UNIVERSITY OF BIRMINGHAM

School of Computer Science

Data Structures, Algorithms and Databases

Class Test #2 [2023-24]

Data Structures, Algorithms and Databases

Question 1 Entity-Relationship modelling

A database is required for a company that provides household services such as cleaning, painting, repairs etc. It has a pool of workers specialising in each kind of work, who are contracted to do a specific maximum number of hours per week. The company receives orders from clients for household jobs, schedules the work from its pool of workers, and bills the clients for the work carried out. The charge depends on the type of service and hours involved for carrying it out. Regular clients may be offered a discount. If a job was not satisfactorily carried out, a repeat visit is provided free of charge, possibly by a different worker. Customers give a satisfaction rating for each job, which is recorded by the company to assess the performance record of the workers.

    a. Develop an **Entity-Relationship model** for the application. Explain the key design decisions made in your choice of entities, relationships and any other (ownership or hierarchical) aspects. **[4 marks]**

    Annotate it with **multiplicities** and hierarchy annotations. **[3 marks]**

    b. Carry out **logical design** for the model, by first stating how each relationship and subclass entity in the model should be treated. Represent the design with relational schemas for tables. Annotate the schemas with primary keys and the possibility of null attributes. **[4 marks]**

    c. Write SQL "CREATE TABLE" statements for 2–3 tables. Include among them at least one table that represents or incorporates a relationship. The other table(s) may be those that are linked to this table.

    Include all the necessary constraints and "ON DELETE" actions. **[3 marks]**

Question 2 Relational Algebra

a. Given below are two tables T_1 and T_2.

T_1:

C	W	X	Y	Z
a	1	x	15	e
b	2	x	10	f
b	3	x	15	g
a	4	y	15	h

T_2:

D	X	W	Y
p	x	1	10
t	y	2	10
p	y	3	15
r	x	4	10

Show the table obtained by evaluating the following expression:

$$(\pi_{(C,X,Y,Z)} T_1) \overset{L}{\bowtie} T_2$$

where $\overset{L}{\bowtie}$ denotes the (natural) **left outer join**. **[3 marks]**

b. Given below are the schemas for a database representing staff members, courses, and a relationship of staff members lecturing courses in particular years.

```
staff(sid, title, firstname, lastname, email, office, phone)
courses(cid, level, name, credits)
lecturing(cid, sid, year)
```

We want to find the courses that were taught by a staff member for the first time in 2023, i.e., the staff member should not have taught that course in any previous year. Write a **relational algebra expression** for this purpose.

(Hint: Consider calculating the cid's of such courses first.) **[3 marks]**