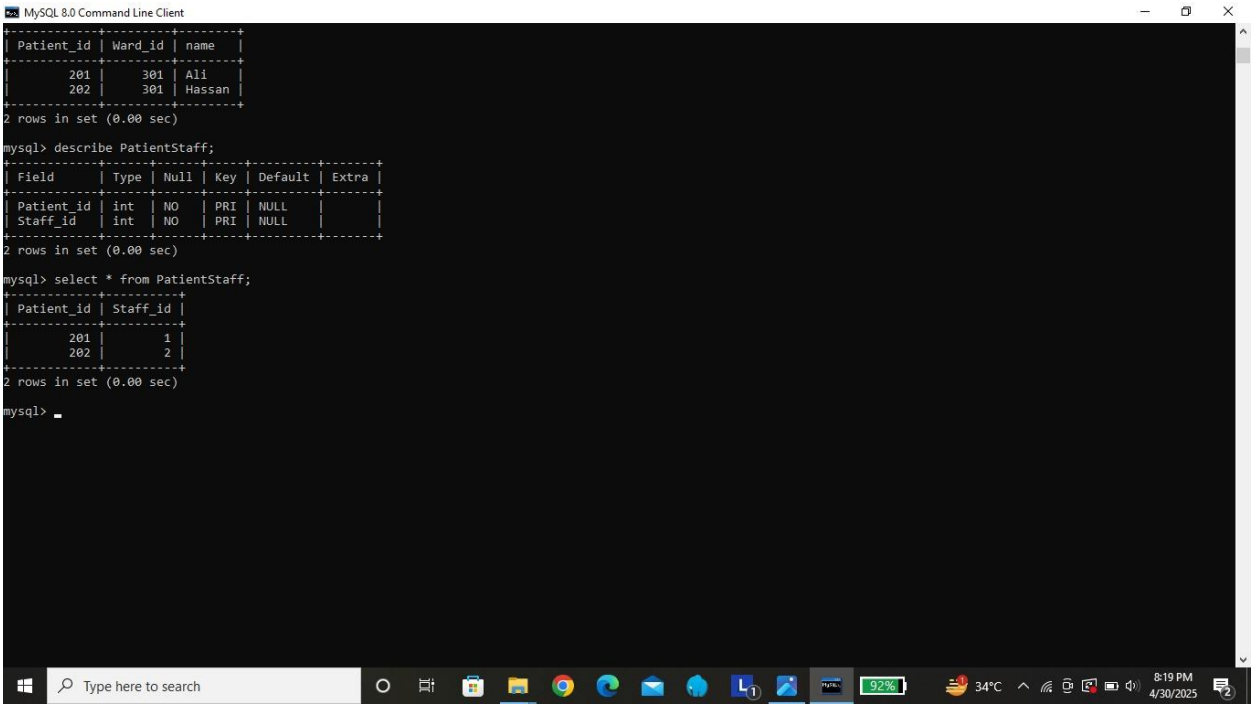
- INSERT INTO StaffShift VALUES (1, 101);
- INSERT INTO StaffShift VALUES (2, 102);



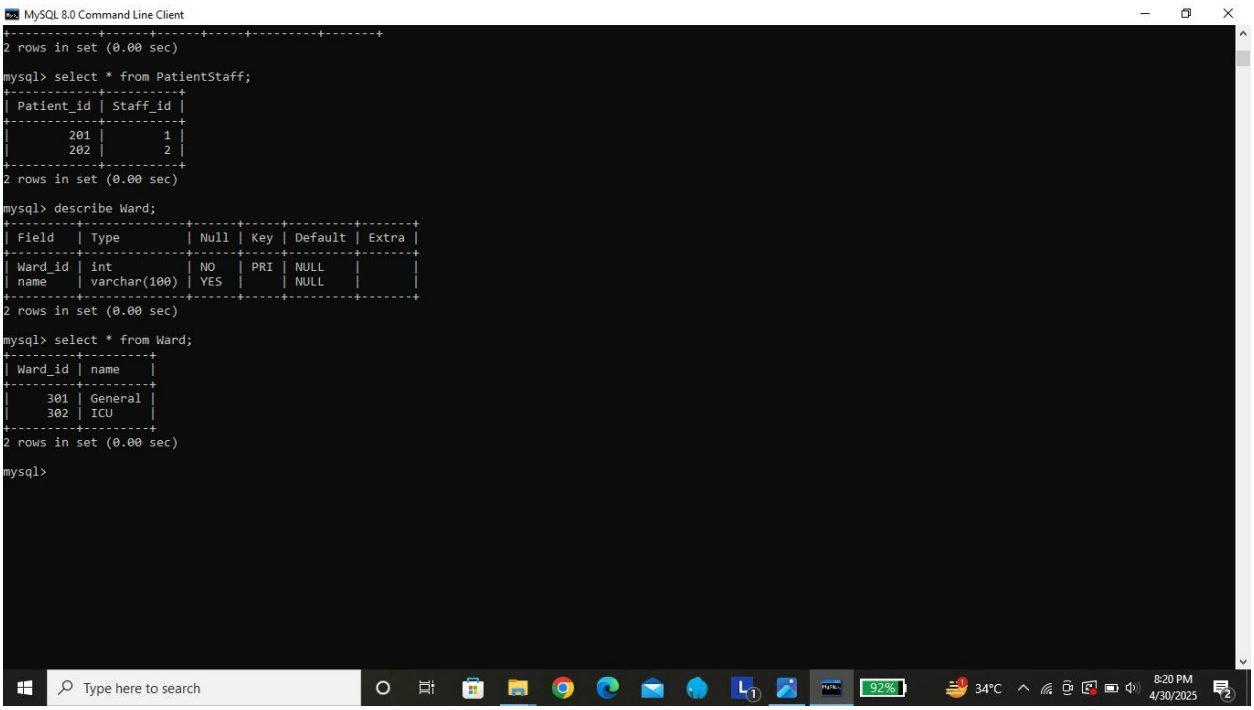
- create table patient(patient_id int(3) primary key,name varchar(30));
- insert into patient values('201','Ali'),('202','Hassan');



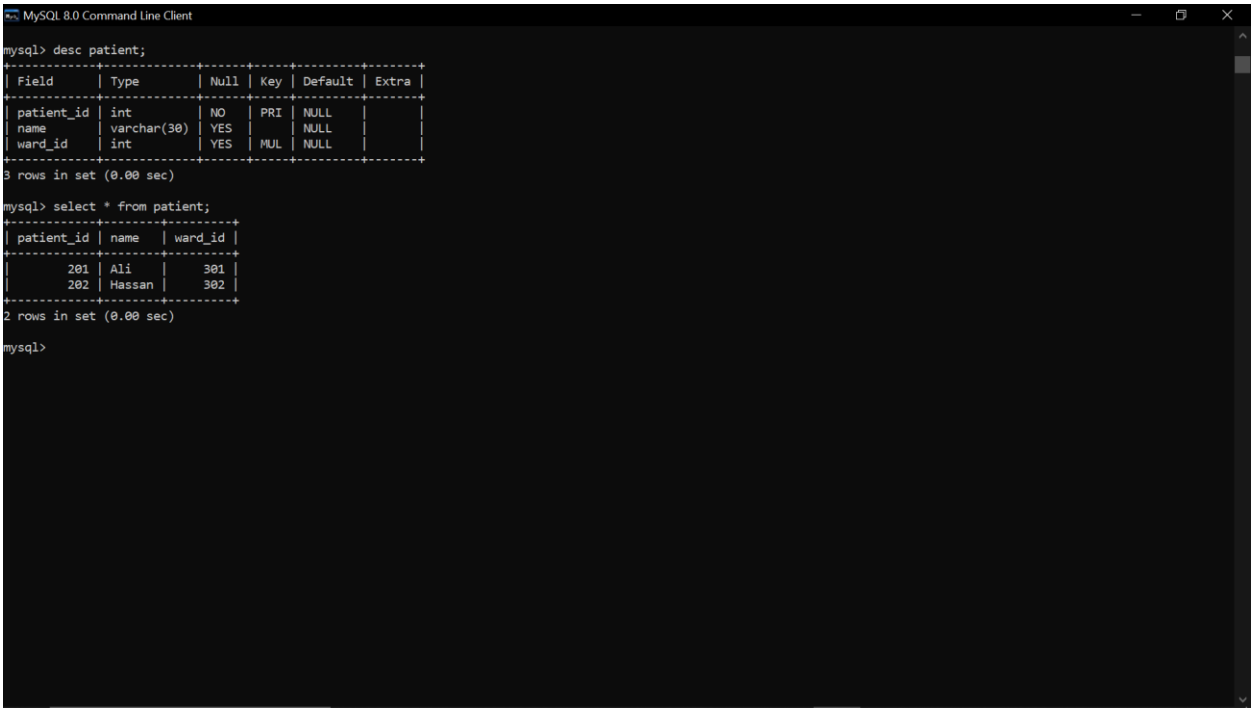
- CREATE TABLE PatientStaff (Patient_Id INT,Staff_Id INT, PRIMARY KEY (Patient_Id, Staff_Id), CONSTRAINT fk_Patient FOREIGN KEY (Patient_Id) REFERENCES Patient(Patient_Id), CONSTRAINT fk_PatientStaff_Staff FOREIGN KEY (Staff_Id) REFERENCES Staff(Staff_Id));
- INSERT INTO PatientStaff VALUES (201, 1);
- INSERT INTO PatientStaff VALUES (202, 2);



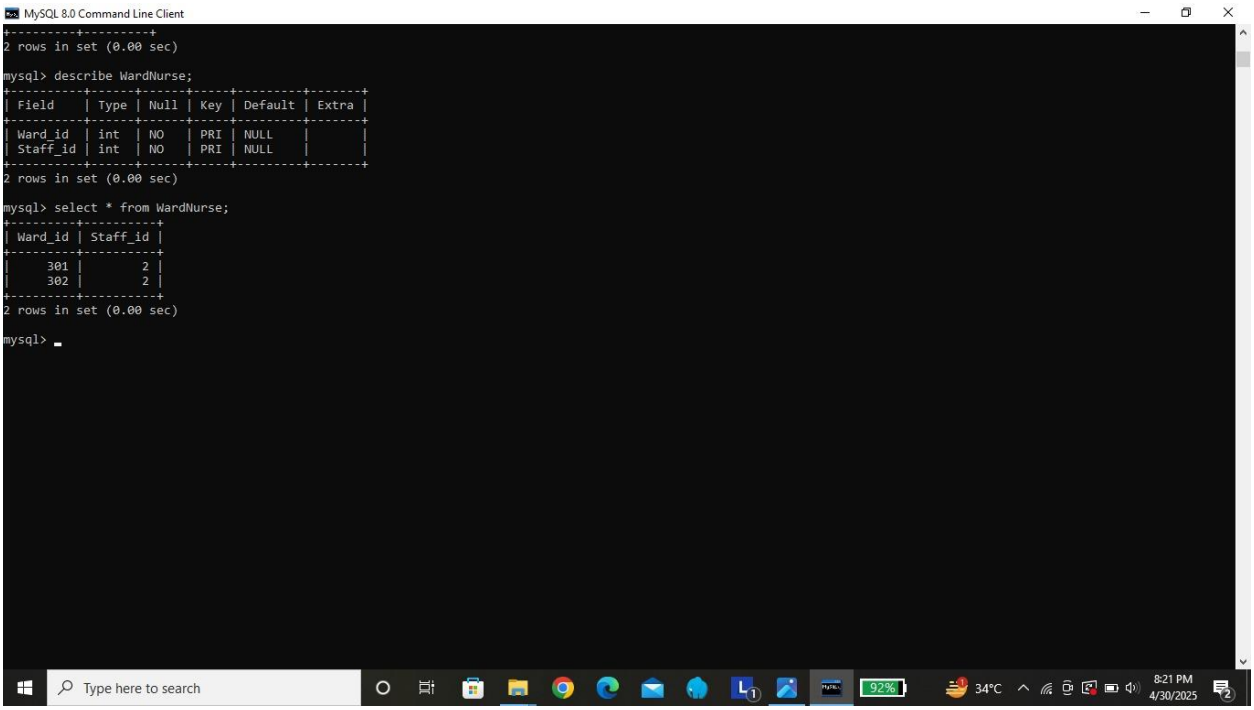
- CREATE TABLE Ward (Ward_Id INT PRIMARY KEY, name VARCHAR(100));
- INSERT INTO Ward VALUES (301, 'General'), (302, 'ICU');



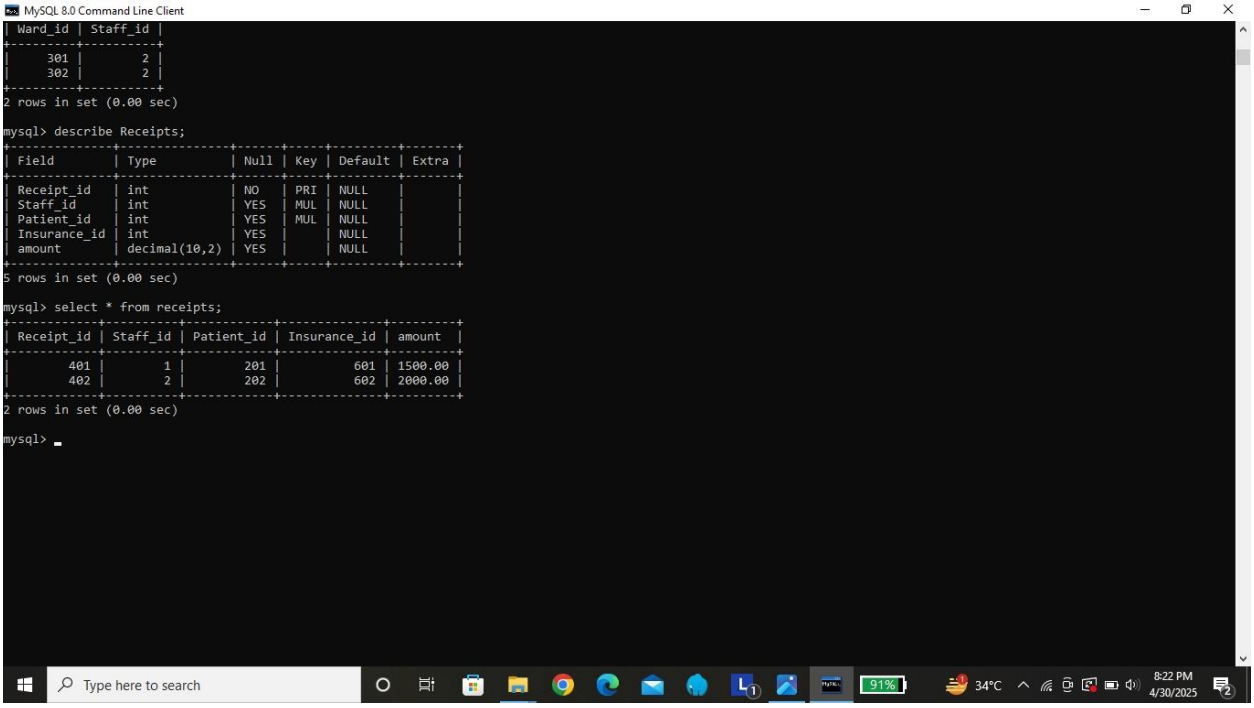
- ALTER TABLE patient ADD ward_id INT,ADD CONSTRAINT fk_ward FOREIGN KEY (ward_id) REFERENCES ward(ward_id);
- update patient set ward_id='301' where patient_id=201;

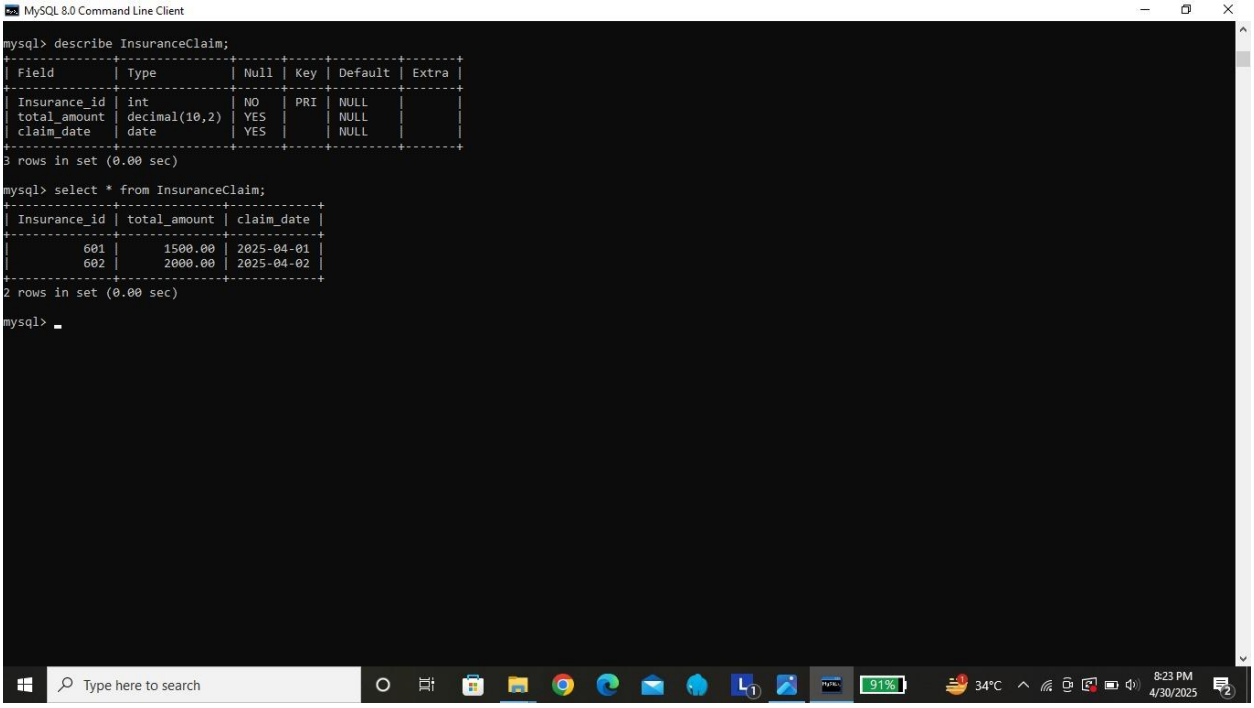


- CREATE TABLE WardNurse (Ward_Id INT,Staff_Id INT, PRIMARY KEY (Ward_Id, Staff_Id), CONSTRAINT fk_Ward FOREIGN KEY (Ward_Id) REFERENCES Ward(Ward_Id), CONSTRAINT fk_WardNurse_Staff FOREIGN KEY (Staff_Id) REFERENCES Staff(Staff_Id));

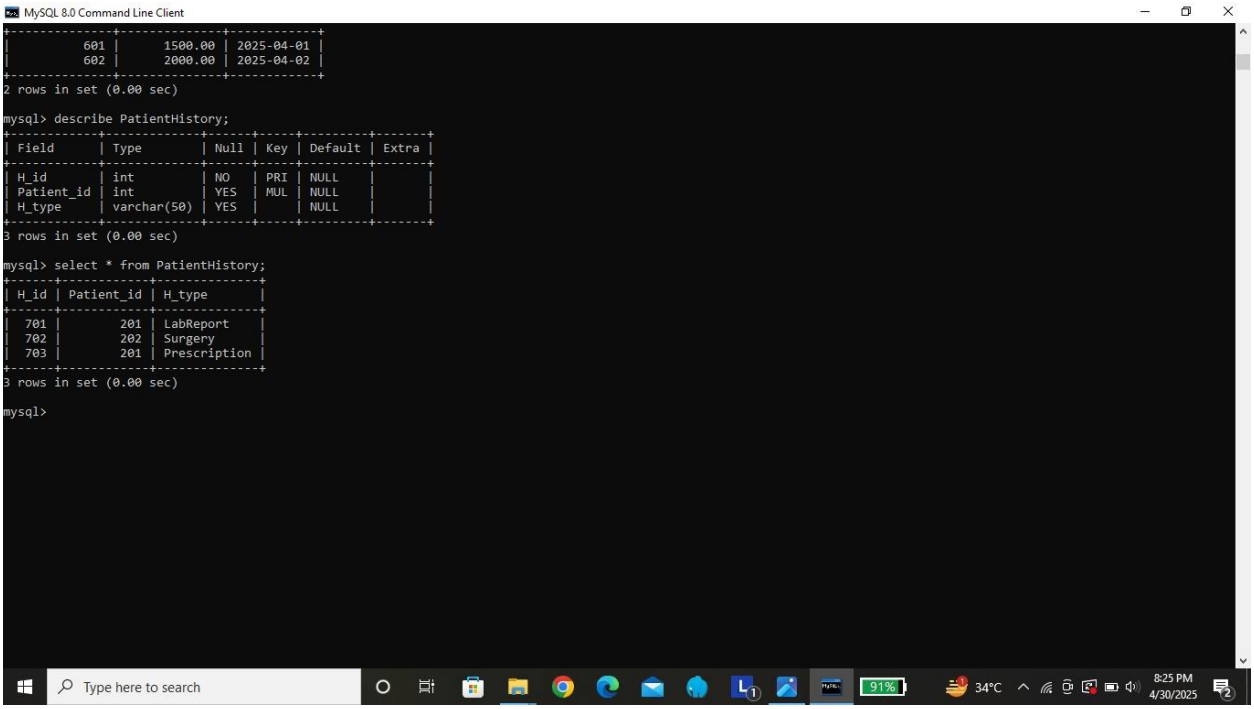


- CREATE TABLE Receipts (Receipts_Id INT PRIMARY KEY, Staff_Id INT, Patient_Id INT, Insurance_Id INT, amount DECIMAL(10, 2), CONSTRAINT fk_Receipts_Staff FOREIGN KEY (Staff_Id) REFERENCES Staff(Staff_Id), CONSTRAINT fk_Receipts_Patient FOREIGN KEY (Patient_Id) REFERENCES Patient(Patient_Id));
- CREATE TABLE InsuranceClaim (Insurance_Id INT PRIMARY KEY, total_amount DECIMAL(10, 2),claim_date DATE);
- INSERT INTO Receipts VALUES (401, 1, 201, 601, 1500.00);
- INSERT INTO Receipts VALUES (402, 2, 202, 602, 2000.00);
- INSERT INTO InsuranceClaim VALUES (601, 1500.00, '2025-04-01');
- INSERT INTO InsuranceClaim VALUES (602, 2000.00, '2025-04-02');

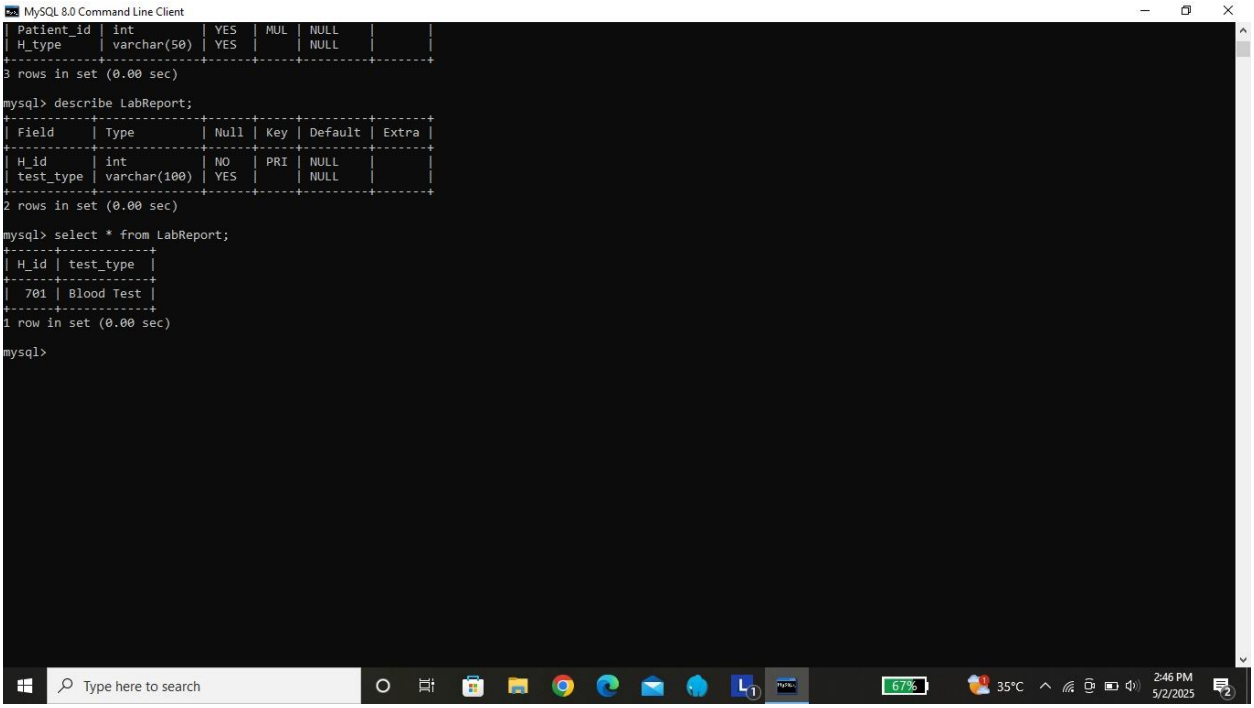


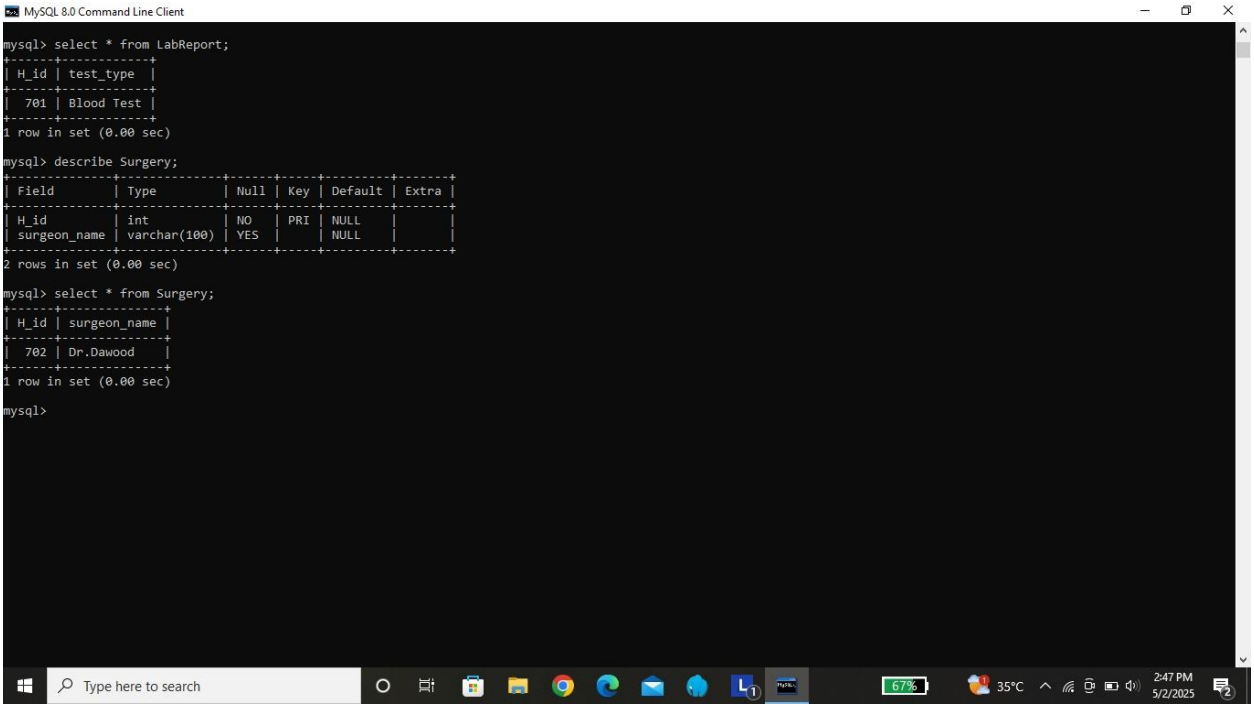


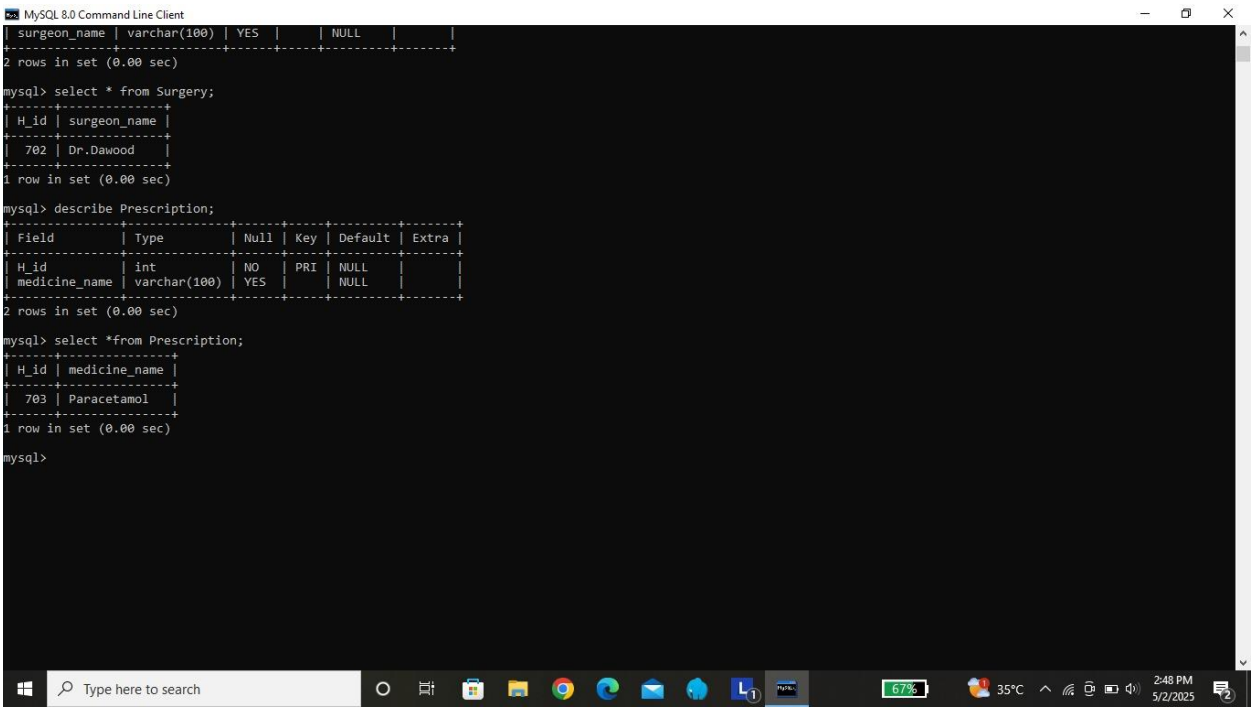
- CREATE TABLE PatientHistory (H_Id INT PRIMARY KEY, Patient_Id INT, H_type VARCHAR(50), CONSTRAINT fk_PatientHistory_Patient FOREIGN KEY (Patient_Id) REFERENCES Patient(Patient_Id));
- INSERT INTO PatientHistory VALUES (701, 201, 'LabReport');



- CREATE TABLE LabReport (H_Id INT(3) primary key, test_type VARCHAR(100), CONSTRAINT fk_PatientHistory FOREIGN KEY (H_Id) REFERENCES PatientHistory(H_Id));
- CREATE TABLE Surgery (H_Id INT(3) primary key, surgeon_name VARCHAR(100), CONSTRAINT fk_Surgery_PatientHistory FOREIGN KEY (H_Id) REFERENCES PatientHistory(H_Id));
- CREATE TABLE Prescription (H_Id INT(3) primary key, medicine_name VARCHAR(100),CONSTRAINT fk_Prescription_PatientHistory FOREIGN KEY (H_Id) REFERENCES PatientHistory(H_Id));

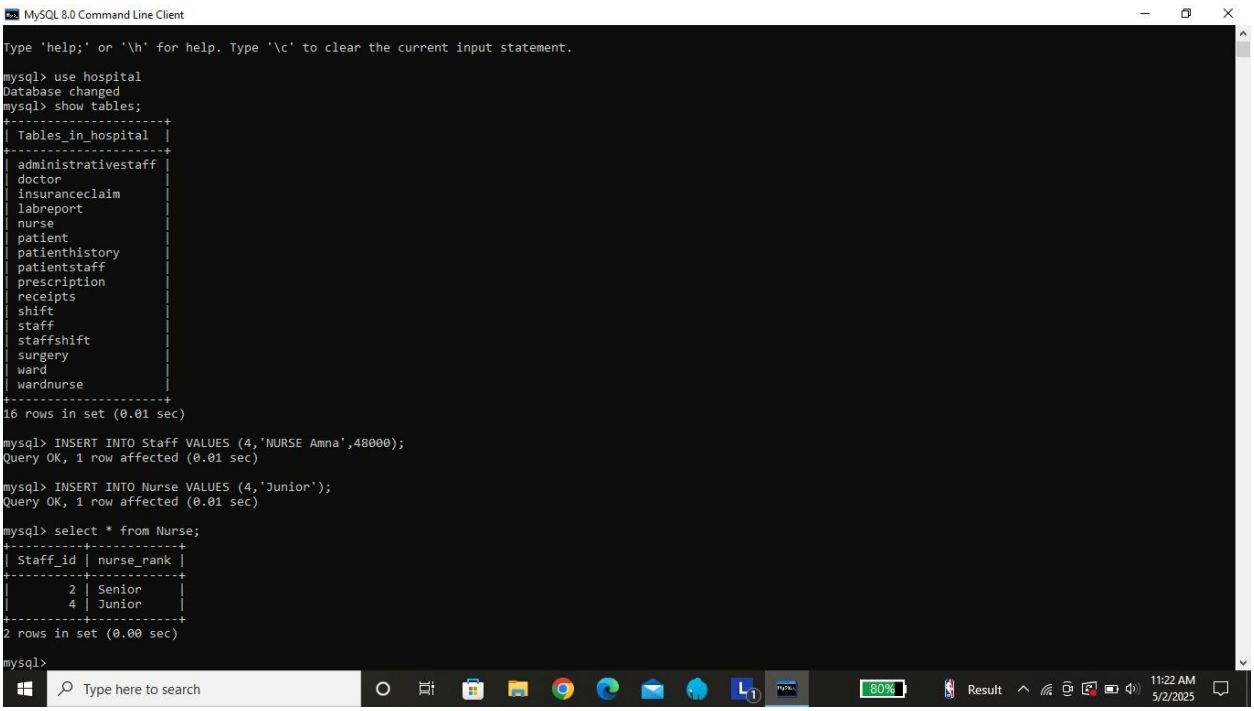

MySQL 8.0 Command Line Client
| Patient_id | int | YES | MUL | NULL | |
| H_type | varchar(50) | YES | | NULL | |
3 rows in set (0.00 sec)
mysql> describe LabReport;
Field	Type	Null	Key	Default	Extra
H_id	int	NO	PRI	NULL	
test_type	varchar(100)	YES		NULL	
2 rows in set (0.00 sec)
mysql> select * from LabReport;
H_id	test_type
701	Blood Test
1 row in set (0.00 sec)
mysql>
Type here to search
67%
35°C
2:46 PM
5/2/2025

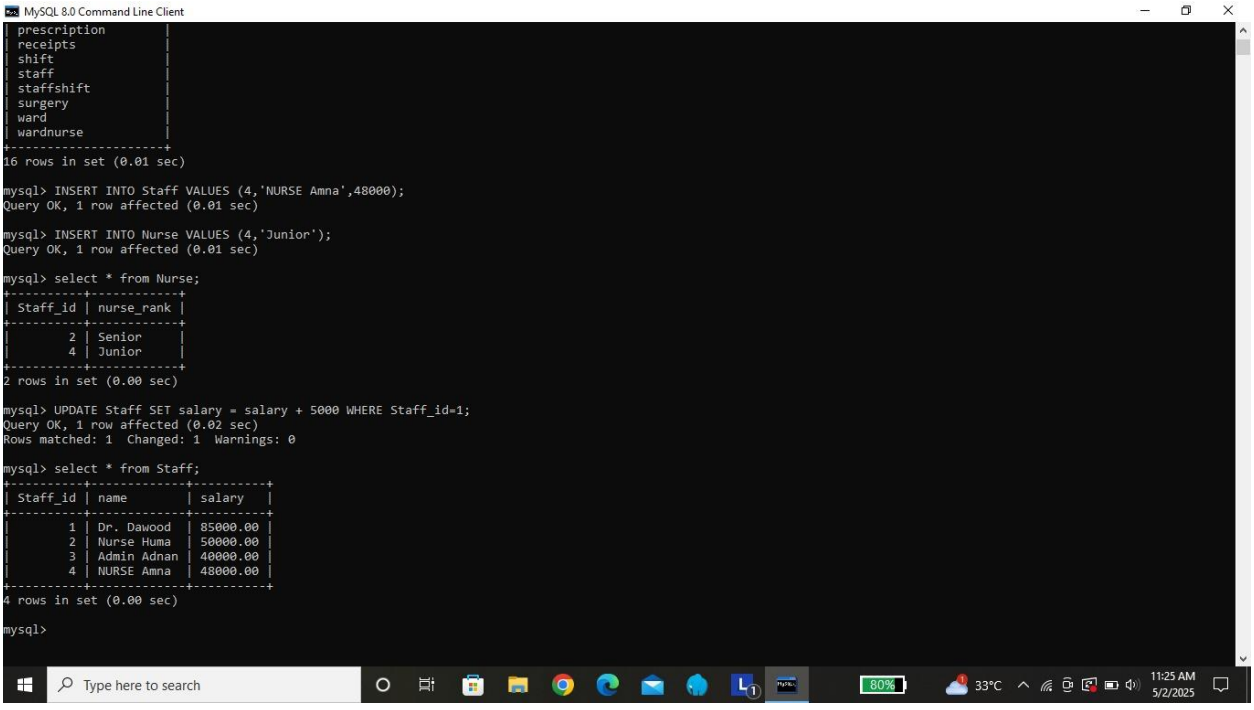

MySQL 8.0 Command Line Client
mysql> select * from LabReport;
| H_id | test_type |
| 701 | Blood Test |
1 row in set (0.00 sec)
mysql> describe Surgery;
Field	Type	Null	Key	Default	Extra
H_id	int	NO	PRI	NULL	
surgeon_name	varchar(100)	YES		NULL	
2 rows in set (0.00 sec)
mysql> select * from Surgery;
H_id	surgeon_name
702	Dr.Dawood
1 row in set (0.00 sec)
mysql>
Type here to search
67%
35°C
2:47 PM
5/2/2025

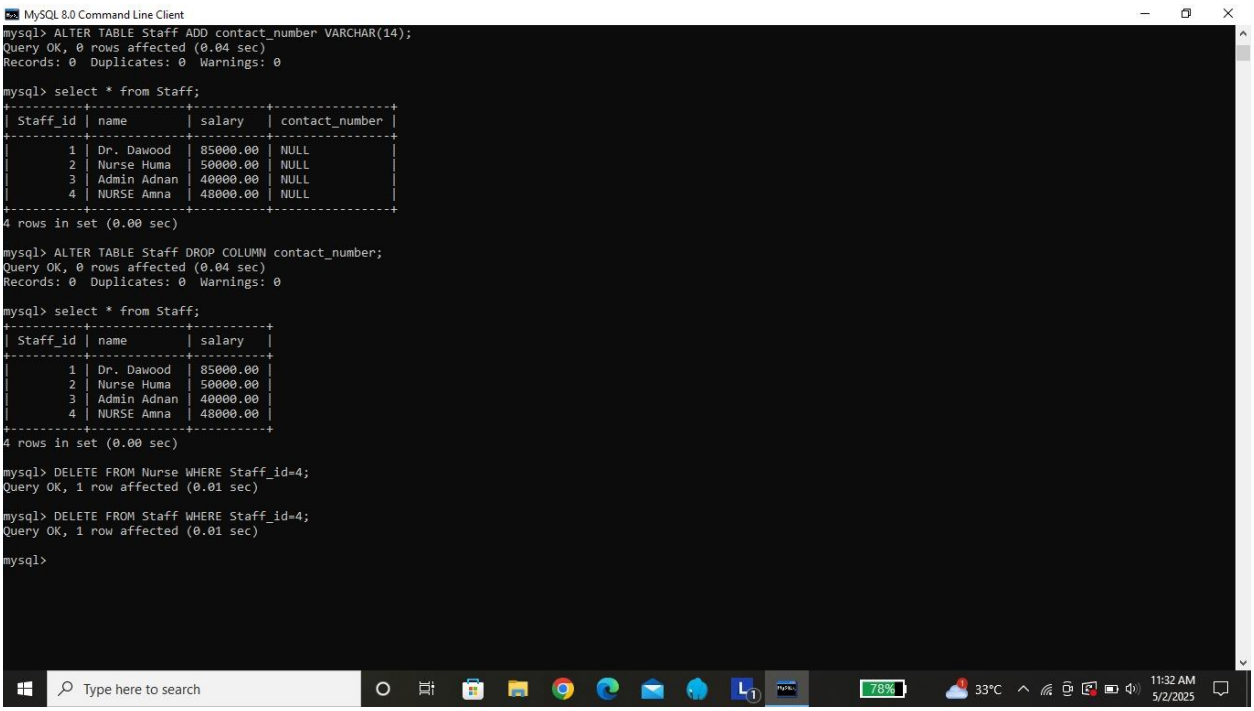


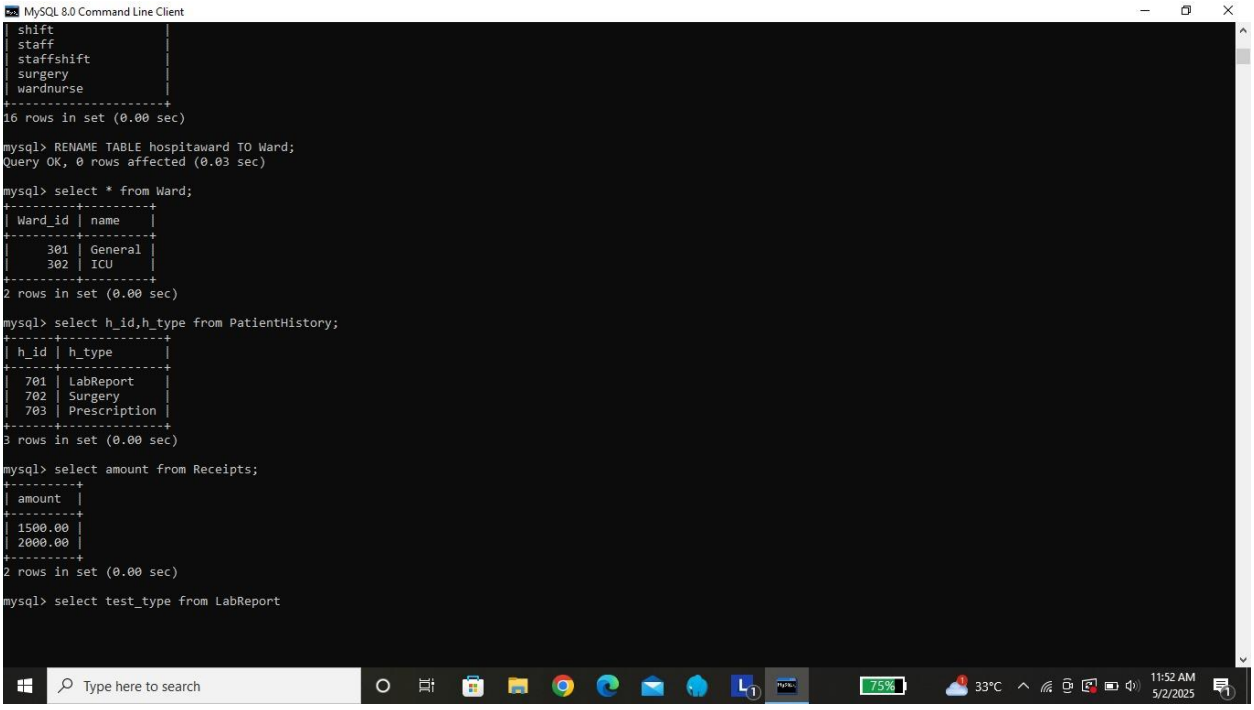
Some queries with implementation:

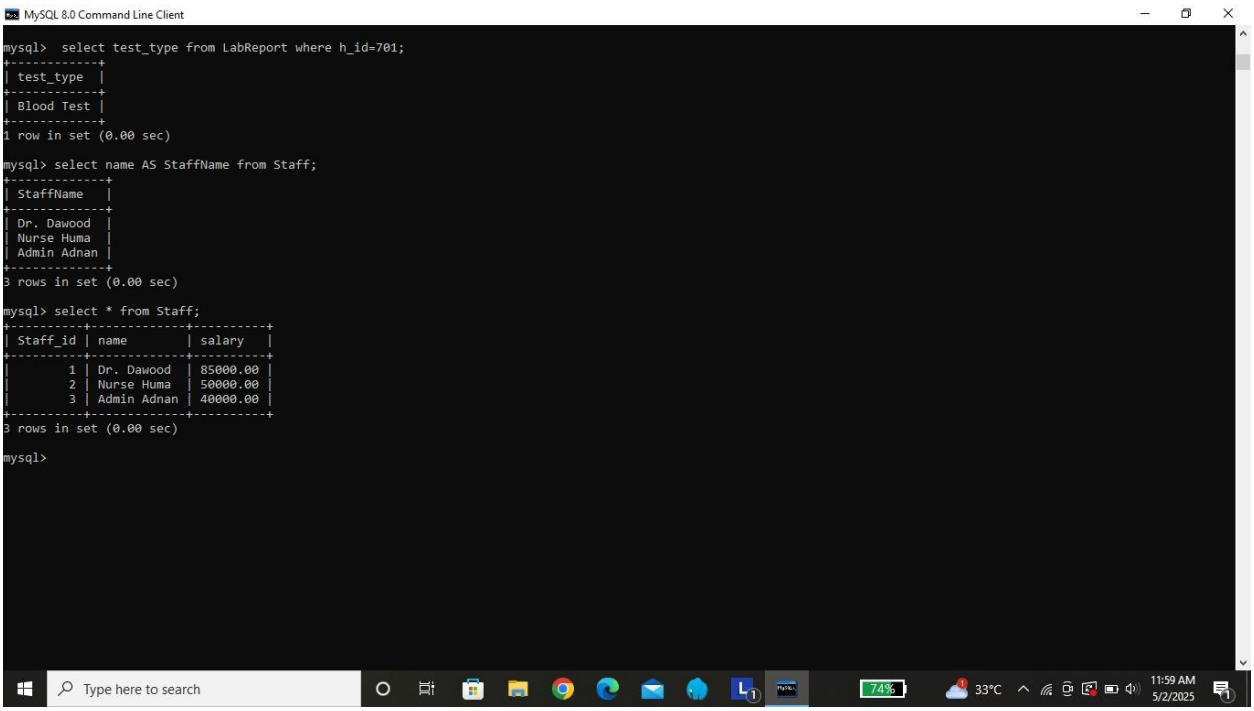
- Show tables;
- update Staff set salary= salary+500 where staff_id=1;
- alter table Staff add contact_num varchar(15);
- alter table Staff drop column contact_num;
- DELETE FROM nurse WHERE staff_id = 4;
- DELETE FROM staff WHERE staff_id = 4;
- RENAME TABLE hospital_ward TO ward;
- SELECT H_Id, H_type FROM patient_history;
- SELECT test_type FROM lab_report;
- SELECT name AS staff_name FROM staff;


MySQL 8.0 Command Line Client
Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.
mysql> use hospital
Database changed
mysql> show tables;
+---------------------+
| Tables_in_hospital |
+---------------------+
| administrativestaff |
| doctor |
| insuranceclaim |
| labreport |
| nurse |
| patient |
| patienthistory |
| patientstaff |
| prescription |
| receipts |
| shift |
| staff |
| staffshift |
| surgery |
| ward |
| wardnurse |
+---------------------+
16 rows in set (0.01 sec)
mysql> INSERT INTO Staff VALUES (4,'NURSE Amna',48000);
Query OK, 1 row affected (0.01 sec)
mysql> INSERT INTO Nurse VALUES (4,'Junior');
Query OK, 1 row affected (0.01 sec)
mysql> select * from Nurse;
+----------+------------+
| Staff_id | nurse_rank |
+----------+------------+
| 2 | Senior |
| 4 | Junior |
+----------+------------+
2 rows in set (0.00 sec)
mysql>
Type here to search
80%
Result
11:22 AM
5/2/2025


MySQL 8.0 Command Line Client
| prescription |
| receipts |
| shift |
| staff |
| staffshift |
| surgery |
| ward |
| wardnurse |
+---------------------+
16 rows in set (0.01 sec)
mysql> INSERT INTO Staff VALUES (4,'NURSE Amna',48000);
Query OK, 1 row affected (0.01 sec)
mysql> INSERT INTO Nurse VALUES (4,'Junior');
Query OK, 1 row affected (0.01 sec)
mysql> select * from Nurse;
+----------+------------+
| Staff_id | nurse_rank |
+----------+------------+
| 2 | Senior |
| 4 | Junior |
+----------+------------+
2 rows in set (0.00 sec)
mysql> UPDATE Staff SET salary = salary + 5000 WHERE Staff_id=1;
Query OK, 1 row affected (0.02 sec)
Rows matched: 1 Changed: 1 Warnings: 0
mysql> select * from Staff;
+----------+-------------+----------+
| Staff_id | name | salary |
+----------+-------------+----------+
1	Dr. Dawood	85000.00
2	Nurse Huma	50000.00
3	Admin Adnan	40000.00
4	NURSE Amna	48000.00
+----------+-------------+----------+
4 rows in set (0.00 sec)
mysql>
Type here to search
80%
33°C
11:25 AM
5/2/2025


MySQL 8.0 Command Line Client
mysql> ALTER TABLE Staff ADD contact_number VARCHAR(14);
Query OK, 0 rows affected (0.04 sec)
Records: 0 Duplicates: 0 Warnings: 0
mysql> select * from Staff;
Staff_id	name	salary	contact_number
1	Dr. Dawood	85000.00	NULL
2	Nurse Huma	50000.00	NULL
3	Admin Adnan	40000.00	NULL
4	NURSE Amna	48000.00	NULL
4 rows in set (0.00 sec)
mysql> ALTER TABLE Staff DROP COLUMN contact_number;
Query OK, 0 rows affected (0.04 sec)
Records: 0 Duplicates: 0 Warnings: 0
mysql> select * from Staff;
Staff_id	name	salary
1	Dr. Dawood	85000.00
2	Nurse Huma	50000.00
3	Admin Adnan	40000.00
4	NURSE Amna	48000.00
4 rows in set (0.00 sec)
mysql> DELETE FROM Nurse WHERE Staff_id=4;
Query OK, 1 row affected (0.01 sec)
mysql> DELETE FROM Staff WHERE Staff_id=4;
Query OK, 1 row affected (0.01 sec)
mysql>
Type here to search
78%
33°C
11:32 AM
5/2/2025


MySQL 8.0 Command Line Client
| shift |
| staff |
| staffshift |
| surgery |
| wardnurse |
16 rows in set (0.00 sec)
mysql> RENAME TABLE hospitaward TO Ward;
Query OK, 0 rows affected (0.03 sec)
mysql> select * from Ward;
Ward_id	name
301	General
302	ICU
2 rows in set (0.00 sec)
mysql> select h_id,h_type from PatientHistory;
h_id	h_type
701	LabReport
702	Surgery
703	Prescription
3 rows in set (0.00 sec)
mysql> select amount from Receipts;
amount
1500.00
2000.00
2 rows in set (0.00 sec)
mysql> select test_type from LabReport
Type here to search
75%
33°C
11:52 AM
5/2/2025


MySQL 8.0 Command Line Client
mysql> select test_type from LabReport where h_id=701;
+------------+
| test_type |
+------------+
| Blood Test |
+------------+
1 row in set (0.00 sec)
mysql> select name AS StaffName from Staff;
+-------------+
| StaffName |
+-------------+
| Dr. Dawood |
| Nurse Huma |
| Admin Adnan |
+-------------+
3 rows in set (0.00 sec)
mysql> select * from Staff;
+----------+-------------+----------+
| Staff_id | name | salary |
+----------+-------------+----------+
1	Dr. Dawood	85000.00
2	Nurse Huma	50000.00
3	Admin Adnan	40000.00
+----------+-------------+----------+
3 rows in set (0.00 sec)
mysql>
Type here to search
74%
33°C
11:59 AM
5/2/2025