INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

ROORKEE – 247667

Database Management Systems (CSN-351)

Sheet: 2

Total Marks: 100

Instructions:

- The deadline for assignment submission is **07 September**.
- If there is any similarity between the two students' submissions, both will be awarded **zero marks**. So, it's the student's responsibility not to share the submission with other students.
- Each late submission will receive a 15% penalty per day for up to 3 days. No submission will be accepted after the 3rd late day.
- You must handwrite your solutions; please scan the hard copy and convert it into a PDF with your name and enrolment number. Your name and roll number should be clearly written on the top of the first page.
- Please do not email us your submissions.
- Your submission must be uploaded to the Microsoft team.
- For questions five to seven, mention all the steps clearly; otherwise, you will lose marks.
- Also, Make sure that you are uploading the **correct file**. Please double-check your submitted file, and update your submission if required. We are not responsible if you get zero or fewer marks for uploading the wrong/older file.

Que. 1: Explain the following terms briefly: attribute, domain, entity, relationship, entity set, relationship set, one-to-many relationship, many-to-many relationship, participation constraint, overlap constraint, covering constraint, weak entity set, aggregation, and role indicator.

[15 Marks]

Que. 2: Design a database for a worldwide package delivery company (e.g., Special Delivery, DHL, or FedEx). The database must be able to keep track of customers who ship items and customers who receive items; some customers may do both. Each package must be identifiable and trackable, so the database must be able to store the location of the package and its history of locations. Locations include trucks, planes, airports, and warehouses. Your design should include an E-R diagram, a set of relational schemas, and a list of constraints, including primary-key and foreign-key constraints.

[15 Marks]

Que.3: Design a database for an airline. The database must keep track of customers and their reservations, flights and their status, seat assignments on individual flights, and the schedule and routing of future flights. Your design should include an E-R diagram, a set of relational schemas, and a list of constraints, including primary-key and foreign-key constraints.

[15 Marks]

Que. 4:

Part-A:

A university database contains information about professors (identified by social security number, or SSN) and courses (identified by course id). Professors teach courses; each of the following situations concerns the Teaches relationship set. For each situation, draw an ER diagram that describes it (assuming that no further constraints hold).

1. Professors can teach the same course in several semesters, and each offering must be recorded.
2. Professors can teach the same course in several semesters, and only the most recent such offering needs to be recorded. (Assume this condition applies in all subsequent questions.)
3. Every professor must teach some course.
4. Every professor teaches exactly one course (no more, no less).
5. Every professor teaches exactly one course (no more, no less), and every course must be taught by some professor.
6. Now suppose that certain courses can be taught by a team of professors jointly, but it is possible that no one professor in a team can teach the course. Model this situation, introducing additional entity sets and relationship sets if necessary.

[10 Marks]

Part-B:

Consider the following information about a university database:

- Professors have an SSN, a name, an age, a rank, and a research specialty.
- Projects have a project number, a sponsor name (e.g., NSF), a starting date, an ending date, and a budget.
- Graduate students have an SSN, a name, an age, and a degree program (e.g., B.Tech. or Ph.D.).
- Each project is managed by one professor (known as the project's principal investigator).
- Each project is worked on by one or more professors (known as the project's co-investigators).
- Professors can manage and/or work on multiple projects.
- Each project is worked on by one or more graduate students (known as the project's research assistants).
- When graduate students work on a project, a professor must supervise their work on the project. Graduate students can work on multiple projects, in which case they will have a (potentially different) supervisor for each one.

- Departments have a department number, a department name, and the main office.
- Departments have a professor (known as the chairman) who runs the department.
- Professors work in one or more departments, and for each department that they work in, a time percentage is associated with their job.
- Graduate students have one major department in which they are working on their degree.
- Each graduate student has another, more senior graduate student (known as a student advisor) who advises him or her on what courses to take.

Design and draw an ER diagram that captures the information about the university. Use only the basic ER model here; that is, entities, relationships, and attributes. Be sure to indicate any key and participation constraints.

[10 Marks]

Que 5: Consider the following functional dependencies in a database for relation R = (Roll_number, Name, Date_of_birth, Age):

```
Data_of_Birth → Age

Age → Eligibility

Name → Roll_number

Roll_number → Name

Course_number → Course_name

Course_number → Instructor

(Roll_number, Course_number) → Grade
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List the candidate keys for R and calculate the correct normal form for the relation R.

[5 Marks]

Que 6: Let a prime attribute be one that appears in at least one candidate key. Let $\alpha$and β be sets of attributes such that $\alpha \rightarrow \beta$ hold, but $\beta \rightarrow \alpha$ does not hold. Let A be an attribute that is not in α, is not in β, and for which $\beta \rightarrow$ A holds. We say that A is **transitively dependent** on α We can restate our definition of 3NF as follows: A relation schema R is in 3NF with respect to a set F of functional dependencies if there are no non-prime attributes A in R for which A is **transitively dependent** on a key for R. Show that this new definition is equivalent to the one which is discussed in the class.

[15 Marks]

Que 7: A functional dependency $\alpha \rightarrow \beta$ is called a **partial dependency** if there is a proper subset γ of α such that $\gamma \rightarrow \beta$; we say that β is partially dependent on α. A relation schema R is in second normal form (2NF) if each attribute A in R meets one of the following criteria:

- It appears in a candidate key.
- It is not partially dependent on a candidate key.

Show that every 3NF schema is in 2NF. Also, show that every partial dependency is a transitive dependency.

[15 Marks]