XIAMEN UNIVERSITY MALAYSIA

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Course Name	:	Database
Lecturer	:	Dr. Subashini A/P Ganapathy
Academic Session	:	2025/09
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Prepared by :

Student ID	Student Name
DSC2409007	Deng Kailong (Leader)
DSC2409009	Du Zhixuan
DSC2409026	Min Yiduo
DSC2409027	Pan Ziliang
DSC2409033	Tao Ouwen

Date Received :

Feedback from Lecturer:

Mark:

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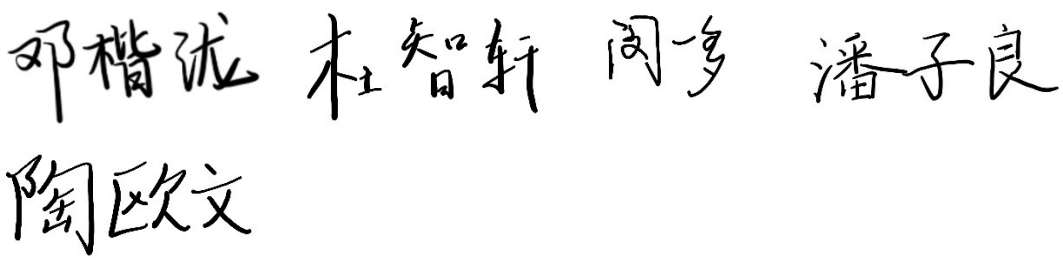


Date: 10 December 2025

Contents

SOF202 Database Lab Report

Group Members: Deng Kailong (Leader), Min Yiduo, Pan Ziliang, Tao Ouwen, Du Zhixuan

Project Start: Wed, 11/19/2025

Display Week: 1

TASK	ASSIGNED TO	PROGRESS	START	END
Phase 1 Review & Setup			11/19/25	11/25/25
Review Assignment Schema	All members	100%	11/19/25	11/21/25
Task Assignment	All members	100%	11/20/25	11/21/25
DBMS Environment Setup	Deng Kailong	100%	11/22/25	11/25/25
Milestone 1			11/25/25	11/25/25
Phase 2: Structure Implementation			11/26/25	12/5/25
Task 1: Database Integrity	Pan Ziliang	100%	11/26/25	11/30/25
Task 2A: Create Tables	Deng Kailong	100%	11/26/25	12/1/25
Task 2B: Insert Data (Populat	Deng Kailong	100%	12/1/25	12/5/25
Milestone 2			12/5/25	12/5/25
Phase 3: Functional Development			12/6/25	12/11/25
Task 2C: SQL Queries (Advan	Min Yiduo	100%	12/6/25	12/11/25
Task 3: Triggers Implementat	Tao Ouwen	100%	12/7/25	12/10/25
Task 4: Access Control	Du Zhixuan	100%	12/8/25	12/11/25
Milestone 3			12/11/25	12/11/25
Phase 4 Report Compilation & Review			12/12/25	12/18/25
Report Integration	Deng Kailong,Min Yiduo	100%	12/12/25	12/15/25
Proofreading & Formatting	Deng Kailong,Min Yiduo	100%	12/15/25	12/17/25
Milestone 4			12/17/25	12/17/25
Final Submission			12/18/25	12/18/25

Milestone 1: Environment Ready (11/25/2025)

Confirmed the previous database schema is error-free and the MySQL environment is configured for all group members.

Milestone 2: Database Populated (12/05/2025)

All tables created with correct integrity constraints (PK/FK) and successfully populated with 6-10 rows of sample data.

Milestone 3: Functionality Verified (12/11/2025)

Advanced SQL queries, triggers, and access control mechanisms are implemented, tested, and screenshots are captured.

Milestone 4: Final Submission (12/18/2025)

The final lab report is compiled, formatted according to guidelines, proofread, and submitted via Moodle.

Task 1 Database Integrity

1.1 Objective and Context

In a sports arena reservation system, data integrity is not a theoretical concern; it directly determines whether bookings are trustworthy, facilities are not double-booked, equipment inventory remains accurate, and operational decisions can be made based on reliable records. Following the requirements in `docs/description.md`, this task demonstrates how our database design enforces integrity through three complementary constraint families: **domain integrity**, **entity integrity**, and **referential integrity**.

All examples in this section are strictly aligned with the implemented schema exported in `sports_arena.sql`. We intentionally select representative tables that are central to the business workflow: `equipment`, `reservation`, `member`, and `booking`.

1.2 Task 1A: Sample `CREATE TABLE` Statements with Integrity Constraints

1.2.1 Domain Integrity Constraints

Domain integrity ensures that each attribute value stays within a valid domain (type, range, format, and business-validity rules). In our schema, domain integrity is enforced through:

- appropriate data types (e.g., `DATE`, `TIME(6)`, `INT UNSIGNED`),
- `NOT NULL` to prevent incomplete records, and
- `CHECK` constraints to express semantic rules at the database level.

The `equipment` table below demonstrates a numeric domain restriction: `Total_Quantity` is defined as `INT UNSIGNED` and further protected by a `CHECK` constraint, ensuring inventory quantities are non-negative.

```
1 -- Domain integrity example (from sports_arena.sql): non-negative equipment
    inventory
2 CREATE TABLE `equipment`  (
3   `Equipment_ID` int NOT NULL AUTO_INCREMENT,
4   `Equipment_Name` varchar(100) CHARACTER SET utf8mb4 COLLATE utf8mb4_unicode_ci NOT
      NULL,
5   `Type` varchar(50) CHARACTER SET utf8mb4 COLLATE utf8mb4_unicode_ci NOT NULL,
6   `Status` varchar(20) CHARACTER SET utf8mb4 COLLATE utf8mb4_unicode_ci NOT NULL,
7   `Total_Quantity` int UNSIGNED NOT NULL,
8   PRIMARY KEY (`Equipment_ID`) USING BTREE,
```

```
  CONSTRAINT `equipment_chk_1` CHECK (`Total_Quantity` >= 0)
) ENGINE = InnoDB AUTO_INCREMENT = 16 CHARACTER SET = utf8mb4 COLLATE =
  utf8mb4_unicode_ci ROW_FORMAT = Dynamic;
```

The `reservation` table demonstrates temporal domain rules: (i) a reservation must have a valid time interval, and (ii) each facility cannot have duplicated reservation start times on the same date. These are captured with `CHECK` and a composite `UNIQUE` index respectively.

```
-- Domain integrity example (from sports_arena.sql): valid time interval and slot
  uniqueness
CREATE TABLE `reservation`  (
  `Reservation_ID` int NOT NULL AUTO_INCREMENT,
  `Reservation_Date` date NOT NULL,
  `Start_Time` time(6) NOT NULL,
  `End_Time` time(6) NOT NULL,
  `Facility_ID` int NOT NULL,
  PRIMARY KEY (`Reservation_ID`) USING BTREE,
  UNIQUE INDEX `Reservation_Facility_ID_Reservation__55861018_uniq`(`Facility_ID`
    ASC, `Reservation_Date` ASC, `Start_Time` ASC) USING BTREE,
  INDEX `Reservation_Facilit_e090a5_idx`(`Facility_ID` ASC, `Reservation_Date` ASC)
    USING BTREE,
  CONSTRAINT `Reservation_Facility_ID_3e1ddf39_fk_Facility_Facility_ID` FOREIGN KEY
    (`Facility_ID`) REFERENCES `facility` (`Facility_ID`) ON DELETE RESTRICT ON
    UPDATE RESTRICT,
  CONSTRAINT `chk_reservation_time` CHECK (`Start_Time` < `End_Time`)
) ENGINE = InnoDB AUTO_INCREMENT = 3 CHARACTER SET = utf8mb4 COLLATE =
  utf8mb4_unicode_ci ROW_FORMAT = Dynamic;
```

1.2.2 Entity Integrity Constraints

Entity integrity guarantees that each row is uniquely identifiable and non-ambiguous. In practice, this is achieved through:

- primary keys (`PRIMARY KEY`) that are unique and non-null,
- additional `UNIQUE` constraints for real-world uniqueness rules, and
- careful key design for specialization tables (where a child table key is also a foreign key).

The `member` table below illustrates entity integrity: `Member_ID` is an auto-increment primary key, and `user_id` is uniquely constrained to preserve the one-to-one relationship between a Django account (`auth_user`) and the corresponding member profile.

```
-- Entity integrity example (from sports_arena.sql): primary key + unique user
  mapping
```

```
CREATE TABLE `member`  (
  `Member_ID` int NOT NULL AUTO_INCREMENT,
  `First_Name` varchar(50) CHARACTER SET utf8mb4 COLLATE utf8mb4_unicode_ci NOT NULL
    ,
  `Last_Name` varchar(50) CHARACTER SET utf8mb4 COLLATE utf8mb4_unicode_ci NOT NULL,
  `Registration_Date` date NOT NULL,
  `Membership_Status` varchar(20) CHARACTER SET utf8mb4 COLLATE utf8mb4_unicode_ci
    NOT NULL,
  `user_id` int NULL DEFAULT NULL,
  PRIMARY KEY (`Member_ID`) USING BTREE,
  UNIQUE INDEX `user_id`(`user_id` ASC) USING BTREE,
  CONSTRAINT `Member_user_id_2cb16a29_fk_auth_user_id` FOREIGN KEY (`user_id`)
    REFERENCES `auth_user` (`id`) ON DELETE RESTRICT ON UPDATE RESTRICT
) ENGINE = InnoDB AUTO_INCREMENT = 4 CHARACTER SET = utf8mb4 COLLATE =
  utf8mb4_unicode_ci ROW_FORMAT = Dynamic;
```

1.2.3 Referential Integrity Constraints

Referential integrity ensures that relationships between tables remain valid. In other words, a foreign key must reference an existing primary key, preventing orphan records and broken associations.

The `booking` table implements a specialization of `reservation`: `Reservation_ID` acts as the primary key of `booking` and simultaneously references `reservation(Reservation_ID)`. Additionally, each booking must reference a valid member via `Member_ID`.

```
-- Referential integrity example (from sports_arena.sql): booking must link to
  existing reservation and member
CREATE TABLE `booking`  (
  `Reservation_ID` int NOT NULL,
  `Booking_Status` varchar(20) CHARACTER SET utf8mb4 COLLATE utf8mb4_unicode_ci NOT
    NULL,
  `Member_ID` int NOT NULL,
  PRIMARY KEY (`Reservation_ID`) USING BTREE,
  INDEX `Booking_Member__138c47_idx`(`Member_ID` ASC) USING BTREE,
  CONSTRAINT `Booking_Member_ID_311d123e_fk_Member_Member_ID`
    FOREIGN KEY (`Member_ID`) REFERENCES `member` (`Member_ID`)
    ON DELETE RESTRICT ON UPDATE RESTRICT,
  CONSTRAINT `Booking_Reservation_ID_2e41085d_fk_Reservation_Reservation_ID`
    FOREIGN KEY (`Reservation_ID`) REFERENCES `reservation` (`Reservation_ID`)
    ON DELETE RESTRICT ON UPDATE RESTRICT
) ENGINE = InnoDB CHARACTER SET = utf8mb4 COLLATE = utf8mb4_unicode_ci ROW_FORMAT =
  Dynamic;
```

1.3 SQL Evidence: Table Creation Verification

After deploying the schema, we verified the actual DDL stored in MySQL using `SHOW CREATE TABLE`. Figure 1.1 shows successful execution for `equipment` and `reservation`, confirming that the domain constraints (data types and `CHECK`), entity constraints (primary keys and `UNIQUE` indices), and referential constraints (foreign keys such as `reservation.Facility_ID`) are present as designed in `sports_arena.sql`.

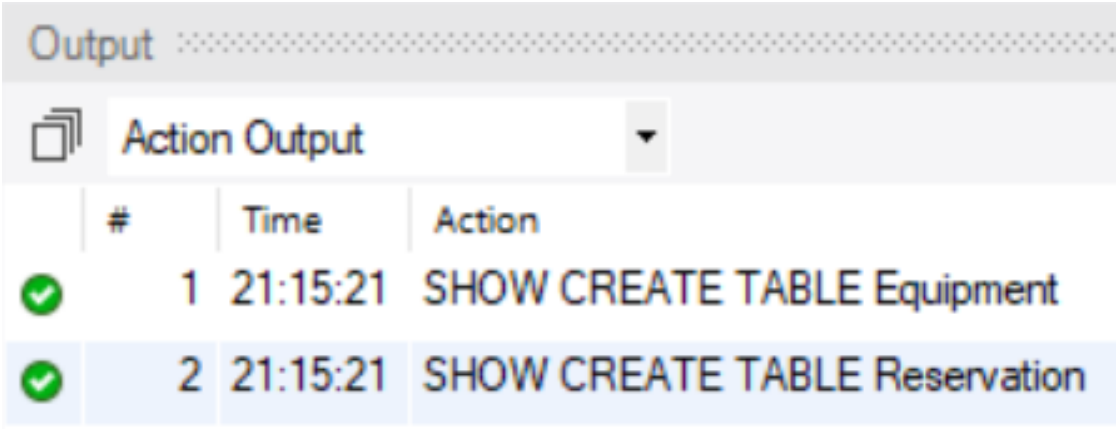


Figure 1.1: *SQL verification: successful `SHOW CREATE TABLE` execution for `equipment` and `reservation`, confirming that integrity constraints are deployed in the DBMS.*

1.4 Task 1B: How Integrity Constraints Are Applied and Maintained

1.4.1 Maintaining Domain Integrity (DB + Django)

Database enforcement. Domain rules are enforced at the DBMS boundary as the final, non-bypassable safeguard. For example, inserting a negative value into `equipment.Total_Quantity` violates the attribute domain (`INT UNSIGNED`) and is rejected by MySQL. Figure 1.2 shows `Error Code: 1264 (Out of range)`, which provides direct evidence that invalid domain values cannot be persisted.

Figure 1.2: *Domain integrity enforcement (SQL): inserting a negative `Total_Quantity` is rejected as an out-of-range value (`INT UNSIGNED`).*

Application enforcement. While DB constraints guarantee correctness, the application layer should prevent invalid inputs early and provide user-friendly feedback. In our Django implementation, reservation-related domain rules are validated before database submission:

- **Time-slot conflict prevention:** the system checks whether the selected facility and time range overlaps with an existing reservation. If a conflict is detected, the request is blocked with a clear validation message (Figure 1.3).
- **Advance booking limit:** bookings can only be made up to 1 week in advance. Inputs beyond the allowed range are rejected with an explanatory error message (Figure 1.4).

Figure 1.3: *Domain integrity enforcement (Django): reservation conflict detection prevents overlapping time slots at the application layer.*

Figure 1.4: *Domain integrity enforcement (Django): the system enforces a 1-week advance booking policy and reports the latest allowed date.*

Together, these validations demonstrate a robust strategy: Django provides early prevention and usability, while MySQL constraints remain the ultimate guardrail against invalid domain values.

1.4.2 Maintaining Entity Integrity

Entity integrity in our database is maintained primarily through `PRIMARY KEY` and `UNIQUE` constraints:

- **Stable identifiers:** auto-increment primary keys such as `Member_ID` and `Reservation_ID` ensure that each entity instance can be referenced unambiguously across the system.
- **Real-world uniqueness rules:** unique indices (e.g., the unique `user_id` mapping in `member`) prevent duplicate profiles for the same login account, preserving a consistent identity model.
- **Slot-level uniqueness:** the composite unique index on `reservation(Facility_ID, Reservation_Date, Start_Time)` prevents duplicated reservation slots and reduces the risk of double booking.

In Django, entity integrity is naturally reinforced by the ORM: each model instance is identified by its primary key, and unique constraints raise immediate errors if violated. This dual-layer alignment keeps identity and uniqueness consistent across the database and application.

1.4.3 Maintaining Referential Integrity

Referential integrity is maintained through foreign key constraints with restrictive actions:

- **No orphan bookings:** the `Reservation_ID` and `Member_ID` columns in `booking` must reference existing rows in `reservation` and `member` respectively.
- **Controlled deletes/updates:** the use of `ON DELETE RESTRICT` and `ON UPDATE RESTRICT` prevents accidental cascades that could silently destroy dependent records or break relationships.

On the Django side, referential integrity is supported by model relationships and form design: users select foreign-key objects from validated querysets, which ensures that referenced entities exist at the time of submission. As a result, relationships remain consistent even under concurrent usage.

1.5 Summary

This task demonstrates that our database integrity strategy is both **correct by design** and **verifiable in practice**. Domain constraints prevent invalid values (e.g., negative quantities and invalid booking dates), entity constraints guarantee unique and stable identities, and referential constraints preserve valid relationships between members, reservations, and bookings. By combining MySQL constraints with Django validation, the system achieves integrity that is rigorous, user-friendly, and aligned with the implemented schema in `sports_arena.sql`.

1.6 Schema Diagram (Supplementary)

Figure 1.5 provides a compact overview of the core relational schema used in this report. It clarifies the supertype–subtype design (`reservation` → `booking`/`training_session`) and the associative entities (`session_enrollment`, `reservation_equipments`), which supports the integrity discussion above.

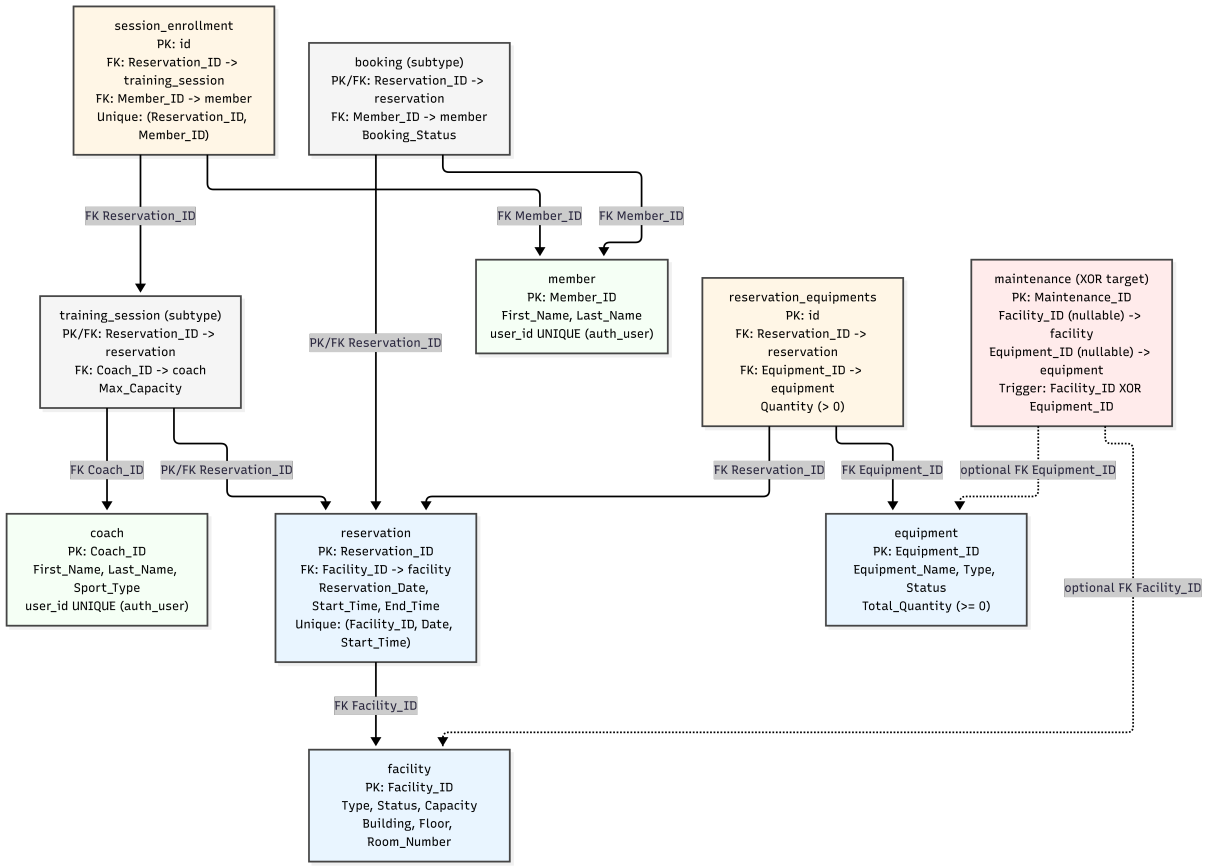


Figure 1.5: *Core relational schema overview aligned with* `sports_arena.sql`.

Task 2 SQL

This section demonstrates the practical implementation of the University Sports Complex Management System database. It covers the creation of the remaining tables, data population, and various data retrieval operations using SQL.

2.1 Table Creation

Following the initial examples in Task 1, we proceeded to create the remaining tables to complete the database schema. These tables include entities for different member types (Student, Staff, External Visitor), contact information, coaching staff, facility details, and various transaction tables like maintenance records and session enrollments.

The following screenshots demonstrate the successful execution of the `CREATE TABLE` commands for these entities.

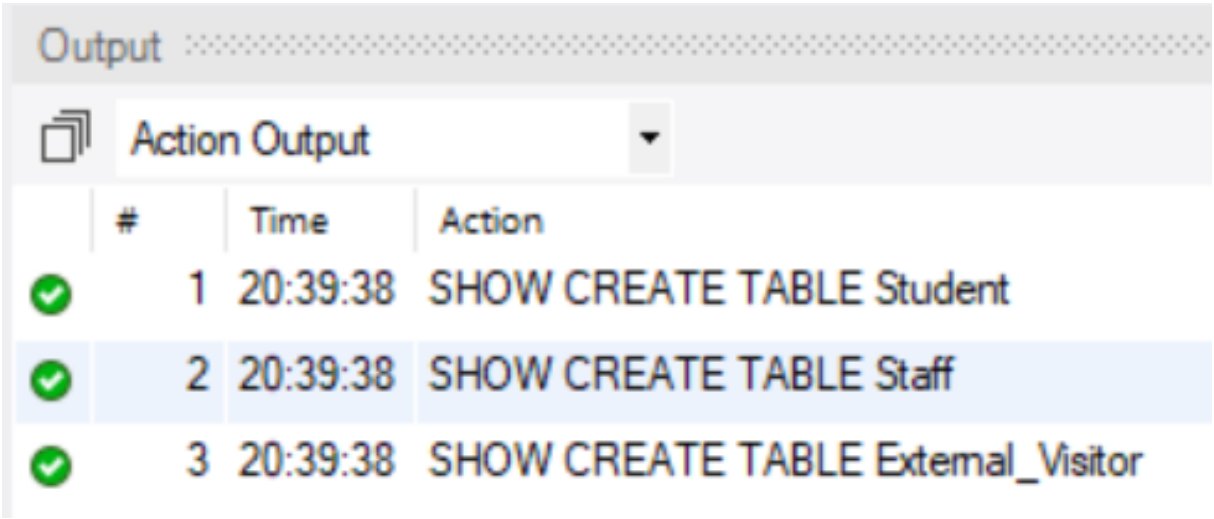


Figure 2.1: *CREATE TABLE execution (`student`, `staff`, `external_visitor`)*

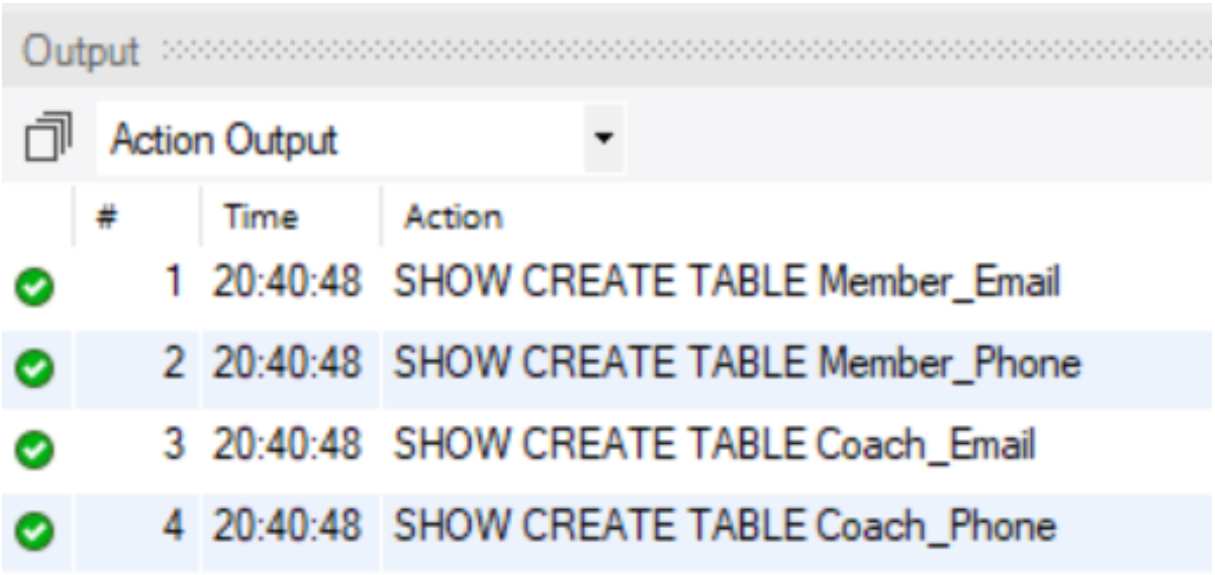


Figure 2.2: *CREATE TABLE execution (`member_email`, `member_phone`, `coach_email`, `coach_phone`)*

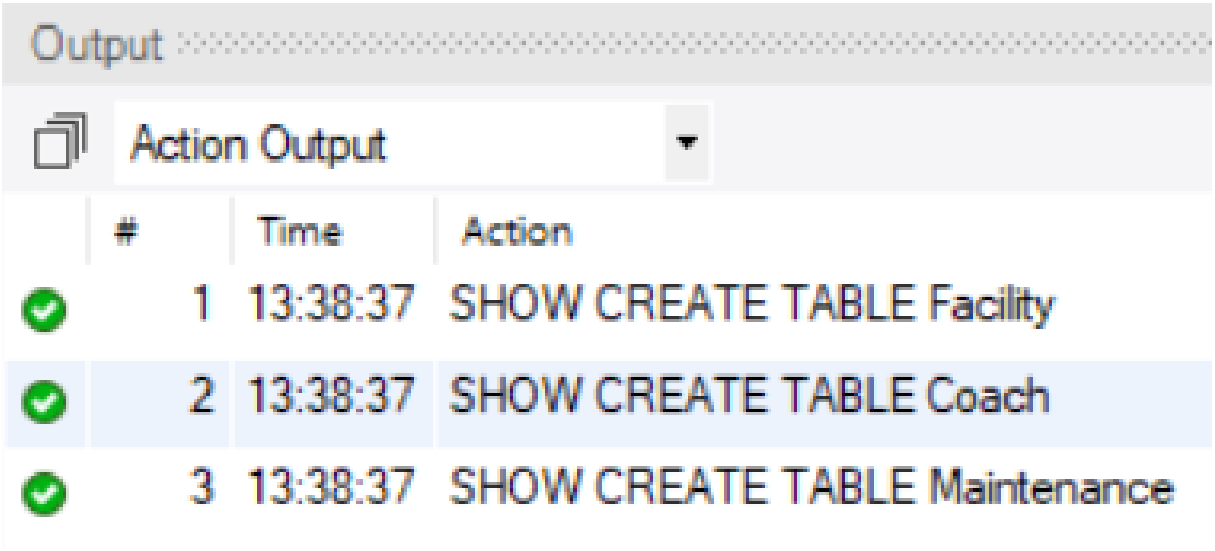


Figure 2.3: *CREATE TABLE execution (`facility`, `coach`, `maintenance`)*

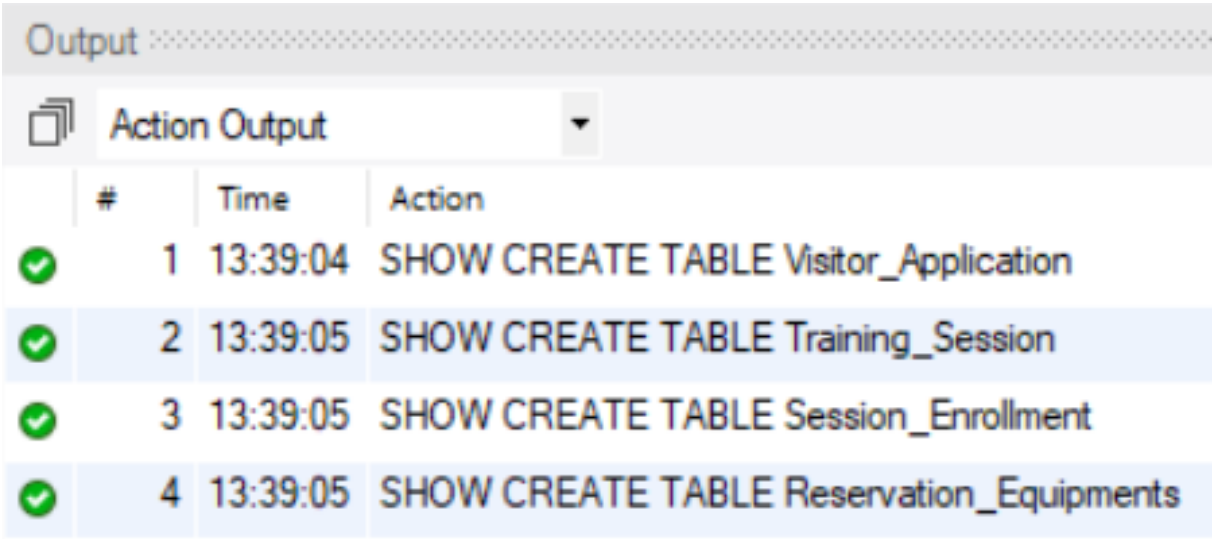
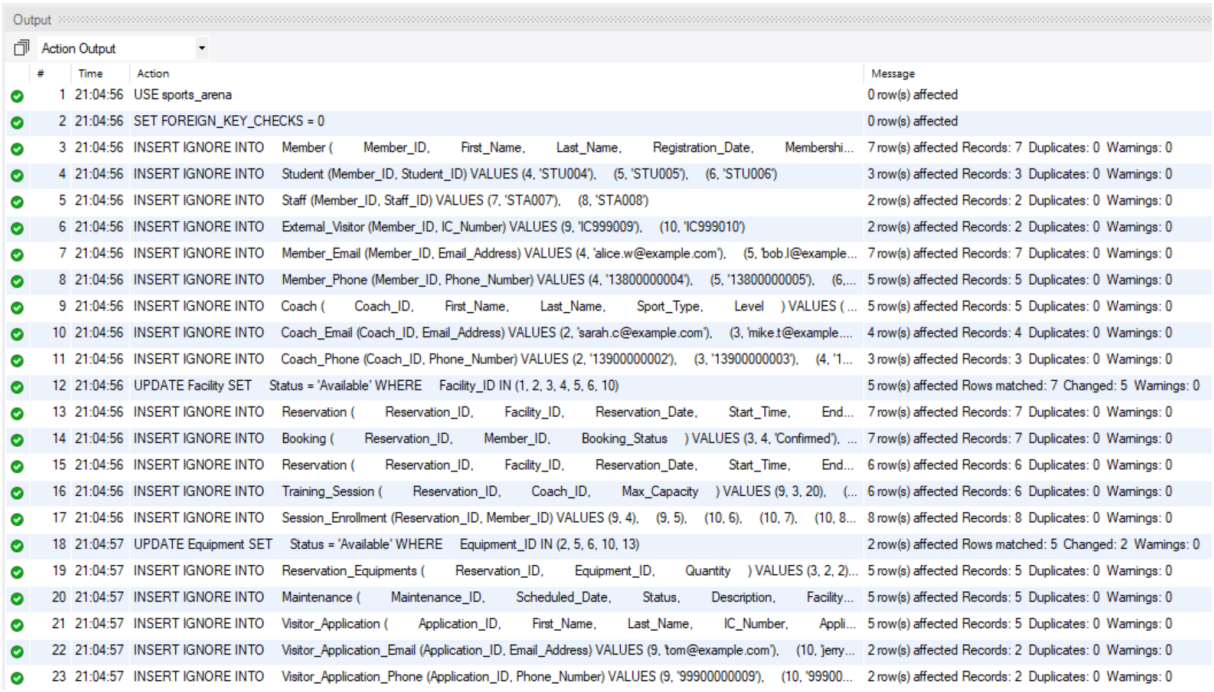


Figure 2.4: *CREATE TABLE execution (`visitor_application`, `training_session`, `session_enrollment`, `reservation_equipments`)*

2.2 Data Population

To ensure the database is functional for testing and queries, we populated each table with at least 6 rows of data (meeting the required 6–10 rows where practical). In a few cases, additional rows were inserted to support more comprehensive trigger testing scenarios in Task 3. The screenshots below provide evidence of successful data population and a row-count summary for key tables.

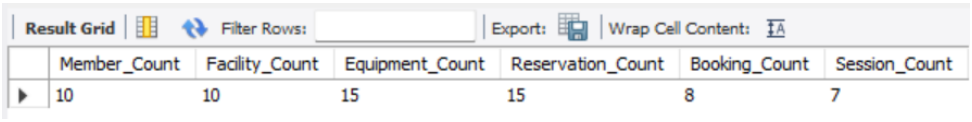


Output

Action Output

#	Time	Action	Message
1	21:04:56	USE sports_arena	0 row(s) affected
2	21:04:56	SET FOREIGN_KEY_CHECKS = 0	0 row(s) affected
3	21:04:56	INSERT IGNORE INTO Member (Member_ID, First_Name, Last_Name, Registration_Date, Membershi...	7 row(s) affected Records: 7 Duplicates: 0 Warnings: 0
4	21:04:56	INSERT IGNORE INTO Student (Member_ID, Student_ID) VALUES (4, 'STU004'), (5, 'STU005'), (6, 'STU006')	3 row(s) affected Records: 3 Duplicates: 0 Warnings: 0
5	21:04:56	INSERT IGNORE INTO Staff (Member_ID, Staff_ID) VALUES (7, 'STA007'), (8, 'STA008')	2 row(s) affected Records: 2 Duplicates: 0 Warnings: 0
6	21:04:56	INSERT IGNORE INTO External_Visitor (Member_ID, IC_Number) VALUES (9, 'IC999009'), (10, 'IC999010')	2 row(s) affected Records: 2 Duplicates: 0 Warnings: 0
7	21:04:56	INSERT IGNORE INTO Member_Email (Member_ID, Email_Address) VALUES (4, 'alice.w@example.com'), (5, 'bob.l@example...	7 row(s) affected Records: 7 Duplicates: 0 Warnings: 0
8	21:04:56	INSERT IGNORE INTO Member_Phone (Member_ID, Phone_Number) VALUES (4, '13800000004'), (5, '13800000005'), (6,...	5 row(s) affected Records: 5 Duplicates: 0 Warnings: 0
9	21:04:56	INSERT IGNORE INTO Coach (Coach_ID, First_Name, Last_Name, Sport_Type, Level) VALUES (...	5 row(s) affected Records: 5 Duplicates: 0 Warnings: 0
10	21:04:56	INSERT IGNORE INTO Coach_Email (Coach_ID, Email_Address) VALUES (2, 'sarah.c@example.com'), (3, 'mike.t@example....	4 row(s) affected Records: 4 Duplicates: 0 Warnings: 0
11	21:04:56	INSERT IGNORE INTO Coach_Phone (Coach_ID, Phone_Number) VALUES (2, '13900000002'), (3, '13900000003'), (4, '1...	3 row(s) affected Records: 3 Duplicates: 0 Warnings: 0
12	21:04:56	UPDATE Facility SET Status = 'Available' WHERE Facility_ID IN (1, 2, 3, 4, 5, 6, 10)	5 row(s) affected Rows matched: 7 Changed: 5 Warnings: 0
13	21:04:56	INSERT IGNORE INTO Reservation (Reservation_ID, Facility_ID, Reservation_Date, Start_Time, End...	7 row(s) affected Records: 7 Duplicates: 0 Warnings: 0
14	21:04:56	INSERT IGNORE INTO Booking (Reservation_ID, Member_ID, Booking_Status) VALUES (3, 4, 'Confirmed'), ...	7 row(s) affected Records: 7 Duplicates: 0 Warnings: 0
15	21:04:56	INSERT IGNORE INTO Reservation (Reservation_ID, Facility_ID, Reservation_Date, Start_Time, End...	6 row(s) affected Records: 6 Duplicates: 0 Warnings: 0
16	21:04:56	INSERT IGNORE INTO Training_Session (Reservation_ID, Coach_ID, Max_Capacity) VALUES (9, 3, 20), (...	6 row(s) affected Records: 6 Duplicates: 0 Warnings: 0
17	21:04:56	INSERT IGNORE INTO Session_Enrollment (Reservation_ID, Member_ID) VALUES (9, 4), (9, 5), (10, 6), (10, 7), (10, 8...	8 row(s) affected Records: 8 Duplicates: 0 Warnings: 0
18	21:04:57	UPDATE Equipment SET Status = 'Available' WHERE Equipment_ID IN (2, 5, 6, 10, 13)	2 row(s) affected Rows matched: 5 Changed: 2 Warnings: 0
19	21:04:57	INSERT IGNORE INTO Reservation_Equipments (Reservation_ID, Equipment_ID, Quantity) VALUES (3, 2, 2)...	5 row(s) affected Records: 5 Duplicates: 0 Warnings: 0
20	21:04:57	INSERT IGNORE INTO Maintenance (Maintenance_ID, Scheduled_Date, Status, Description, Facility...	5 row(s) affected Records: 5 Duplicates: 0 Warnings: 0
21	21:04:57	INSERT IGNORE INTO Visitor_Application (Application_ID, First_Name, Last_Name, IC_Number, Appli...	5 row(s) affected Records: 5 Duplicates: 0 Warnings: 0
22	21:04:57	INSERT IGNORE INTO Visitor_Application_Email (Application_ID, Email_Address) VALUES (9, 'tom@example.com'), (10, 'jerry...	2 row(s) affected Records: 2 Duplicates: 0 Warnings: 0
23	21:04:57	INSERT IGNORE INTO Visitor_Application_Phone (Application_ID, Phone_Number) VALUES (9, '99900000009'), (10, '99900...	2 row(s) affected Records: 2 Duplicates: 0 Warnings: 0

Figure 2.5: *Data population execution evidence: representative `INSERT/UPDATE` statements executed successfully across the schema.*



Result Grid | Filter Rows: | Export: | Wrap Cell Content:

Member_Count	Facility_Count	Equipment_Count	Reservation_Count	Booking_Count	Session_Count
10	10	15	15	8	7

Figure 2.6: *Verification of Data Population (Row Counts)*

2.3 Data Retrieval and Manipulation

We executed various SQL commands across six categories to demonstrate data retrieval and manipulation capabilities.

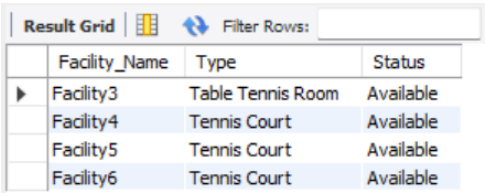
2.3.1 Filtering

This category demonstrates the use of `LIKE`, `BETWEEN`, and `IN` clauses to filter results.

Query 1: Filtering by Pattern (LIKE)
Find all facilities related to 'Tennis' that are currently available.

Listing 2.1: *Filtering with LIKE*

```
SELECT Facility_Name, Type, Status
FROM facility
WHERE Type LIKE '%Tennis%' AND Status='Available';
```



Facility_Name	Type	Status
Facility3	Table Tennis Room	Available
Facility4	Tennis Court	Available
Facility5	Tennis Court	Available
Facility6	Tennis Court	Available

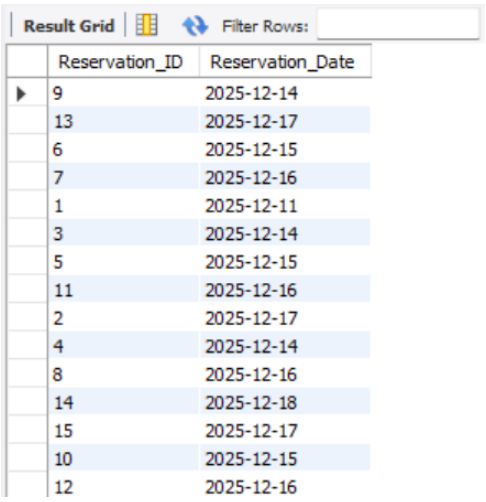
Figure 2.7: *Output of Query 1*

Query 2: Filtering by Range (BETWEEN)

Retrieve reservations made for the month of December 2025.

Listing 2.2: *Filtering with BETWEEN*

```
SELECT Reservation_ID, Reservation_Date
FROM reservation
WHERE Reservation_Date BETWEEN '2025-12-01' AND '2025-12-31';
```



Reservation_ID	Reservation_Date
9	2025-12-14
13	2025-12-17
6	2025-12-15
7	2025-12-16
1	2025-12-11
3	2025-12-14
5	2025-12-15
11	2025-12-16
2	2025-12-17
4	2025-12-14
8	2025-12-16
14	2025-12-18
15	2025-12-17
10	2025-12-15
12	2025-12-16

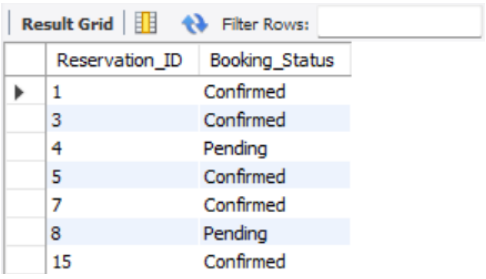
Figure 2.8: *Output of Query 2*

Query 3: Filtering by Set (IN)

List bookings that are either 'Pending' or 'Confirmed'.

Listing 2.3: *Filtering with IN*

```
SELECT Reservation_ID, Booking_Status
FROM booking
WHERE Booking_Status IN ('Pending','Confirmed');
```



Reservation_ID	Booking_Status
1	Confirmed
3	Confirmed
4	Pending
5	Confirmed
7	Confirmed
8	Pending
15	Confirmed

Figure 2.9: *Output of Query 3*

2.3.2 Aggregate Functions

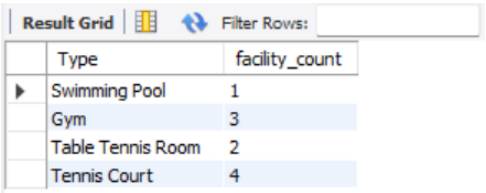
This category uses functions like `COUNT`, `SUM`, and `AVG` to summarize data.

Query 4: Counting Records (COUNT)

Count the number of facilities for each type.

Listing 2.4: *Aggregation with COUNT*

```
1 SELECT Type, COUNT(*) AS facility_count
2 FROM facility
3 GROUP BY Type;
```



Type	facility_count
Swimming Pool	1
Gym	3
Table Tennis Room	2
Tennis Court	4

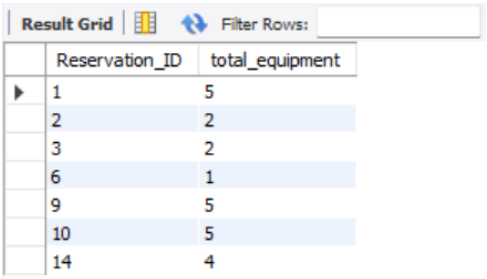
Figure 2.10: *Output of Query 4*

Query 5: Summing Values (SUM)

Calculate the total quantity of equipment reserved for each reservation ID.

Listing 2.5: *Aggregation with SUM*

```
1 SELECT Reservation_ID, SUM(Quantity) AS total_equipment
2 FROM reservation_equipments
3 GROUP BY Reservation_ID;
```



Reservation_ID	total_equipment
1	5
2	2
3	2
6	1
9	5
10	5
14	4

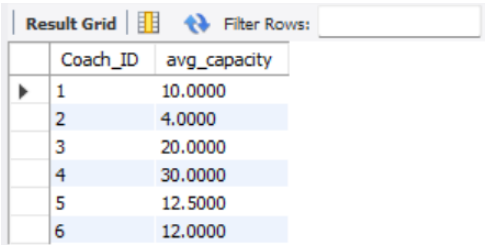
Figure 2.11: *Output of Query 5*

Query 6: Averaging Values (AVG)

Calculate the average maximum capacity of training sessions for each coach.

Listing 2.6: *Aggregation with AVG*

```
SELECT Coach_ID, AVG(Max_Capacity) AS avg_capacity
FROM training_session
GROUP BY Coach_ID;
```



Result Grid | Filter Rows:

Coach_ID	avg_capacity
1	10.0000
2	4.0000
3	20.0000
4	30.0000
5	12.5000
6	12.0000

Figure 2.12: *Output of Query 6*

2.3.3 Limit / Sorting

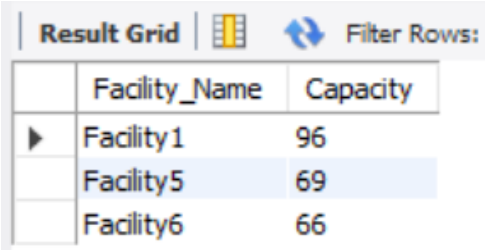
This category demonstrates sorting results with `ORDER BY` and restricting output with `LIMIT`.

Query 7: Ordering and Limiting

List the top 3 available facilities with the highest capacity.

Listing 2.7: *Sorting and Limiting results*

```
SELECT Facility_Name, Capacity
FROM facility
WHERE Status='Available'
ORDER BY Capacity DESC
LIMIT 3;
```



Result Grid | Filter Rows:

Facility_Name	Capacity
Facility1	96
Facility5	69
Facility6	66

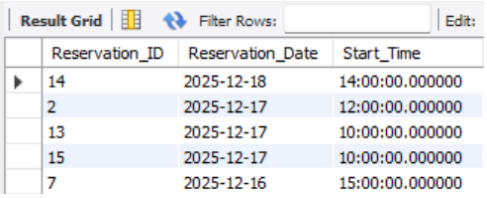
Figure 2.13: *Output of Query 7*

Query 8: Multi-level Sorting

Show recent reservations ordered by date and time in descending order.

Listing 2.8: *Multi-column Sorting*

```
SELECT Reservation_ID, Reservation_Date, Start_Time
FROM reservation
ORDER BY Reservation_Date DESC, Start_Time DESC
LIMIT 5;
```



Result Grid | Filter Rows: | Edit:

Reservation_ID	Reservation_Date	Start_Time
14	2025-12-18	14:00:00.000000
2	2025-12-17	12:00:00.000000
13	2025-12-17	10:00:00.000000
15	2025-12-17	10:00:00.000000
7	2025-12-16	15:00:00.000000

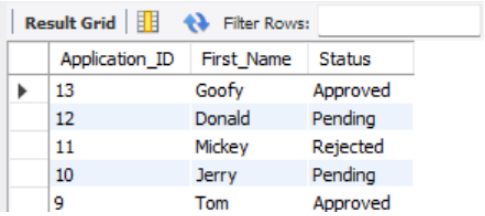
Figure 2.14: *Output of Query 8*

Query 9: Sorting Applications

List the 5 most recent visitor applications.

Listing 2.9: *Sorting Visitor Applications*

```
SELECT Application_ID, First_Name, Status
FROM visitor_application
ORDER BY Application_Date DESC
LIMIT 5;
```



Result Grid | Filter Rows:

Application_ID	First_Name	Status
13	Goofy	Approved
12	Donald	Pending
11	Mickey	Rejected
10	Jerry	Pending
9	Tom	Approved

Figure 2.15: *Output of Query 9*

2.3.4 Join Operators

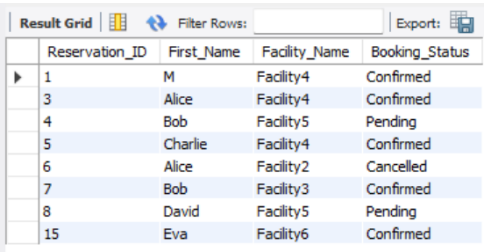
This category demonstrates `INNER JOIN`, `LEFT JOIN`, and `RIGHT JOIN` to combine data from multiple tables.

Query 10: Inner Join

Retrieve booking details including member name, facility name, and booking status.

Listing 2.10: *Inner Join Example*

```
SELECT b.Reservation_ID, m.First_Name, f.Facility_Name, b.Booking_Status
FROM booking b
JOIN member m ON b.Member_ID=m.Member_ID
JOIN reservation r ON b.Reservation_ID=r.Reservation_ID
JOIN facility f ON r.Facility_ID=f.Facility_ID;
```



Result Grid | Filter Rows: | Export:

Reservation_ID	First_Name	Facility_Name	Booking_Status
1	M	Facility4	Confirmed
3	Alice	Facility4	Confirmed
4	Bob	Facility5	Pending
5	Charlie	Facility4	Confirmed
6	Alice	Facility2	Cancelled
7	Bob	Facility3	Confirmed
8	David	Facility5	Pending
15	Eva	Facility6	Confirmed

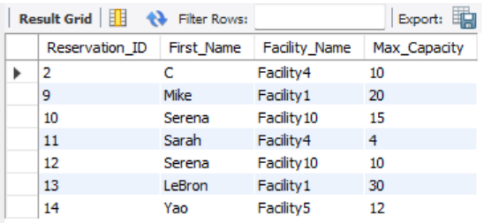
Figure 2.16: *Output of Query 10*

Query 11: Left Join

List all training sessions and their coaches (if assigned), facilities, and capacity.

Listing 2.11: *Left Join Example*

```
SELECT ts.Reservation_ID, c.First_Name, f.Facility_Name,
       ts.Max_Capacity
FROM training_session ts
LEFT JOIN coach c ON ts.Coach_ID=c.Coach_ID
LEFT JOIN reservation r ON ts.Reservation_ID=r.Reservation_ID
LEFT JOIN facility f ON r.Facility_ID=f.Facility_ID;
```



Result Grid | Filter Rows: | Export:

Reservation_ID	First_Name	Facility_Name	Max_Capacity
2	C	Facility4	10
9	Mike	Facility1	20
10	Serena	Facility10	15
11	Sarah	Facility4	4
12	Serena	Facility10	10
13	LeBron	Facility1	30
14	Yao	Facility5	12

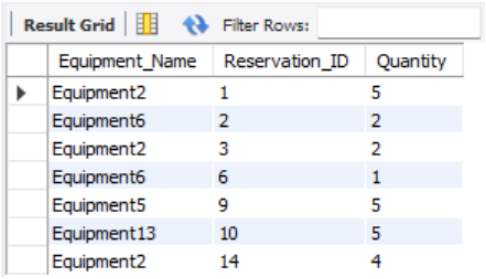
Figure 2.17: *Output of Query 11*

Query 12: Right Join

List equipment reservation-assignment rows, demonstrating `RIGHT JOIN` syntax.

Listing 2.12: *Right Join Example*

```
SELECT e.Equipment_Name, re.Reservation_ID, re.Quantity
FROM equipment e
RIGHT JOIN reservation_equipments re ON e.Equipment_ID=re.Equipment_ID;
```



Result Grid | Filter Rows:

Equipment_Name	Reservation_ID	Quantity
Equipment2	1	5
Equipment6	2	2
Equipment2	3	2
Equipment6	6	1
Equipment5	9	5
Equipment13	10	5
Equipment2	14	4

Figure 2.18: *Output of Query 12*

2.3.5 String / Arithmetic Operations

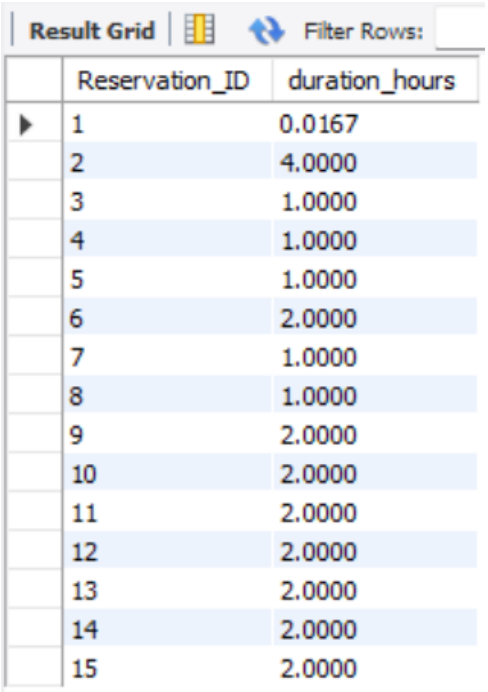
This category performs calculations and string manipulations on retrieved data.

Query 13: Arithmetic Expression

Calculate the duration of reservations in hours.

Listing 2.13: *Arithmetic Operation*

```
SELECT Reservation_ID,
       TIMESTAMPDIFF(MINUTE, Start_Time, End_Time)/60 AS duration_hours
FROM reservation;
```



Result Grid | Filter Rows:

Reservation_ID	duration_hours
1	0.0167
2	4.0000
3	1.0000
4	1.0000
5	1.0000
6	2.0000
7	1.0000
8	1.0000
9	2.0000
10	2.0000
11	2.0000
12	2.0000
13	2.0000
14	2.0000
15	2.0000

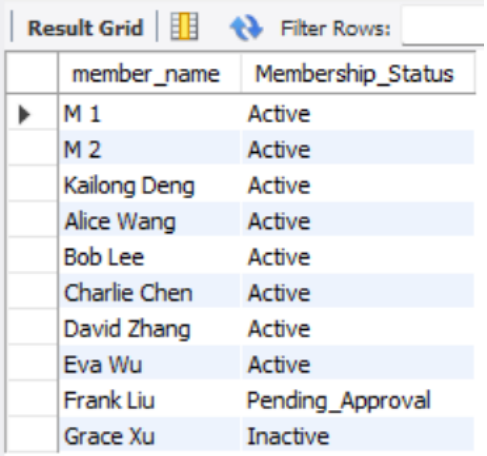
Figure 2.19: *Output of Query 13*

Query 14: String Concatenation

Combine first and last names into a single full name column for members.

Listing 2.14: *String Concatenation*

```
SELECT CONCAT(First_Name, ' ', Last_Name) AS member_name,
       Membership_Status
FROM member;
```



Result Grid | Filter Rows:

member_name	Membership_Status
M 1	Active
M 2	Active
Kailong Deng	Active
Alice Wang	Active
Bob Lee	Active
Charlie Chen	Active
David Zhang	Active
Eva Wu	Active
Frank Liu	Pending_Approval
Grace Xu	Inactive

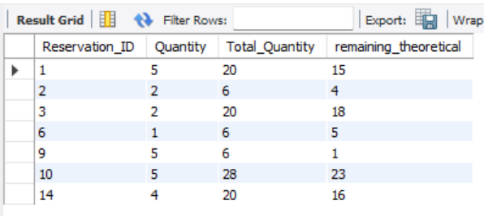
Figure 2.20: *Output of Query 14*

Query 15: Complex Calculation

Calculate the theoretical remaining quantity of equipment after reservations.

Listing 2.15: *Complex Arithmetic*

```
SELECT re.Reservation_ID, re.Quantity, e.Total_Quantity,
       (e.Total_Quantity - re.Quantity) AS remaining_theoretical
FROM reservation_equipments re
JOIN equipment e ON re.Equipment_ID=e.Equipment_ID;
```



Result Grid | Filter Rows: | Export: | Wrap

Reservation_ID	Quantity	Total_Quantity	remaining_theoretical
1	5	20	15
2	2	6	4
3	2	20	18
6	1	6	5
9	5	6	1
10	5	28	23
14	4	20	16

Figure 2.21: *Output of Query 15*

2.3.6 Formatting

This category focuses on formatting query output using aliases and concatenation for better readability.

Query 16: Column Aliasing

Rename columns for a clear facility location report.

Listing 2.16: *Column Aliasing*

```
SELECT Facility_ID AS ID, Facility_Name AS Name,
       CONCAT(Building,'-',Floor,'-',Room_Number) AS Location
FROM facility;
```

Result Grid | Filter Rows:

ID	Name	Location
1	Facility1	Main Building-4-401
2	Facility2	Main Building-2-202
3	Facility3	Sports Hall B-4-403
4	Facility4	Main Building-3-304
5	Facility5	Sports Hall B-1-105
6	Facility6	Sports Hall B-1-106
7	Facility7	Activity Center-2-207
8	Facility8	Activity Center-3-308
9	Facility9	Main Building-3-309
10	Facility10	Sports Hall B-1-110

Figure 2.22: *Output of Query 16*

Query 17: Date Formatting

Format reservation dates and create user-friendly booking summaries.

Listing 2.17: *Date Formatting and Concatenation*

```
SELECT b.Reservation_ID AS BookingID,
       CONCAT(m.First_Name,' ',m.Last_Name) AS Member,
       DATE_FORMAT(r.Reservation_Date,'%Y-%m-%d') AS Date
FROM booking b
JOIN member m ON b.Member_ID=m.Member_ID
JOIN reservation r ON b.Reservation_ID=r.Reservation_ID;
```

Result Grid | Filter Rows:

BookingID	Member	Date
1	M 1	2025-12-11
3	Alice Wang	2025-12-14
6	Alice Wang	2025-12-15
4	Bob Lee	2025-12-14
7	Bob Lee	2025-12-16
5	Charlie Chen	2025-12-15
8	David Zhang	2025-12-16
15	Eva Wu	2025-12-17

Figure 2.23: *Output of Query 17*

Query 18: Session Formatting

Create a formatted schedule for training sessions.

Listing 2.18: *Result Set Formatting*

```
SELECT ts.Reservation_ID AS SessionID,
       CONCAT(c.First_Name,' ',c.Last_Name) AS CoachName,
       CONCAT(r.Start_Time,'-',r.End_Time) AS TimeSlot
FROM training_session ts
JOIN coach c ON ts.Coach_ID=c.Coach_ID
JOIN reservation r ON ts.Reservation_ID=r.Reservation_ID;
```

Result Grid | Filter Rows: | Export:

SessionID	CoachName	TimeSlot
2	C 1	12:00:00.000000-16:00:00.000000
11	Sarah Connor	09:00:00.000000-11:00:00.000000
9	Mike Tyson	08:00:00.000000-10:00:00.000000
13	LeBron James	10:00:00.000000-12:00:00.000000
10	Serena Williams	18:00:00.000000-20:00:00.000000
12	Serena Williams	14:00:00.000000-16:00:00.000000
14	Yao Ming	14:00:00.000000-16:00:00.000000

Figure 2.24: *Output of Query 18*

Task 3 Triggering

To ensure data integrity and enforce business rules at the database level, we selected two trigger event types—**INSERT** and **UPDATE**—and implemented **BEFORE** triggers so invalid operations are rejected before any row is committed. All trigger definitions shown in this section are aligned with the deployed schema in `sports\_arena.sql`. The evidence scenarios below explicitly show the database state *before* and *after* each attempted operation (success or rejection).

3.1 Implemented Triggers

3.1.1 Booking Guardrails

These triggers ensure a member cannot have more than 2 pending bookings, sessions do not exceed 3 hours, and bookings are made within a valid 7-day window.

Listing 3.1: *Trigger: Booking Before Insert Checks*

```
CREATE TRIGGER `booking_bi_guardrails` BEFORE INSERT ON `booking` FOR EACH ROW BEGIN
DECLARE v_pending INT DEFAULT 0;
DECLARE v_reservation_date DATE;
DECLARE v_start TIME;
DECLARE v_end TIME;
DECLARE v_duration_minutes INT;
```

```
7
8  SELECT COUNT(*) INTO v_pending
9  FROM `booking`
10 WHERE `Member_ID` = NEW.Member_ID
11     AND `Booking_Status` = 'Pending';
12
13 IF NEW.Booking_Status = 'Pending' AND v_pending >= 2 THEN
14     SIGNAL SQLSTATE '45000'
15     SET MESSAGE_TEXT = 'Member already has 2 pending bookings';
16 END IF;
17
18 SELECT `Reservation_Date`, `Start_Time`, `End_Time`
19     INTO v_reservation_date, v_start, v_end
20 FROM `reservation`
21 WHERE `Reservation_ID` = NEW.Reservation_ID;
22
23 IF v_reservation_date IS NULL THEN
24     SIGNAL SQLSTATE '45000'
25     SET MESSAGE_TEXT = 'Reservation not found for booking';
26 END IF;
27
28 SET v_duration_minutes = TIMESTAMPDIFF(MINUTE, v_start, v_end);
29
30 IF v_duration_minutes > 180 THEN
31     SIGNAL SQLSTATE '45000'
32     SET MESSAGE_TEXT = 'Single booking session cannot exceed 3 hours';
33 END IF;
34
35 IF v_reservation_date < CURDATE() THEN
36     SIGNAL SQLSTATE '45000'
37     SET MESSAGE_TEXT = 'Cannot book for past dates';
38 END IF;
39
40 IF v_reservation_date > DATE_ADD(CURDATE(), INTERVAL 7 DAY) THEN
41     SIGNAL SQLSTATE '45000'
42     SET MESSAGE_TEXT = 'Bookings can only be made up to 7 days in advance';
43 END IF;
44 END;
```

Listing 3.2: *Trigger: Booking Before Update Checks*

```
1 CREATE TRIGGER `booking_bu_guardrails` BEFORE UPDATE ON `booking` FOR EACH ROW BEGIN
2 DECLARE v_pending INT DEFAULT 0;
3 DECLARE v_reservation_date DATE;
4 DECLARE v_start TIME;
5 DECLARE v_end TIME;
6 DECLARE v_duration_minutes INT;
```

```
7
8  SELECT COUNT(*) INTO v_pending
9  FROM `booking`
10 WHERE `Member_ID` = NEW.Member_ID
11     AND `Booking_Status` = 'Pending'
12     AND `Reservation_ID` <> OLD.Reservation_ID;
13
14 IF NEW.Booking_Status = 'Pending' AND v_pending >= 2 THEN
15     SIGNAL SQLSTATE '45000'
16     SET MESSAGE_TEXT = 'Member already has 2 pending bookings';
17 END IF;
18
19 IF NEW.Reservation_ID <> OLD.Reservation_ID THEN
20     SELECT `Reservation_Date`, `Start_Time`, `End_Time`
21     INTO v_reservation_date, v_start, v_end
22     FROM `reservation`
23     WHERE `Reservation_ID` = NEW.Reservation_ID;
24
25     IF v_reservation_date IS NULL THEN
26     SIGNAL SQLSTATE '45000'
27         SET MESSAGE_TEXT = 'Reservation not found for booking';
28     END IF;
29
30     SET v_duration_minutes = TIMESTAMPDIFF(MINUTE, v_start, v_end);
31
32     IF v_duration_minutes > 180 THEN
33     SIGNAL SQLSTATE '45000'
34         SET MESSAGE_TEXT = 'Single booking session cannot exceed 3 hours';
35     END IF;
36
37     IF v_reservation_date < CURDATE() THEN
38     SIGNAL SQLSTATE '45000'
39         SET MESSAGE_TEXT = 'Cannot book for past dates';
40     END IF;
41
42     IF v_reservation_date > DATE_ADD(CURDATE(), INTERVAL 7 DAY) THEN
43     SIGNAL SQLSTATE '45000'
44         SET MESSAGE_TEXT = 'Bookings can only be made up to 7 days in advance';
45     END IF;
46 END IF;
47 END;
```

3.1.2 Maintenance XOR Constraints

These triggers enforce that a maintenance record targets either a facility OR equipment, but not both and not neither.

Listing 3.3: *Trigger: Maintenance Before Insert XOR Constraint*

```
CREATE TRIGGER `maintenance_bi_xor` BEFORE INSERT ON `maintenance` FOR EACH ROW
  BEGIN
IF (NEW.Facility_ID IS NULL AND NEW.Equipment_ID IS NULL)
    OR (NEW.Facility_ID IS NOT NULL AND NEW.Equipment_ID IS NOT NULL) THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Maintenance must target either a facility or equipment (
      exclusively)';
END IF;
END;
```

Listing 3.4: *Trigger: Maintenance Before Update XOR Constraint*

```
CREATE TRIGGER `maintenance_bu_xor` BEFORE UPDATE ON `maintenance` FOR EACH ROW
  BEGIN
IF (NEW.Facility_ID IS NULL AND NEW.Equipment_ID IS NULL)
    OR (NEW.Facility_ID IS NOT NULL AND NEW.Equipment_ID IS NOT NULL) THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Maintenance must target either a facility or equipment (
      exclusively)';
END IF;
END;
```

3.1.3 Reservation Overlap and Availability

These triggers prevent overlapping reservations for the same facility and ensure the facility is available and not under maintenance.

Listing 3.5: *Trigger: Reservation Before Insert Checks*

```
CREATE TRIGGER `reservation_bi_guardrails` BEFORE INSERT ON `reservation` FOR EACH
  ROW BEGIN
DECLARE v_facility_status VARCHAR(20);
DECLARE v_conflicts INT DEFAULT 0;
DECLARE v_maintenance INT DEFAULT 0;

SELECT `Status` INTO v_facility_status
FROM `facility`
WHERE `Facility_ID` = NEW.Facility_ID
FOR UPDATE;

IF v_facility_status IS NULL THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Facility does not exist for this reservation';
END IF;

```

```
IF NEW.Start_Time >= NEW.End_Time THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Reservation start time must be earlier than end time';
END IF;

IF v_facility_status <> 'Available' THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Facility is not available for reservation';
END IF;

SELECT COUNT(*) INTO v_maintenance
FROM `maintenance` m
WHERE m.`Facility_ID` = NEW.Facility_ID
    AND m.`Scheduled_Date` = NEW.Reservation_Date
    AND m.`Status` IN ('Scheduled', 'In_Progress', 'In Progress');

IF v_maintenance > 0 THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Facility has maintenance scheduled for the requested date';
END IF;

SELECT COUNT(*) INTO v_conflicts
FROM `reservation` r
WHERE r.`Facility_ID` = NEW.Facility_ID
    AND r.`Reservation_Date` = NEW.Reservation_Date
    AND NOT (NEW.End_Time <= r.`Start_Time` OR NEW.Start_Time >= r.`End_Time`);

IF v_conflicts > 0 THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Reservation overlaps with an existing booking for this
      facility';
END IF;
END;
```

Listing 3.6: *Trigger: Reservation Before Update Checks*

```
CREATE TRIGGER `reservation_bu_guardrails` BEFORE UPDATE ON `reservation` FOR EACH
  ROW BEGIN
DECLARE v_facility_status VARCHAR(20);
DECLARE v_conflicts INT DEFAULT 0;
DECLARE v_maintenance INT DEFAULT 0;

SELECT `Status` INTO v_facility_status
FROM `facility`
WHERE `Facility_ID` = NEW.Facility_ID
FOR UPDATE;

```

```
IF v_facility_status IS NULL THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Facility does not exist for this reservation';
END IF;

IF NEW.Start_Time >= NEW.End_Time THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Reservation start time must be earlier than end time';
END IF;

IF v_facility_status <> 'Available' THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Facility is not available for reservation';
END IF;

SELECT COUNT(*) INTO v_maintenance
FROM `maintenance` m
WHERE m.`Facility_ID` = NEW.Facility_ID
    AND m.`Scheduled_Date` = NEW.Reservation_Date
    AND m.`Status` IN ('Scheduled', 'In_Progress', 'In Progress');

IF v_maintenance > 0 THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Facility has maintenance scheduled for the requested date';
END IF;

SELECT COUNT(*) INTO v_conflicts
FROM `reservation` r
WHERE r.`Facility_ID` = NEW.Facility_ID
    AND r.`Reservation_Date` = NEW.Reservation_Date
    AND r.`Reservation_ID` <> OLD.Reservation_ID
    AND NOT (NEW.End_Time <= r.`Start_Time` OR NEW.Start_Time >= r.`End_Time`);

IF v_conflicts > 0 THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Reservation overlaps with an existing booking for this
      facility';
END IF;
END;
```

3.1.4 Reservation Equipment Availability

These triggers ensure enough equipment stock is available for a reservation, accounting for other reservations and maintenance.

Listing 3.7: *Trigger: Reservation Equipments Before Insert Checks*

```
CREATE TRIGGER `reservation_equipments_bi_guardrails` BEFORE INSERT ON `
  reservation_equipments` FOR EACH ROW BEGIN
DECLARE v_total INT;
DECLARE v_reserved INT DEFAULT 0;
DECLARE v_available INT;
DECLARE v_status VARCHAR(20);
DECLARE v_reservation_date DATE;
DECLARE v_start TIME;
DECLARE v_end TIME;
DECLARE v_maintenance INT DEFAULT 0;

SELECT r.`Reservation_Date`, r.`Start_Time`, r.`End_Time`
    INTO v_reservation_date, v_start, v_end
FROM `reservation` r
WHERE r.`Reservation_ID` = NEW.Reservation_ID
FOR UPDATE;

IF v_reservation_date IS NULL THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Reservation not found for equipment assignment';
END IF;

SELECT e.`Total_Quantity`, e.`Status`
    INTO v_total, v_status
FROM `equipment` e
WHERE e.`Equipment_ID` = NEW.Equipment_ID
FOR UPDATE;

IF v_status IS NULL THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Equipment does not exist';
END IF;

IF v_status <> 'Available' THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Equipment is not available for reservation';
END IF;

IF NEW.Quantity <= 0 THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Quantity must be positive';
END IF;

SELECT COUNT(*) INTO v_maintenance
FROM `maintenance` m
WHERE m.`Equipment_ID` = NEW.Equipment_ID
    AND m.`Scheduled_Date` = v_reservation_date
```

```
    AND m.`Status` IN ('Scheduled', 'In_Progress', 'In Progress');

SELECT COALESCE(SUM(re2.`Quantity`), 0) INTO v_reserved
FROM `reservation_equipments` re2
JOIN `reservation` r2 ON r2.`Reservation_ID` = re2.`Reservation_ID`
WHERE re2.`Equipment_ID` = NEW.Equipment_ID
    AND r2.`Reservation_Date` = v_reservation_date
    AND NOT (v_end <= r2.`Start_Time` OR v_start >= r2.`End_Time`);

SET v_available = v_total - v_reserved - v_maintenance;

IF NEW.Quantity > v_available THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Requested equipment exceeds available quantity';
END IF;
END;
```

Listing 3.8: *Trigger: Reservation Equipments Before Update Checks*

```
CREATE TRIGGER `reservation_equipments_bu_guardrails` BEFORE UPDATE ON `
  reservation_equipments` FOR EACH ROW BEGIN
DECLARE v_total INT;
DECLARE v_reserved INT DEFAULT 0;
DECLARE v_available INT;
DECLARE v_status VARCHAR(20);
DECLARE v_reservation_date DATE;
DECLARE v_start TIME;
DECLARE v_end TIME;
DECLARE v_maintenance INT DEFAULT 0;

SELECT r.`Reservation_Date`, r.`Start_Time`, r.`End_Time`
    INTO v_reservation_date, v_start, v_end
FROM `reservation` r
WHERE r.`Reservation_ID` = NEW.Reservation_ID
FOR UPDATE;

IF v_reservation_date IS NULL THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Reservation not found for equipment assignment';
END IF;

SELECT e.`Total_Quantity`, e.`Status`
    INTO v_total, v_status
FROM `equipment` e
WHERE e.`Equipment_ID` = NEW.Equipment_ID
FOR UPDATE;

```

```
IF v_status IS NULL THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Equipment does not exist';
END IF;

IF v_status <> 'Available' THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Equipment is not available for reservation';
END IF;

IF NEW.Quantity <= 0 THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Quantity must be positive';
END IF;

SELECT COUNT(*) INTO v_maintenance
FROM `maintenance` m
WHERE m.`Equipment_ID` = NEW.Equipment_ID
    AND m.`Scheduled_Date` = v_reservation_date
    AND m.`Status` IN ('Scheduled', 'In_Progress', 'In Progress');

SELECT COALESCE(SUM(re2.`Quantity`), 0) INTO v_reserved
FROM `reservation_equipments` re2
JOIN `reservation` r2 ON r2.`Reservation_ID` = re2.`Reservation_ID`
WHERE re2.`Equipment_ID` = NEW.Equipment_ID
    AND r2.`Reservation_Date` = v_reservation_date
    AND NOT (v_end <= r2.`Start_Time` OR v_start >= r2.`End_Time`)
    AND re2.`id` <> OLD.`id`;

SET v_available = v_total - v_reserved - v_maintenance;

IF NEW.Quantity > v_available THEN
    SIGNAL SQLSTATE '45000'
    SET MESSAGE_TEXT = 'Requested equipment exceeds available quantity';
END IF;
END;
```

3.1.5 Session Enrollment Capacity

These triggers prevent enrollment if the training session has reached its maximum capacity.

Listing 3.9: *Trigger: Session Enrollment Before Insert Capacity Check*

```
CREATE TRIGGER `session_enrollment_bi_capacity` BEFORE INSERT ON `session_enrollment
  ` FOR EACH ROW BEGIN
DECLARE v_capacity INT;
DECLARE v_current INT DEFAULT 0;
```

```
4
5  SELECT `Max_Capacity` INTO v_capacity
6  FROM `training_session`
7  WHERE `Reservation_ID` = NEW.Reservation_ID
8  FOR UPDATE;
9
10 IF v_capacity IS NULL THEN
11     SIGNAL SQLSTATE '45000'
12     SET MESSAGE_TEXT = 'Training session not found for enrollment';
13 END IF;
14
15 IF v_capacity <= 0 THEN
16     SIGNAL SQLSTATE '45000'
17     SET MESSAGE_TEXT = 'Training session has no available capacity';
18 END IF;
19
20 SELECT COUNT(*) INTO v_current
21 FROM `session_enrollment`
22 WHERE `Reservation_ID` = NEW.Reservation_ID;
23
24 IF v_current >= v_capacity THEN
25     SIGNAL SQLSTATE '45000'
26     SET MESSAGE_TEXT = 'Training session is full';
27 END IF;
28 END;
```

Listing 3.10: *Trigger: Session Enrollment Before Update Capacity Check*

```
1  CREATE TRIGGER `session_enrollment_bu_capacity` BEFORE UPDATE ON `session_enrollment
     ` FOR EACH ROW BEGIN
2  DECLARE v_capacity INT;
3  DECLARE v_current INT DEFAULT 0;
4
5  SELECT `Max_Capacity` INTO v_capacity
6  FROM `training_session`
7  WHERE `Reservation_ID` = NEW.Reservation_ID
8  FOR UPDATE;
9
10 IF v_capacity IS NULL THEN
11     SIGNAL SQLSTATE '45000'
12     SET MESSAGE_TEXT = 'Training session not found for enrollment';
13 END IF;
14
15 IF v_capacity <= 0 THEN
16     SIGNAL SQLSTATE '45000'
17     SET MESSAGE_TEXT = 'Training session has no available capacity';
18 END IF;
```

```
19
20 SELECT COUNT(*) INTO v_current
21 FROM `session_enrollment`
22 WHERE `Reservation_ID` = NEW.Reservation_ID
23     AND `id` <> OLD.`id`;
24
25 IF v_current >= v_capacity THEN
26     SIGNAL SQLSTATE '45000'
27     SET MESSAGE_TEXT = 'Training session is full';
28 END IF;
29 END;
```

3.2 Evidence Scenarios

3.2.1 Trigger Interaction Diagram

Figure 3.1 summarizes how the implemented triggers collaborate to enforce business rules in the reservation workflow. It also highlights the shared dependency on base constraints (e.g., foreign keys, checks) and the common rejection behavior (`SIGNAL SQLSTATE '45000'`).

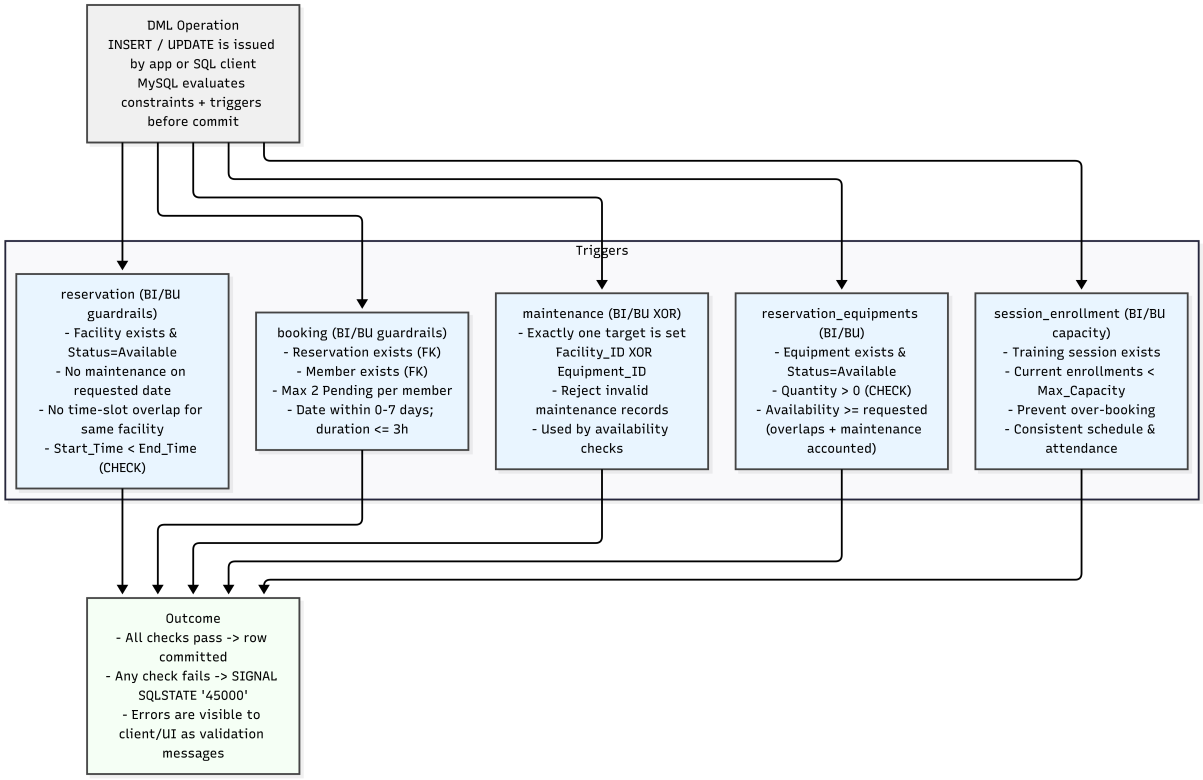


Figure 3.1: *Trigger enforcement overview: major trigger points and the resulting accept/reject outcomes during `INSERT/UPDATE`.*

3.2.2 Scenario A: Reservation Overlap is Blocked

Before: The target facility has two valid, non-overlapping reservations on the chosen date (Scenario A1). **Action:** Attempt to insert a reservation that overlaps an existing time interval for the same facility. **After:** The trigger blocks the overlapping insert with an error (Scenario A2), and the reservation list remains unchanged (Scenario A3).

Listing 3.11: *Scenario A1 SQL: Create two non-overlapping reservations*

```
SET @res_facility := 4;
SET @res_date := DATE_ADD(CURDATE(), INTERVAL 1 DAY);
INSERT INTO reservation (Reservation_Date, Start_Time, End_Time, Facility_ID)
VALUES (@res_date, '10:00:00', '11:00:00', @res_facility);
SET @res_ok_1 := LAST_INSERT_ID();
INSERT INTO reservation (Reservation_Date, Start_Time, End_Time, Facility_ID)
VALUES (@res_date, '12:00:00', '13:00:00', @res_facility);
SET @res_ok_2 := LAST_INSERT_ID();
SELECT 'current reservations' AS step, Reservation_ID, Start_Time, End_Time
FROM reservation WHERE Reservation_ID IN (@res_ok_1, @res_ok_2) ORDER BY
  Reservation_ID;
```

Result Grid | Filter Rows: | Export: | Wrap Cell Content:

step	Reservation_ID	Start_Time	End_Time
current reservations	3	10:00:00.000000	11:00:00.000000
current reservations	4	12:00:00.000000	13:00:00.000000

Figure 3.2: *Scenario A1: Successful creation of non-overlapping reservations*

Then, we attempt an overlapping insert, which should fail.

Listing 3.12: *Scenario A2 SQL: Attempt overlapping reservation*

```
INSERT INTO reservation (Reservation_Date, Start_Time, End_Time, Facility_ID)
VALUES (@res_date, '10:30:00', '11:30:00', @res_facility);
```

881 15:31:51 INSERT INTO reservation (Reservation_Date, Start_... Error Code: 1644. Reservation overlaps with an existing booking for this facility

Figure 3.3: *Scenario A2: Overlapping reservation attempt blocked*

Confirmation that only the valid rows remain:

Listing 3.13: *Scenario A3 SQL: Verify reservations found*

```
SELECT Reservation_ID, Start_Time, End_Time
FROM reservation
WHERE Facility_ID = @res_facility AND Reservation_Date = @res_date
ORDER BY Reservation_ID;
```

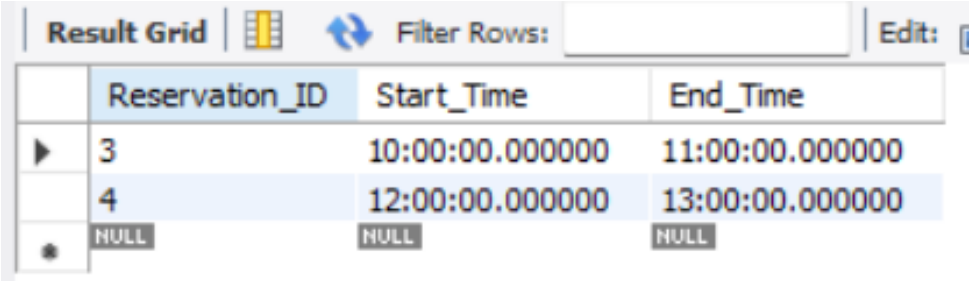


Figure 3.4: *Scenario A3: Verification of existing reservations*

3.2.3 Scenario B: Booking Pending Limit

Rule: A member may have at most two `Pending` bookings. **Before:** Member 1 has fewer than two pending bookings. **Action:** Prepare three future reservation slots (Scenario B1), insert two pending bookings (Scenario B2), then attempt a third pending booking (Scenario B3). **After:** The trigger raises `'Member already has 2 pending bookings'` and the database still contains only two pending bookings for the member (Scenario B4).

Listing 3.14: *Scenario B1 SQL: Prepare three reservations*

```
SET @booking_member := 1;
SET @booking_date := DATE_ADD(CURDATE(), INTERVAL 2 DAY);
INSERT INTO reservation (Reservation_Date, Start_Time, End_Time, Facility_ID)
VALUES (@booking_date, '09:00:00', '10:00:00', 5);
SET @book_res_1 := LAST_INSERT_ID();
INSERT INTO reservation (Reservation_Date, Start_Time, End_Time, Facility_ID)
VALUES (@booking_date, '10:10:00', '11:10:00', 5);
SET @book_res_2 := LAST_INSERT_ID();
INSERT INTO reservation (Reservation_Date, Start_Time, End_Time, Facility_ID)
VALUES (@booking_date, '11:20:00', '12:20:00', 5);
SET @book_res_3 := LAST_INSERT_ID();
SELECT 'prep reservations' AS step, Reservation_ID, Reservation_Date, Start_Time,
  End_Time
FROM reservation WHERE Reservation_ID IN (@book_res_1, @book_res_2, @book_res_3)
ORDER BY Reservation_ID;
```

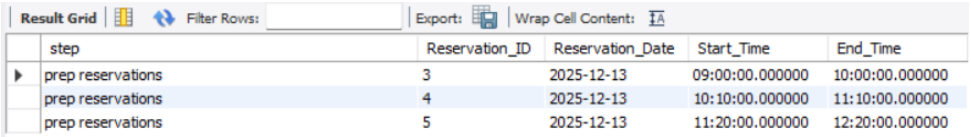


Figure 3.5: *Scenario B1: Preparation of reservations*

Insert two Pending bookings (allowed) and count:

Listing 3.15: *Scenario B2 SQL: Insert two pending bookings*

```sql
INSERT INTO booking (Reservation_ID, Booking_Status, Member_ID)
VALUES (@book_res_1, 'Pending', @booking_member);
INSERT INTO booking (Reservation_ID, Booking_Status, Member_ID)
VALUES (@book_res_2, 'Pending', @booking_member);
SELECT 'after two pendings' AS step, COUNT(*) AS pending_count
FROM booking WHERE Member_ID = @booking_member AND Booking_Status = 'Pending';
```

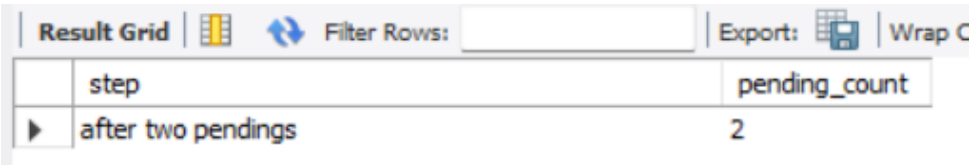


Figure 3.6: *Scenario B2: Two pending bookings successfully created*

Attempt third Pending (should fail) and verify list:

Listing 3.16: *Scenario B3 SQL: Attempt third pending booking*

```sql
INSERT INTO booking (Reservation_ID, Booking_Status, Member_ID)
VALUES (@book_res_3, 'Pending', @booking_member);
SELECT Reservation_ID, Booking_Status
FROM booking WHERE Member_ID = @booking_member ORDER BY Reservation_ID;
```

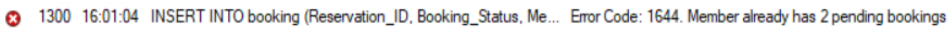


Figure 3.7: *Scenario B3: Third pending booking blocked*

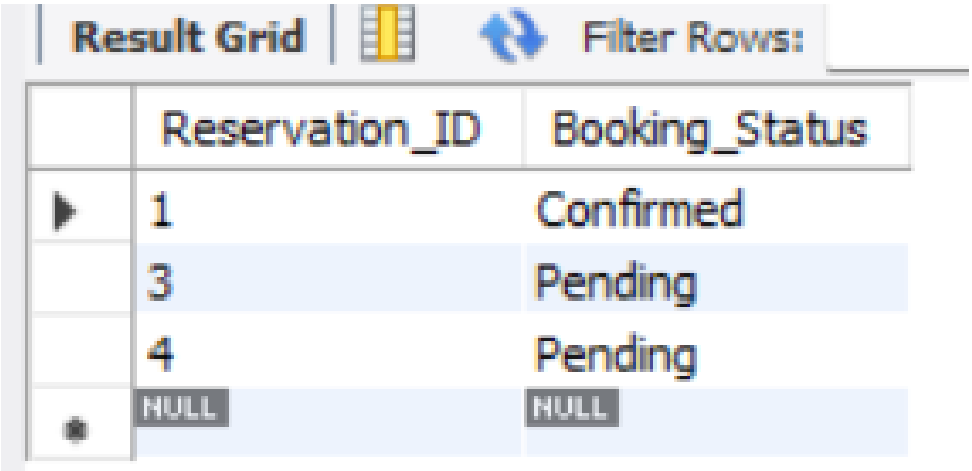


Figure 3.8: *Scenario B4: Verification of booking list*

3.2.4 Scenario C: Maintenance XOR Constraint

Rule: Maintenance must target either a facility *or* equipment (exclusive-or), never both and never neither. **Before:** No invalid maintenance row exists for the tested combinations.

Action: Attempt two invalid inserts (neither target / both targets), then insert one valid maintenance record. **After:** The invalid inserts are rejected with the trigger error (Scenario C1), while the valid insert succeeds and is queryable (Scenario C2).

Listing 3.17: *Scenario C SQL: Maintenance Insert Tests*

```
INSERT INTO maintenance (Scheduled_Date, Completion_Date, Status, Description,
  Equipment_ID, Facility_ID)
VALUES (DATE_ADD(CURDATE(), INTERVAL 4 DAY), NULL, 'Scheduled', 'Invalid: none',
  NULL, NULL); -- expect error

INSERT INTO maintenance (Scheduled_Date, Completion_Date, Status, Description,
  Equipment_ID, Facility_ID)
VALUES (DATE_ADD(CURDATE(), INTERVAL 4 DAY), NULL, 'Scheduled', 'Invalid: both', 2,
  4); -- expect error

INSERT INTO maintenance (Scheduled_Date, Completion_Date, Status, Description,
  Equipment_ID, Facility_ID)
VALUES (DATE_ADD(CURDATE(), INTERVAL 4 DAY), NULL, 'Scheduled', 'Valid facility
  maintenance', NULL, 4);
SELECT 'valid maintenance inserted' AS step, Maintenance_ID, Equipment_ID,
  Facility_ID, Scheduled_Date, Status
FROM maintenance ORDER BY Maintenance_ID DESC LIMIT 1;
```

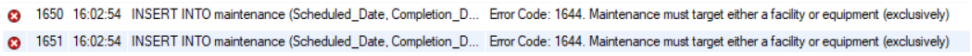


Figure 3.9: *Scenario C1: Invalid maintenance keys blocked*

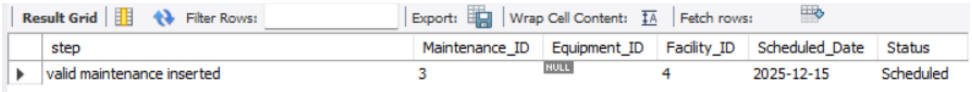


Figure 3.10: *Scenario C2: Valid maintenance entry inserted*

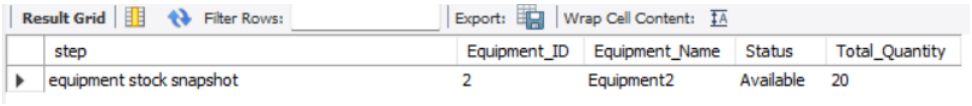
3.2.5 Scenario D: Equipment Availability

Rule: Reserved quantity cannot exceed available equipment stock (total quantity minus overlapping reservations and maintenance). **Before:** Equipment stock is recorded in `equipment.Total_Quantity` and is currently available (Scenario D1). **Action:** Assign a valid quantity to the first reservation (Scenario D2), then attempt to over-allocate for an overlapping reservation (Scenario D3). **After:** The over-allocation is rejected with `'Requested equipment exceeds available quantity'` (Scenario D3), preserving inventory correctness.

Listing 3.18: *Scenario D1 SQL: Setup and Stock Check*

```
SET @equip_date := DATE_ADD(CURDATE(), INTERVAL 2 DAY);
```

```sql
INSERT INTO reservation (Reservation_Date, Start_Time, End_Time, Facility_ID)
VALUES (@equip_date, '14:00:00', '15:00:00', 8);
SET @equip_res_1 := LAST_INSERT_ID();
INSERT INTO reservation (Reservation_Date, Start_Time, End_Time, Facility_ID)
VALUES (@equip_date, '14:30:00', '15:30:00', 5);
SET @equip_res_2 := LAST_INSERT_ID();
SELECT 'equipment stock snapshot' AS step, Equipment_ID, Equipment_Name, Status,
  Total_Quantity
FROM equipment WHERE Equipment_ID = 2;
```



Result Grid | Filter Rows: | Export: | Wrap Cell Content:

step	Equipment_ID	Equipment_Name	Status	Total_Quantity
equipment stock snapshot	2	Equipment2	Available	20

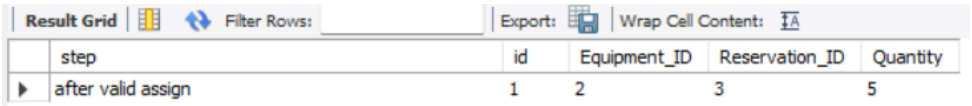
Figure 3.11: *Scenario D1: Equipment stock snapshot*

Valid assign, then over-allocate (should fail):

Listing 3.19: *Scenario D2 SQL: Assignment Tests*

```sql
INSERT INTO reservation_equipments (Quantity, Equipment_ID, Reservation_ID)
VALUES (5, 2, @equip_res_1);
SET @equip_row := LAST_INSERT_ID();
SELECT 'after valid assign' AS step, id, Equipment_ID, Reservation_ID, Quantity
FROM reservation_equipments WHERE id = @equip_row;

INSERT INTO reservation_equipments (Quantity, Equipment_ID, Reservation_ID)
VALUES (16, 2, @equip_res_2); -- expect error
```



Result Grid | Filter Rows: | Export: | Wrap Cell Content:

step	id	Equipment_ID	Reservation_ID	Quantity
after valid assign	1	2	3	5

Figure 3.12: *Scenario D2: Valid equipment assignment*

2011 16:05:05 INSERT INTO reservation_equipments (Quantity, Equipment_... Error Code: 1644. Requested equipment exceeds available quantity

Figure 3.13: *Scenario D3: Over-allocation blocked*

3.2.6 Scenario E: Session Enrollment Capacity

Rule: A training session cannot exceed its `Max_Capacity`. **Before:** A training session is created with `Max_Capacity = 1` (Scenario E1). **Action:** Insert the first enrollment (Scenario E2), then attempt a second enrollment. **After:** The second enrollment is rejected with `'Training session is full'` (Scenario E3), and the session enrollment count remains within capacity.

Listing 3.20: *Scenario E SQL: Session Capacity Tests*

```sql
SET @session_date := DATE_ADD(CURDATE(), INTERVAL 3 DAY);
INSERT INTO reservation (Reservation_Date, Start_Time, End_Time, Facility_ID)
VALUES (@session_date, '16:00:00', '17:00:00', 4);
SET @session_res_full := LAST_INSERT_ID();
INSERT INTO training_session (Reservation_ID, Max_Capacity, Coach_ID)
VALUES (@session_res_full, 1, 1);
SELECT 'session created' AS step, Reservation_ID, Max_Capacity, Coach_ID
FROM training_session WHERE Reservation_ID = @session_res_full;

INSERT INTO session_enrollment (Member_ID, Reservation_ID)
VALUES (1, @session_res_full);
SELECT 'after first enrollment' AS step, id, Member_ID, Reservation_ID
FROM session_enrollment WHERE Reservation_ID = @session_res_full;

INSERT INTO session_enrollment (Member_ID, Reservation_ID)
VALUES (2, @session_res_full); -- expect error
```

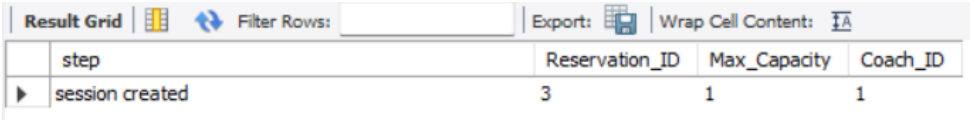


Figure 3.14: *Scenario E1: Session creation*

Figure 3.15: *Scenario E2: First enrollment successful*

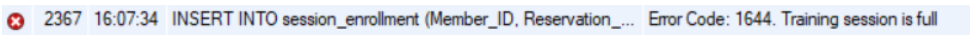


Figure 3.16: *Scenario E3: Second enrollment blocked due to capacity*

Task 4 Access Control

4.1 Objective and Alignment with the Implemented Schema

This task requires the implementation and verification of **two (2)** access control mechanisms, supported by clear evidence (screenshots) demonstrating users' ability (or inability) to *view, update, and delete* data. Our implementation is strictly aligned with the exported database schema in `sports\_arena.sql` and the role design previously proposed in the assignment.

In this system, booking-related data is modeled around the following tables (all names and attributes follow `sports\_arena.sql`):

- `reservation` stores the reservable time slot (`Reservation_Date`, `Start_Time`, `End_Time`) and the target facility (`Facility_ID`).
- `booking` is a specialization of `reservation` for members, where `Reservation_ID` is both the primary key and a foreign key to `reservation`, and `Booking_Status` captures lifecycle states (e.g., *Pending*, *Confirmed*, *Cancelled*).
- `training_session` is another specialization of `reservation`, linked to `coach` by `Coach_ID` and constrained by `Max_Capacity`.
- `session_enrollment` records member enrollments in training sessions (`Member_ID` + `Reservation_ID`).

Given the multi-role nature of the sports arena, access control must ensure: **(i)** confidentiality of member-related data, **(ii)** integrity of bookings and schedules, and **(iii)** least-privilege operations for each role. To achieve this, we implement **RBAC (Role-Based Access Control)** and **row-level access control (own-row/own-session)** in a defense-in-depth manner (database + Django application layer).

4.2 Mechanism 1: Role-Based Access Control (RBAC)

4.2.1 Role Model and Privilege Boundary

RBAC assigns permissions based on business responsibilities instead of individual identities. The system defines five operational roles consistent with the project implementation (Django `Group`) and the database security model: `dba_role`, `manager_role`, `booking_officer_role`, `coach_role`, and `member_role`.

To keep the evidence concise, the SQL verification screenshots in this task focus on two representative roles (`coach_role` and `member_role`). The remaining roles are included in the privilege boundary matrix to document the full intended least-privilege model.

Table 4.1 summarizes the key **DML** boundaries on the booking-related tables. The principle of *least privilege* is enforced by granting only the minimal operations required to complete legitimate tasks, while explicitly preventing destructive or cross-domain actions (e.g., coaches deleting members).

Role	booking	reservation	training_session	member
dba_role	S/I/U/D	S/I/U/D	S/I/U/D	S/I/U/D
manager_role	S/U	S/U	S	S
booking_officer_role	S/I/U	S/I/U	S	S
coach_role	—	—	S	—
member_role	— (via view)	— (via view)	—	—

Table 4.1: *RBAC privilege boundary (S=SELECT, I=INSERT, U=UPDATE, D=DELETE). Members are forced to access booking data through restricted views (Mechanism 2), rather than the base tables.*

4.2.2 SQL Enforcement via `GRANT` / `REVOKE`

At the DBMS layer, we enforce RBAC using MySQL authorization. The following snippet illustrates the core idea: coaches are permitted to read training sessions, while members are denied direct access to sensitive base tables such as `booking`. In our testing, we used dedicated database accounts to represent the `coach_role` and `member_role` sessions.

```
-- Example RBAC (simplified for demonstration; aligned to sports_arena.sql table
  names)
CREATE ROLE coach_role;
CREATE ROLE member_role;

-- Coach: can read training session information (e.g., capacity and schedule)
GRANT SELECT ON sports_arena.training_session TO coach_role;

-- Coach: must not manipulate core identity data (member table)
REVOKE DELETE ON sports_arena.member FROM coach_role;

-- Member: cannot directly access the base booking table
REVOKE SELECT ON sports_arena.booking FROM member_role;
```

4.2.3 Verification Evidence (SQL)

Figure 4.1 demonstrates an allowed operation: a coach account can successfully read rows from `training_session` (showing `Reservation_ID`, `Max_Capacity`, and `Coach_ID`). This supports day-to-day coaching tasks such as checking the sessions they are responsible for.

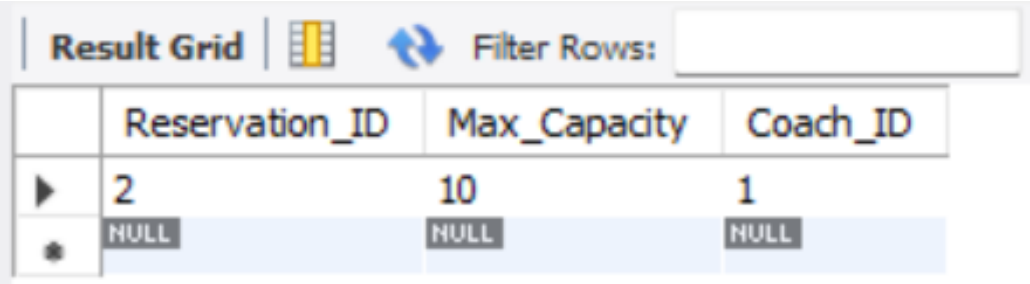


Figure 4.1: *RBAC verification (allowed): coach can* `SELECT` *from* `training_session`*.*

Figure 4.2 demonstrates a blocked operation: the same coach account is explicitly denied from deleting member records. MySQL returns `Error Code: 1142`, which confirms that high-risk actions on identity tables are not available to coaches.

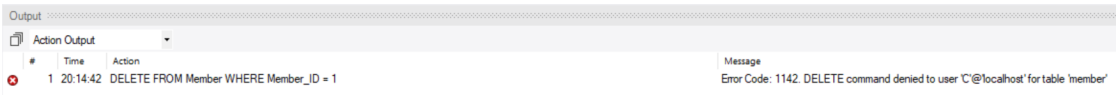


Figure 4.2: *RBAC verification (denied): coach cannot* `DELETE` *from* `member` *(*`Error Code: 1142`*).*

Similarly, Figure 4.3 shows that a member account is denied direct access to the `booking` base table. This is a critical control, because unrestricted reads on `booking` would expose other members' reservation activities.

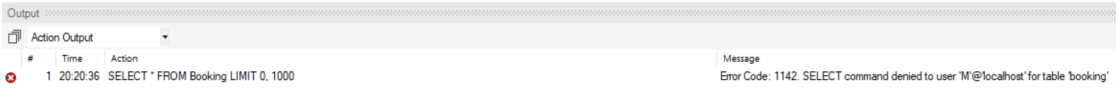


Figure 4.3: *RBAC verification (denied): member cannot* `SELECT` *from the* `booking` *base table (*`Error Code: 1142`*).*

4.2.4 Django Mapping and User Experience

At the application layer, the same RBAC model is mapped to Django `Group` memberships. Views are protected by role checks (e.g., only booking officers/managers can manage all bookings; members can only access member-facing booking pages). This avoids the common pitfall of "front-end hiding only" by ensuring authorization is enforced server-side.

Figure 4.4 shows a privileged operational view where an administrative role can list and manage bookings across multiple members (the *Member* column is visible and the *Manage* action is available). In contrast, members do not receive this interface and cannot access it directly (see the 403 evidence in Mechanism 2).

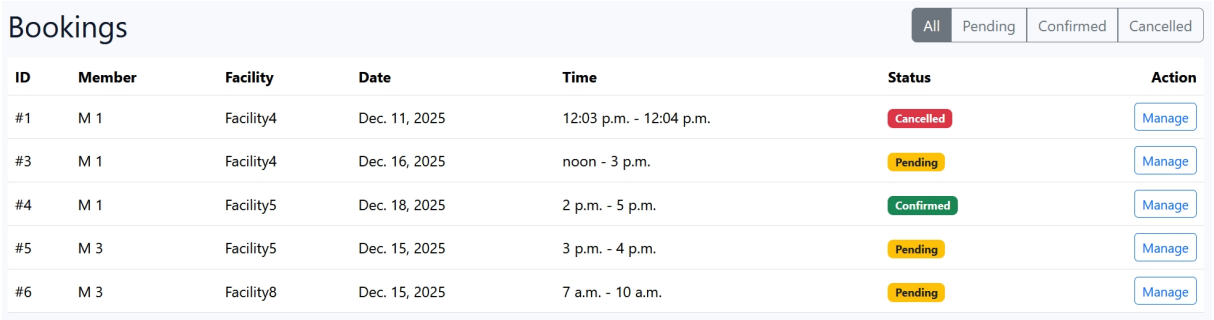


Figure 4.4: *Django RBAC evidence: an administrative role can view bookings across members and access management actions.*

4.3 Mechanism 2: Row-Level Access Control (Own-Row / Own-Session)

4.3.1 Rationale

RBAC alone is not sufficient when users with the same role should not access each other's records. For example, all members share the `member_role`, yet each member must be restricted to *their own* bookings. Therefore, we implement row-level access control to enforce **data ownership** and **minimal exposure** within the same role.

We enforce row-level control through two complementary techniques:

- **Database layer (view-based filtering):** revoke access to sensitive base tables and grant access only through a restricted view.
- **Application layer (queryset filtering + 403 blocking):** Django filters records by the authenticated user, and blocks any unauthorized access attempts with a 403 response.

4.3.2 SQL View for Member Booking Data

To ensure members cannot bypass row-level filtering, we expose a restricted view that returns only the booking information the member is allowed to see. The view joins `booking`, `reservation`, and `facility` to provide a user-friendly result consistent with the system UI (date and facility name are not stored in `booking` directly).

```
1 -- View-based row-level access control (aligned to sports_arena.sql)
2 -- The WHERE clause represents "current member only" logic.
3 CREATE OR REPLACE VIEW v_member_booking_detail AS
4 SELECT
5   b.Reservation_ID,
6   b.Booking_Status,
7   b.Member_ID,
```

```
  r.Reservation_Date,
  f.Facility_Name
FROM booking b
JOIN reservation r ON r.Reservation_ID = b.Reservation_ID
JOIN facility f ON f.Facility_ID = r.Facility_ID
WHERE b.Member_ID = 1;  -- demo: current member (e.g., Member_ID=1)

GRANT SELECT ON v_member_booking_detail TO member_role;
```

Figure 4.5 confirms that, after revoking base-table access (Figure 4.3), the member can still retrieve necessary booking details through the view, without exposing other members' data.

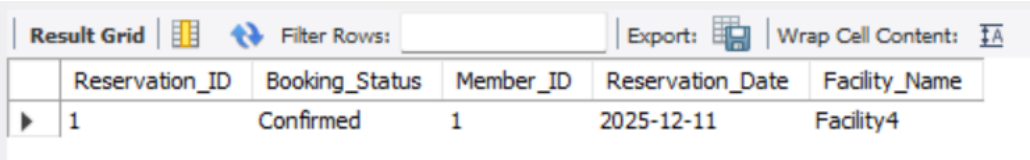


Figure 4.5: *Row-level control (allowed via view): member queries the restricted booking view and receives only permitted rows.*

4.3.3 Django Row-Level Filtering and Update Boundaries

In the Django application, row-level access control is enforced by filtering the booking list by the logged-in member. Practically, this means:

- A member sees only bookings where `booking.Member_ID` matches the member profile linked to `request.user` (via `member.user_id` in the schema).
- Members are allowed to perform **safe updates** on their own records, such as cancelling their own bookings (implemented as updating `Booking_Status` to *Cancelled* rather than issuing destructive deletes).
- Any attempt to access another role's page or another member's record is blocked server-side and returns HTTP 403.

Figure 4.6 shows that **Member 1** can view their own bookings and is provided with the *Cancel* action for eligible items, which demonstrates controlled **UPDATE** capability within an ownership boundary.

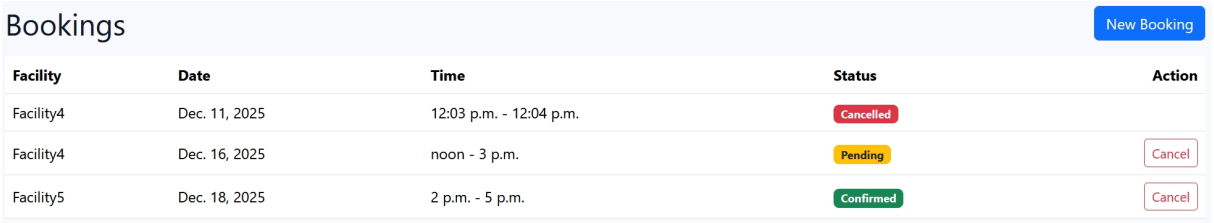


Figure 4.6: *Row-level control (member view): Member 1 can see only their own booking records and perform a bounded update (Cancel).*

Figure 4.7 demonstrates the isolation effect: **Member 2** does not see Member 1's bookings; the page correctly returns "No bookings found." This is direct evidence that record visibility is constrained by user identity rather than by UI convention.

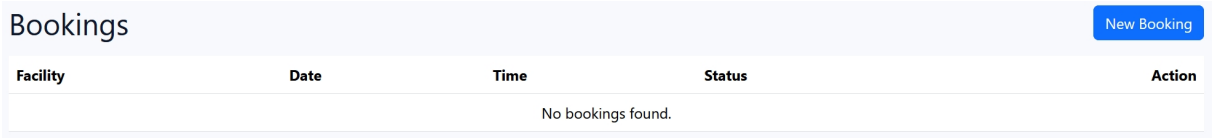


Figure 4.7: *Row-level control (member isolation): Member 2 cannot see Member 1's booking records; the list is empty for unrelated data.*

Finally, Figure 4.8 shows the system behavior when a user attempts to access a resource outside their authorized role boundary: the request is rejected with a clear 403 page. This verifies that authorization is enforced by the server (not merely by hiding buttons), and that the system provides a secure and user-friendly failure mode.

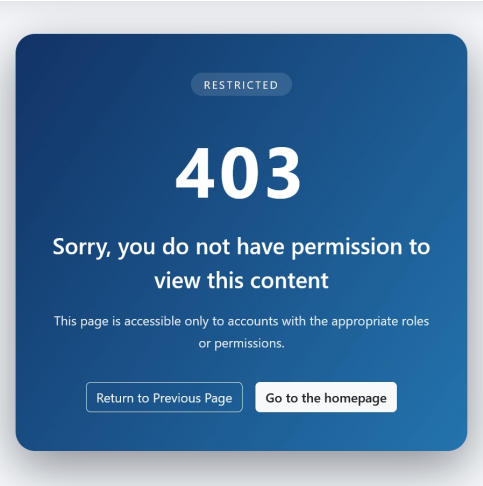


Figure 4.8: *Authorization enforcement: unauthorized access is blocked with HTTP 403 and a dedicated error page.*

4.4 Summary

This task implements and validates two complementary access control mechanisms:

- **RBAC:** separates privileges across operational roles and prevents unauthorized DML actions (e.g., coach cannot delete members; member cannot directly read the booking base table).
- **Row-level access control:** restricts users to "own data" via view-based filtering (DB) and queryset constraints (Django), and blocks unauthorized access with HTTP 403.

Together, these controls enforce least privilege, prevent data leakage, and protect the integrity of bookings and schedules in a practical, verifiable manner.

APPENDIX 1

MARKING RUBRICS

Component Title	Lab Report (Grouping)				Percentage (%)	24%	
Criteria	Score and Descriptors					Weight	Marks
	Excellent (9.0 – 10.0)	**Good (7.0 – 8.5)**	**Average (5.0 – 6.5)**	**Need Improvement (3.0 – 4.5)**	**Poor (0 – 2.5)**		
Task 1: Database Integrity (20 Marks)	All CREATE TABLE commands are accurate; all integrity constraints correctly applied. Screenshots complete, clear, and well-organized. Explanations are thorough and show strong understanding.	Most tables and constraints are correctly implemented; minor errors. Screenshots provided and generally clear. Explanations show good understanding but lack depth.	Some tables correctly created; constraints may be incomplete or partially wrong. Screenshots provided. Explanations are basic.	Many constraints incorrect or missing. Screenshots unclear or incomplete. Explanations lack clarity and accuracy.	Incomplete or inaccurate SQL statements. Little or no screenshots. Weak or missing explanations.	20	
Task 2: SQL Implementation (30 Marks)	• All remaining CREATE TABLE commands are fully correct and clearly shown with screenshots. • All tables populated with 6–10 valid rows each. • All SQL categories include 3 correct queries each,	• CREATE TABLE commands mostly correct with minor errors. • Tables filled properly with 6–10 rows each. • Most SQL categories include 3 correct queries (some minor mistakes allowed).	• Some CREATE TABLE commands incomplete or inaccurate. • Tables partially populated (some missing rows or incorrect data). • SQL categories include fewer than 3 correct queries or have notable	• CREATE TABLE commands contain multiple mistakes or missing screenshots. • Many tables not properly populated. • Several SQL categories missing or	• Missing or incorrect CREATE TABLE commands. • Very little or no data inserted. SQL queries missing, incorrect, or not executed. • Screenshots mostly missing.	30	

	executed without errors. • Screenshots of queries and outputs are complete, clear, and well-organized. • Demonstrates excellent understanding of SQL, filtering, joins, arithmetic expressions, and formatting.	• Screenshots are provided but may lack full clarity or formatting. • Shows good understanding but misses depth in a few areas.	syntax/output issues. • Screenshots provided but not consistent or clear. • Understanding is present but basic.	incorrectly executed. • Screenshots unclear, incomplete, or missing outputs. • Limited understanding of SQL syntax and application.	• Shows minimal or no understanding of SQL concepts.		
Task 3: Triggering (15 Marks)	Both triggers fully correct and functional. BEFORE/AFTER results clearly demonstrated with proper screenshots. No syntax errors.	Two triggers implemented with minor mistakes. Evidence provided for BEFORE/AFTER. Screenshots mostly clear.	One trigger corrects, the second partially implemented. Limited or basic BEFORE/AFTER evidence.	Triggers contain multiple errors; screenshots unclear or incomplete. Limited understanding shown.	Triggers missing, non-functional, or incorrect. No valid evidence provided.	**15**	
Task 4: Access Control (15 Marks)	Two access control mechanisms implemented correctly. Permissions tested and verified with clear screenshots. Demonstrates strong security understanding.	Both mechanisms implemented with minor issues. Screenshots provided and mostly clear. Verification mostly correct	One mechanism corrects, the other partially correct. Screenshots basic or incomplete.	Incorrect or incomplete access control commands. Screenshots unclear or missing verification	Access control incorrectly implemented or not attempted. No valid evidence.	**15**	
					TOTAL MARKS (/80)		