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EXP-11

- **<u>AIM:</u>** To demonstrate how **row-level locking and transactions** can prevent duplicate enrollments and preserve **data consistency** when multiple users attempt concurrent operations on the same student record.
- **<u>THEORY:</u>**

- Transactions in DBMS: Transactions ensure a sequence of operations executes as a single unit, maintaining Atomicity, Consistency, Isolation, and Durability (ACID).
- Concurrency Problems: Without proper locking, two users could insert or update the same student record simultaneously, causing duplicate enrolments or inconsistent data.
- Unique Constraints:Define (student_name, course_id) as UNIQUE to prevent duplicate enrollments.
- Row-Level Locking with SELECT FOR UPDATE:Locks specific rows during a transaction, blocking other users from updating the same rows until the transaction is committed or rolled back.
- Prevents race conditions in concurrent environments.
- Locking Preserves Consistency:Ensures no duplicate enrollments occur.
- Conflicting operations are serialized automatically.

- **<u>CODES:</u>**

- Part A: Prevent Duplicate Enrollments Using Unique Constraint
-
    - -- Drop table if exists

```
DROP TABLE IF EXISTS StudentEnrollments;

-- Create table with unique constraint
CREATE TABLE StudentEnrollments (
    enrollment_id INT PRIMARY KEY,
    student_name VARCHAR(100) NOT NULL,
    course_id VARCHAR(10) NOT NULL,
    enrollment_date DATE NOT NULL,
    UNIQUE(student_name, course_id)
);

-- Begin transaction to insert multiple records
START TRANSACTION;

INSERT INTO StudentEnrollments (enrollment_id,
student_name, course_id, enrollment_date)
VALUES
(1, 'Ashish', 'CSE101', '2024-07-01'),
(2, 'Smaran', 'CSE102', '2024-07-01'),
(3, 'Vaibhav', 'CSE101', '2024-07-01');
```

```
COMMIT;


-- Verify inserted records

SELECT * FROM StudentEnrollments;
```

Part B: Use SELECT FOR UPDATE to Lock a Student Record

```
-- User A locks a row for Ashish in CSE101

START TRANSACTION;


SELECT * FROM StudentEnrollments

WHERE student_name = 'Ashish' AND course_id =
'CSE101'

FOR UPDATE;


-- At this point, User A keeps transaction open

-- User B attempts to update the same row:

-- UPDATE StudentEnrollments SET enrollment_date =
'2024-08-01'

-- WHERE student_name = 'Ashish' AND course_id =
'CSE101';
```

-- User B will be blocked until User A commits or rolls back

-- User A then commits

COMMIT;

-- After commit, User B can proceed

- Part C: Demonstrate Locking Preserving Consistency

-- Simulate concurrent updates

-- User A starts transaction

START TRANSACTION;

SELECT * FROM StudentEnrollments

WHERE student_name = 'Ashish' AND course_id = 'CSE101'

FOR UPDATE;

-- User A updates enrollment_date

UPDATE StudentEnrollments

SET enrollment_date = '2024-07-15'

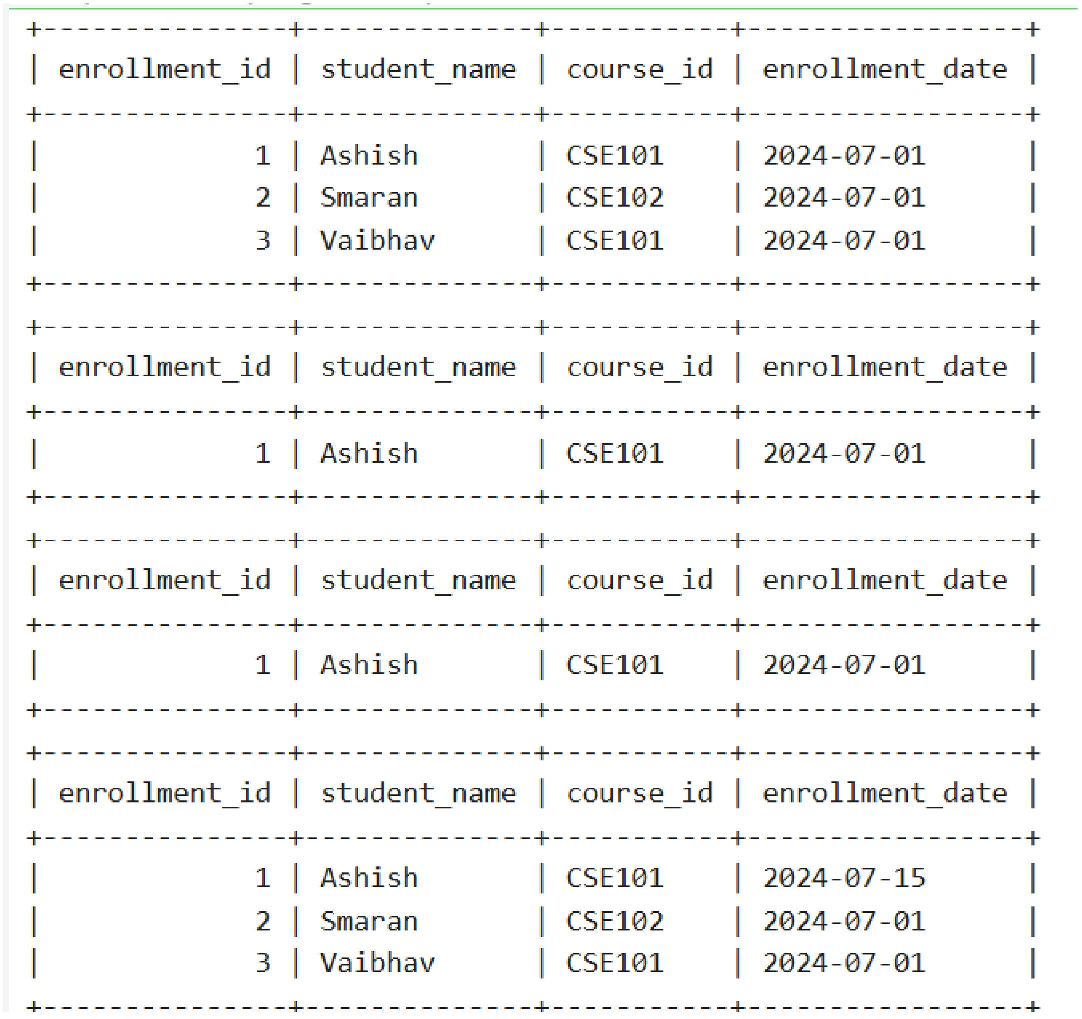
WHERE student_name = 'Ashish' AND course_id = 'CSE101';

-- User B (simulated concurrently) tries to update same row

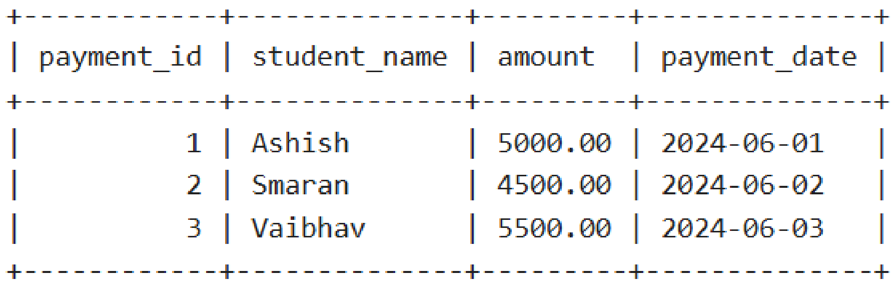
-- UPDATE StudentEnrollments SET enrollment_date = '2024-08-01'

```
-- WHERE student_name = 'Ashish' AND course_id =
'CSE101';
-- This will be blocked until User A commits


-- User A commits
COMMIT;


-- Verify final state
SELECT * FROM StudentEnrollments;
```

OUTPUTS:



```
+---------------+--------------+-----------+-----------------+
| enrollment_id | student_name | course_id | enrollment_date |
+---------------+--------------+-----------+-----------------+
|             1 | Ashish       | CSE101    | 2024-07-01      |
|             2 | Smaran       | CSE102    | 2024-07-01      |
|             3 | Vaibhav      | CSE101    | 2024-07-01      |
+---------------+--------------+-----------+-----------------+
+---------------+--------------+-----------+-----------------+
| enrollment_id | student_name | course_id | enrollment_date |
+---------------+--------------+-----------+-----------------+
|             1 | Ashish       | CSE101    | 2024-07-01      |
+---------------+--------------+-----------+-----------------+
+---------------+--------------+-----------+-----------------+
| enrollment_id | student_name | course_id | enrollment_date |
+---------------+--------------+-----------+-----------------+
|             1 | Ashish       | CSE101    | 2024-07-01      |
+---------------+--------------+-----------+-----------------+
+---------------+--------------+-----------+-----------------+
| enrollment_id | student_name | course_id | enrollment_date |
+---------------+--------------+-----------+-----------------+
|             1 | Ashish       | CSE101    | 2024-07-15      |
|             2 | Smaran       | CSE102    | 2024-07-01      |
|             3 | Vaibhav      | CSE101    | 2024-07-01      |
+---------------+--------------+-----------+-----------------+
```



```
+------------+--------------+---------+--------------+
| payment_id | student_name | amount  | payment_date |
+------------+--------------+---------+--------------+
|          1 | Ashish       | 5000.00 | 2024-06-01   |
|          2 | Smaran       | 4500.00 | 2024-06-02   |
|          3 | Vaibhav      | 5500.00 | 2024-06-03   |
+------------+--------------+---------+--------------+
```

➢ <u>**LEARNING OUTCOMES:**</u>

1. Learned to enforce unique constraints to prevent duplicate student enrollments.
2. Understood row-level locking using SELECT FOR UPDATE to handle concurrent transactions.
3. Observed how transactions preserve Atomicity and Consistency in a multi-user environment.

4. Practiced handling blocked transactions and understanding isolation effects.
5. Gained hands-on experience with ACID principles in a practical enrollment scenario.