Dhirubhai Ambani Institute of Information and Communication Technology

IT214 – Database Management System

Database to manage online competitive Coding Platform

Lab Group - 5 : Team - 2 (G5-T2)

Group Members :-

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This Submission contains the ER Diagram, Relational Schema and the BCNF Normalization Proofs along with the minimal FD set

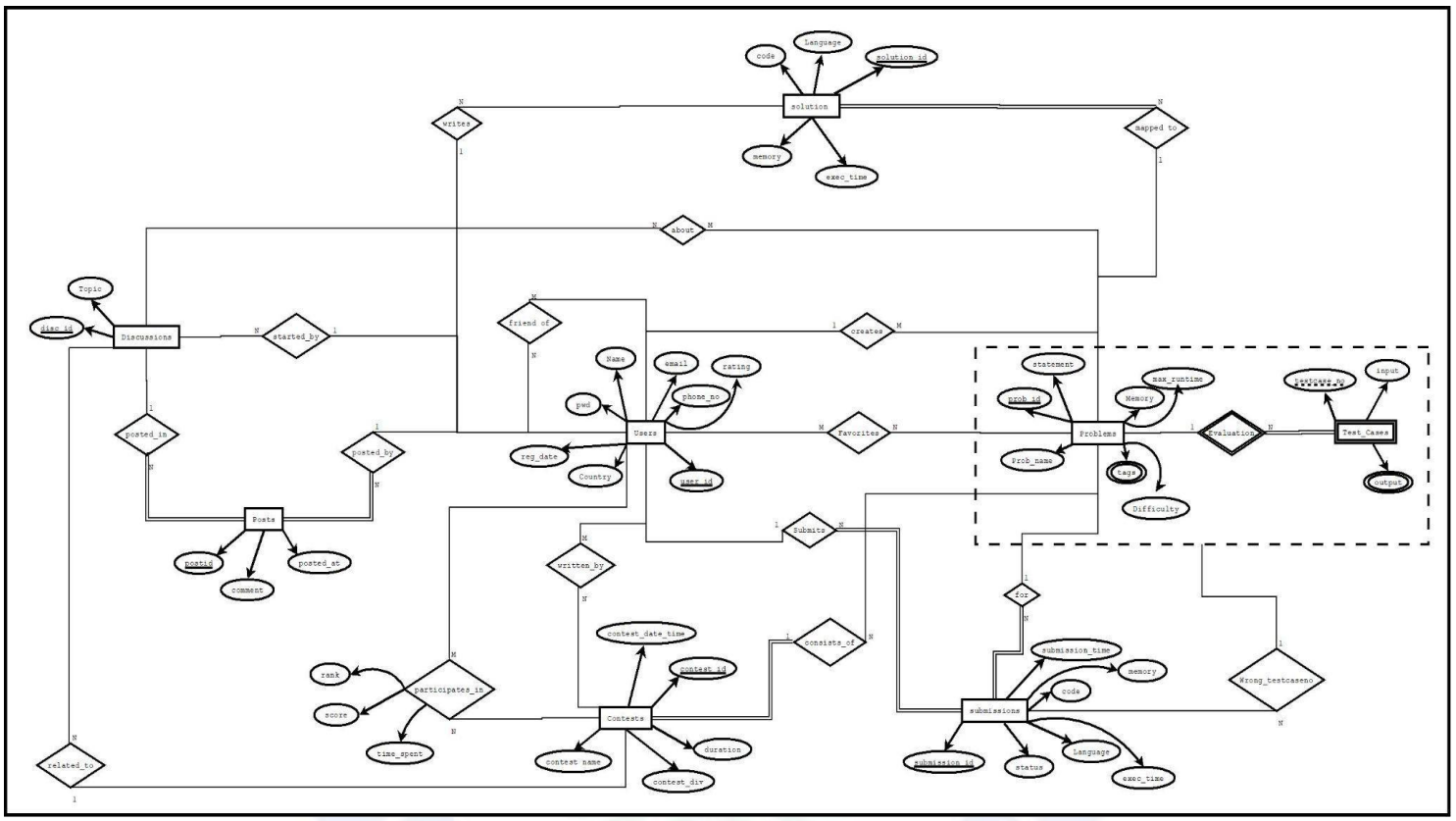
Special Note : Our project only deals with the data storing and retrieval aspects (database management) of the online coding platform, i.e., the area concerned with our course. However, we have not looked into the running and evaluation of codes, since it is outside the scope of DBMS.

We are considering that our project requires and depends on an external compiler/IDE to compile codes, run them, compare them and evaluate them, in order to make it an actual complete competitive coding platform.

Our project is treating all these aspects (program codes and others) as simple data provided by the compiler software.

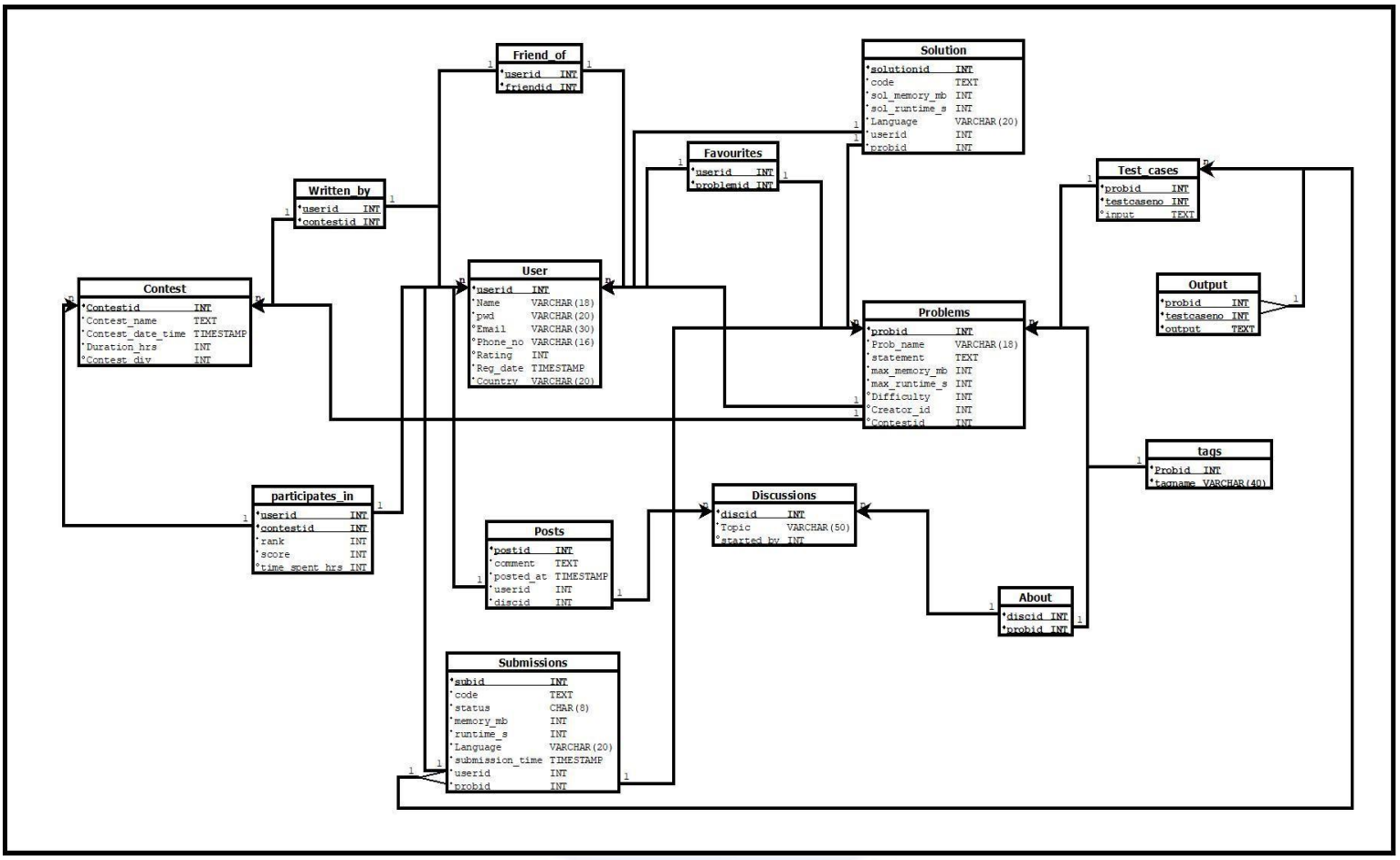
Nevertheless, we can assure that we have dealt with the portion concerning DBMS (our course) to the best of our knowledge and hard work to get as close as we can to an actual platform.

(1) Entity Relationship - ER Diagram



Attached is the google photos link to view the entire image of the ER diagram clearly, as it was difficult to fit the large diagram here in portrait : [ER Image]

(2) Relational Schema



➢ **<u>Remark</u> :** We have made a few considerable changes to our ER Diagram and Relational Schema since the initial submission. We are hereby submitting the final versions.

(3) Minimal FD Set

userid -> Name
userid -> email
userid -> phone_no
userid -> rating
userid -> pwd
userid -> reg_date
userid -> country
probid -> statement
probid -> max_memory_mb
probid -> max_runtime_s
probid -> difficulty
probid -> prob_name
probid ->creator_id
probid -> contestid
{probid, testcaseno} -> input
discid -> topic
postid ->comment
postid -> posted_at
postid -> userid
postid -> discid
contestid -> contest_name
constestid -> duration_hrs
constestid -> contest_ div
contestid -> contest_date_time
{userid , contestid } -> rank
{userid , contestid } -> score
{userid , contestid } -> time_spent_hrs
subid -> submission_time

subid -> code
subid -> memory_s
subid -> status
subid -> language
subid -> runtime_s
subid -> userid
subid ->probid
subid -> wrong_testcaseno
solutionid -> language
solutionid -> code
solutionid -> sol_memory_mb
solutionid -> sol_runtime_s
solutionid -> userid
solutionid -> probid

(4) Proof that relations are in BCNF

1. 'Users' relation :

- Attributes :

Users {Userid, Name, email, phone_no, rating, pwd, reg_date, country}

- Functional dependencies :

userid -> Name
userid -> email
userid -> phone_no
userid -> rating
userid -> pwd
userid -> reg_date
userid -> country

Let X = User_id
X^+ = {userid, Name, email, phone_no, rating, pwd, reg_date, country}
Thus, **Primary key = userid**

We can see that the left side of all the FDs in the minimal set of FDs for the relation 'Users' is userid, which is the primary key of this relation, so "Users" **is in BCNF.**

2. 'Friend_of' relation:

- Attributes:

  Friend_of {userid, friendid}

- The only functional dependency existing here is the trivial one:

  {userid, friendid} -> {userid, friendid}

  Thus, the entire set of attributes, i.e, **{userid, friendid}** is the primary key and the relation complies with BCNF as it is not violating any of its rules.
  We can see that the left side of the only FD in the minimal FD set for this relation is equivalent to the Primary Key itself, so "Friend_of" **is in BCNF.**

3. ‘Problems’ relation :

- Attributes :

Problems {probid, statement, memory, max_runtime, difficulty, prob_name, tags,creator_id,contestid}

- Functional dependencies :

probid -> prob_name
probid -> statement
probid -> max_memory_mb
probid -> max_runtime_s
probid -> difficulty
probid -> tags
probid -> creator_id
probid -> contestid

Let X = probid
X^+ = {probid, statement,max_ memory_mb, max_runtime_s, difficulty, prob_name, tags, creator_id, contestid}
Thus, **Primary key = probid**

We can see that the left side of all the FDs in the minimal set of FDs for the relation ‘Problems’ is probid , which is the primary key of this relation, so “Problems” **is in BCNF.**

4. ‘Tags’ Relation:

- Attributes:

  Friend_of {probid, tagname}

- The only functional dependency existing here is the trivial one:

  {probid, tagname} -> {probid, tagname}

  Thus, the entire set of attributes, i.e, **{probid, tagname}** is the primary key and the relation complies with BCNF as it is not violating any of its rules.

  We can see that the left side of the only FD in the minimal FD set for this relation is equivalent to the Primary Key itself, so “Tags” **is in BCNF.**

5. ‘Favorites’ Relation:

- Attributes:

  Friend_of {userid, probid}

- The only functional dependency existing here is the trivial one:

  {userid, probid} -> {userid, probid}

  Thus, the entire set of attributes, i.e, **{userid, probid}** is the primary key and the relation complies with BCNF as it is not violating any of its rules.
  We can see that the left side of the only FD in the minimal FD set for this relation is equivalent to the Primary Key itself, so “Favorites” **is in BCNF.**

6. ‘Test_cases’ relation :

- Attributes :

Test_cases {probid, testcaseno, input}

- Functional dependencies :

  {probid, testcaseno} -> input

Let X = {probid, testcaseno}
X^+ = {probid, testcaseno, input}
Thus, **Primary key = {probid, testcaseno}**

We can see that the left side of all the FDs in the minimal set of FDs for the relation ‘Test_cases’ is {probid, testcaseno} , which is the primary key of this relation, so “Test_cases” **is in BCNF.**

7. ‘Output’ Relation:

- Attributes:

  Friend_of { probid, testcaseno, output}
- The only functional dependency existing here is the trivial one:

  {probid, testcaseno, output} -> {probid, testcaseno, output}

  Thus, the entire set of attributes, i.e, **{probid, testcaseno, output}** is the primary key and the relation complies with BCNF as it is not violating any of its rules.
  We can see that the left side of the only FD in the minimal FD set for this relation is equivalent to the Primary Key itself, so “Output” **is in BCNF.**

8. ‘Discussions’ relation :

- Attributes :

Discussions {discid, topic}

- Functional dependencies :

  discid -> topic

Let X = discid
X^+ = {discid, topic}
Thus, **Primary key = discid**

We can see that the left side of all the FDs in the minimal set of FDs for the relation Discussions is discid , which is the primary key of this relation, so “Discussions” **is in BCNF.**

9. ‘About’ Relation:

- Attributes:

  Friend_of { discid,probid}

- The only functional dependency existing here is the trivial one:

  {discid,probid} -> {discid,probid}

  Thus, the entire set of attributes, i.e, **{discid, probid}** is the primary key and the relation complies with BCNF as it is not violating any of its rules.

  We can see that the left side of the only FD in the minimal FD set for this relation is equivalent to the Primary Key itself, so “About” **is in BCNF.**

10. ‘Posts’ Relation:

- Attributes :

Posts {postid, comment, posted_at, userid, discid}

- Functional dependencies :

  postid -> comment
  postid -> posted_at
  postid -> userid
  postid -> discid

Let X = postid
X^+ = {postid, comment, posted_at, userid, discid}
Thus, **Primary key = postid**

We can see that the left side of all the FDs in the minimal set of FDs for the relation ‘Posts’ is postid , which is the primary key of this relation, so “Posts” **is in BCNF.**

11. ‘Contests’ relation :

- Attributes :

Contests {contestid, contest_name, contest_div, duration, contest_date_time}

- Functional dependencies :

contestid -> contest_name
contestid -> contest_div
contestid -> duration_hrs
contestid -> contest_date_time

Let X = contestid
X^+ = {contest_name, contest_div, duration_hrs, contest_date_time}
Thus, **Primary key = contestid**

We can see that the left side of all the FDs in the minimal set of FDs for the relation ‘Contests’ is contestid , which is the primary key of this relation, so “Contests” **is in BCNF.**

12. ‘Participates_in’ relation :

- Attributes :

Participates_in {userid, contestid, rank, score, time_spent_hrs}

- Functional dependencies :

{userid, contestid} -> rank
{userid, contestid} -> score
{userid, contestid} -> time_spent_hrs

Let X = {userid, contestid}
X^+ = {userid, contest_id, rank, score, time_spent_hrs}
Thus, **Primary key = {userid, contestid}**

The left side of all the FDs in the minimal set of FDs for the relation ‘Participates_in’ is {userid, contestid}, which is the primary key of this relation, so **“**Participates_in**” is in BCNF.**

13. ‘Written_by’ Relation:

- Attributes:

  Friend_of { userid,contestid}

- The only functional dependency existing here is the trivial one:

  {userid,contestid} -> {userid, contestid}

  Thus, the entire set of attributes, i.e, **{userid, contestid}** is the primary key and the relation complies with BCNF as it is not violating any of its rules.

  We can see that the left side of the only FD in the minimal FD set for this relation is equivalent to the Primary Key itself, so “Written_by” **is in BCNF.**

14. ‘Submissions’ relation :

- Attributes :
  Submissions {subid, code, memory_mb, submission_time, status, language, runtime_s,wrong_testcaseno, userid, probid}
- Functional dependencies :

  subid -> submission_time
  subid -> code
  subid -> memory_mb
  subid -> status
  subid ->language
  subid -> runtime_s
  subid -> userid
  subid -> probid
  subid -> wrong_testcaseno

Let X = subid

X^+ = {subid, code, memory_mb, submission_time, status, language, runtime_s, wrong_testcaseno ,userid, probid}

Thus, **Primary key = subid**

We can see that the left side of all the FDs in the minimal set of FDs for the relation ‘Submissions’ is **subid** , which is the primary key of this relation, so “Submissions” **is in BCNF.**

15. ‘Solution’ relation :

- Attributes :
  Solutions {solutionid, code, language, sol_memory_mb, sol_runtime_s , userid, probid}

- Functional dependencies :

  solutionid -> language
  solutionid -> code
  solutionid -> sol_memory_mb
  solutionid -> sol_runtime_s
  solutionid -> userid
  solutionid -> probid

Let X = solutionid
X^+ = {solutionid, code, language, sol_memory_mb, sol_runtime_s , userid, probid}
Thus, **Primary key = solutionid**

The left side of all the FDs in the minimal set of FDs for the relation ‘Solutions’ is **solutionid**, which is the primary key of this relation, so **“**Solutions**” is in BCNF.**

➔ We have added the screenshots of outputs for initial few queries here in the report file to display their functioning and efficiency.
The accompanied text file contains the entire list of query statements.

- **List of Queries for the Coding Platform database : -**

1. List and details of all platform users in descending order of rating:

SELECT userid, name, rating, email, phone_no, reg_date, country FROM users ORDER BY rating DESC;

Output :

Data Output | Messages | Notifications

Showing rows: 1 to 12 | Page No: 1

	userid [PK] integer	name character varying (18)	rating integer	email character varying (30)	phone_no character varying (16)	reg_date timestamp without time zone	country character varying (20)
1	4	Diana	1600	diana@example.com	4567890123	2023-07-12 00:00:00	USA
2	12	Lalit	1600	lalit@sample.in	9567801234	2025-03-01 00:00:00	India
3	7	Gautam	1550	gautam@sample.in	9012345678	2024-08-09 00:00:00	India
4	10	Jai	1500	jai@sample.in	9345678012	2025-02-14 00:00:00	India
5	1	Alice	1500	alice@example.com	1234567890	2024-12-08 00:00:00	USA
6	11	Kiran	1450	kiran@sample.com	9456780123	2023-11-03 00:00:00	USA
7	6	Fiona	1400	fiona@example.com	6789012345	2024-10-31 00:00:00	Germany
8	9	Isha	1350	isha@sample.in	9234567801	2024-12-25 00:00:00	India
9	2	Bob	1300	bob@example.com	2345678901	2024-11-15 00:00:00	Canada
10	8	Harsha	1250	harsha@sample.in	9123456780	2024-09-30 00:00:00	India
11	3	Charlie	1200	charlie@example.com	3456789012	2025-01-05 00:00:00	UK
12	5	Evan	1100	evan@example.com	5678901234	2024-03-20 00:00:00	Australia

2. List of winners (participants with rank-1) for all contests:

SELECT c.contest_name, c.contest_div AS division, u.name AS winner_name, u.email, pi.score, pi.time_spent_hrs FROM contests c JOIN participates_in pi ON c.contestid = pi.contestid JOIN users u ON pi.userid = u.userid WHERE pi.rank = 1
ORDER BY c.contest_date_time DESC;

Output :

Data Output | Messages | Notifications

Showing r

	contest_name text	division integer	winner_name character varying (18)	email character varying (30)	score integer	time_spent_hrs integer
1	New Year Sprint	1	Alice	alice@example.com	99	2
2	Winter Bash	3	Harsha	harsha@sample.in	92	2
3	Summer Showd...	4	Jai	jai@sample.in	90	2
4	Tech Fiesta	2	Diana	diana@example.com	93	2
5	Autumn Cup	2	Evan	evan@example.com	88	1
6	Spring Challenge	1	Alice	alice@example.com	100	2

3. **LEADERBOARD DISPLAY for any given contest (say contestid = 1):**
   SELECT u.userid, u.name, u.rating, pi.rank, pi.score, pi.time_spent_hrs, c.contest_name FROM users u JOIN participates_in pi ON u.userid = pi.userid JOIN contests c ON pi.contestid = c.contestid WHERE pi.contestid = 1 ORDER BY pi.rank ASC;

Output :

Data Output | Messages | Notifications

	userid integer	name character varying (18)	rating integer	rank integer	score integer	time_spent_hrs integer	contest_name text
1	1	Alice	1500	1	100	2	Spring Challenge
2	2	Bob	1300	2	95	2	Spring Challenge
3	3	Charlie	1200	3	90	2	Spring Challenge
4	4	Diana	1600	4	85	2	Spring Challenge
5	7	Gautam	1550	5	80	2	Spring Challenge
6	8	Harsha	1250	6	75	2	Spring Challenge
7	9	Isha	1350	7	70	2	Spring Challenge
8	10	Jai	1500	8	65	2	Spring Challenge
9	11	Kiran	1450	9	60	2	Spring Challenge
10	12	Lalit	1600	10	55	2	Spring Challenge

4. **List of all problems with their status of submissions:**
   SELECT p.probid, p.prob_name, s.subid, s.status, s.wrong_testcaseno AS rejected_testcase, u.name AS submitter_name, s.submission_time FROM problems p LEFT JOIN submissions s ON p.probid = s.probid LEFT JOIN users u ON s.userid = u.userid ORDER BY p.probid ASC, s.subid ASC;

Data Output | Messages | Notifications

Showing rows: 1 to 21 | Page N

	probid integer	prob_name character varying (50)	subid integer	status character varying (20)	rejected_testcase integer	submitter_name character varying (18)	submission_time timestamp without time zone
1	101	Sum of Two Numbers	401	Accepted	[null]	Alice	2025-02-03 18:30:52
2	101	Sum of Two Numbers	407	Accepted	[null]	Gautam	2025-04-09 12:05:50
3	102	Reverse a String	402	Wrong_Answer	2	Bob	2024-12-28 09:15:30
4	102	Reverse a String	408	Accepted	[null]	Harsha	2025-01-10 13:15:25
5	102	Reverse a String	411	Compile_Error	[null]	Bob	2025-01-13 11:40:32
6	102	Reverse a String	412	Compile_Error	[null]	Bob	2025-01-14 00:15:30
7	103	Find Graph Path	403	TLE	[null]	Charlie	2025-04-05 10:20:00
8	103	Find Graph Path	404	Wrong_Answer	1	Diana	2025-04-06 14:05:15
9	103	Find Graph Path	409	Wrong_Answer	1	Isha	2025-04-11 08:55:10
10	103	Find Graph Path	413	Accepted	[null]	Kiran	2025-04-15 12:25:50
11	104	Sort an Array	405	Accepted	[null]	Evan	2025-02-12 16:10:45
12	104	Sort an Array	410	Accepted	[null]	Jai	2025-04-12 09:45:00

5. **Average Rating of users per country;**
   SELECT country, AVG(rating) AS avg_rating, COUNT(*) AS total_users FROM users GROUP BY country;

Data Output | Messages | Notifications

	country character varying (20)	avg_rating numeric	total_users bigint
1	Australia	1100.0000000000000000	1
2	UK	1200.0000000000000000	1
3	USA	1516.6666666666666667	3
4	Germany	1400.0000000000000000	1
5	Canada	1300.0000000000000000	1
6	India	1450.0000000000000000	5

END

➢ We are extremely grateful to our professor - PM Jat Sir for giving us the opportunity to work on such an enriching project and also making us equipped with the requisite set of skills and knowledge throughout the semester. We would also like to extend this gratitude to our respected TAs for their guidance and support during the entire span of the project.

Thank You !!!