Assignment 1
(7 Bonus Points)
Write your answers in this document itself and upload it to Gradescope

NAME Adrian Knight

ID 677179394

Question 1 (5 Points)
department(dept_name, building, budget)
instructor(ID, name, dept_name, salary)

Consider the foreign-key constraint from the dept_name attribute of **instructor** to the **department** relation. Give examples of inserts and deletes to these relations that can cause a violation of the foreign-key constraint.

Department

dept_name	Building	Budget
Science	Building Science	5
Math	Building Math	10

Instructor

ID	name	dept_name	Salary
1	John	Science	100
2	Mary	Math	200

1. INSERT into instructor values (3, Connor, Chemistry, 150) # Chemistry violates the foreign-key constraint as it does not exist
2. INSERT into department values (Math, Newer Math Building, 30) # Math cannot be the primary key as the key already exists for the tuple with a budget of 10
3. DELETE from department (Science, Building Science, 5) # Deleting the science tuple results in Instructor with ID = 1 having a foreign key that points to nothing.

Question 2

Student

Student_ID	Name	Age	Gender	Major	Student_type	GPA	Advisor_name
670190001	Oliver Hayes	21	F	CS	Undergraduate	3.5	Thomas Bradley
670190002	Liam Bennett	24	M	CS	Master	3.8	David Foster
670190003	Ava Turner	22	M	Math	Undergraduate	3.2	Robert Sinclair
670190004	Ethan Mitchell	30	M	CS	PhD	3.8	David Foster
670190005	Mason Brooks	26	F	Biology	PhD	4.0	Olivia Coleman
670190006	Lucas Price	20	M	EE	Undergraduate	3.3	Andrew Bennett
670190007	Mia Hughes	21	F	Nursing	Undergraduate	3.7	Sophia Caldwell
670190008	Henry Russell	23	M	Math	Master	3.5	James Whitaker
670190009	Emily Jenkins	25	M	Physics	Master	3.5	Gregory Winters
670190010	Elijah Torres	22	M	Chemistry	Undergraduate	3.6	Abigail Mercer
670190011	James Carter	27	F	Biology	PhD	3.7	Olivia Coleman
670190012	Sophia Evans	24	F	EE	Master	3.1	Marcus Caldwell
670190013	Noah Bennett	26	M	CS	PhD	4.0	William Thornton
670190014	Mia Scott	22	M	Biology	Undergraduate	3.4	Lydia Keaton

For the above relation named ***Student***, what is the output of the following four queries: **(5 x 5 = 25 points)**

1. $\pi_{Student\_ID,Name}\left(\sigma_{GPA>3.5}\left(Student\right)\right)$

Student_ID	Name
670190002	Liam Bennett
670190004	Ethan Mitchell
670190005	Mason Brooks
670190007	Mia Hughes
670190011	James Carter
670190010	Elijah Torres
670190013	Noah Bennett

2. $\pi_{Student\_ID,Name,Major}\left(\sigma_{Age<25\ \cap\ Major='CS'}\left(\boldsymbol{Student}\right)\right)$

Student_ID	Name	Major
670190001	Oliver Hayes	CS
670190002	Liam Bennett	CS

3. $\pi_{Student\_ID,Name,Major}\left(\sigma_{Gender = 'M' \cup Major='CS'}\left(Student\right)\right)$

Student_ID	Name	Major
670190001	Oliver Hayes	CS
670190002	Liam Bennett	CS
670190003	Ava Turner	Math
670190004	Ethan Mitchell	CS
670190006	Lucas Price	EE
670190008	Henry Russell	Math
670190009	Emily Jenkins	Physics
670190010	Elijah Torres	Chemistry
670190013	Noah Bennett	CS
670190014	Mia Scott	Biology

4. $\pi_{Student\_ID}(\sigma_{Gender = 'F'}(Student)) \cap \pi_{Student\_ID}(\sigma_{Student\_type = 'PhD'}(Student))$

Student_ID
670190005
670190011

5. $\pi_{Major}\,(\boldsymbol{Student})$

Major
CS
CS
Math
CS
Biology
EE
Nursing
Math
Physics
Chemistry
Biology
EE
CS
Biology

Question 3

Consider a database with the following schema:

- Students (student_id, name, major, GPA)
- Instructors (instructor_id, name, department, course_id)
- Courses (course_id, name, instructor, credits)
- Enrollments (student_id, course_id, instructor_id, grade)

Student

student_id	name	major	GPA
670190001	Oliver Hayes	CS	3.5
670190002	Liam Bennett	CS	3.8
670190003	Ava Turner	Math	3.2
670190004	Ethan Mitchell	CS	3.8
670190005	Mason Brooks	Biology	4.0
670190006	Lucas Price	EE	3.3
670190007	Mia Hughes	Nursing	3.7

Instructors

instructor_id	name	department	course_id
UIC0010	Thomas Bradley	CS	2403
UIC0014	David Foster	CS	2406
UIC0023	Robert Sinclair	Math	3401
UIC0037	Olivia Coleman	Biology	0511
UIC0040	Andrew Bennett	EE	2511

Courses

course_id	name	instructor	credits
2403	databases	Thomas Bradley	4
2406	Machine Learning	David Foster	4
3401	Linear Algebra	Robert Sinclair	5
0511	Cell Biology	Olivia Coleman	3
2511	Control Systems	Andrew Bennett	5

Enrollments

student_id	courses_id	instructor_id	grade
670190001	2403	UIC0010	A
670190002	2403	UIC0010	B
670190003	3401	UIC0023	A
670190004	2406	UIC0014	A
670190005	0511	UIC0037	B
670190006	2511	UIC0037	B
670190007	0511	UIC0037	A

Write query in relational algebra for the following (5 x 5 = 25 Points)

1. Find the names of all students enrolled in the course **"databases".**

$\Pi_{name}(\sigma_{"databases"}(Student \bowtie Enrollment \bowtie Courses))$

2. Find the names of instructors teaching students with a **GPA of 4.0**.

$\Pi_{instructors.name}(\sigma_{GPA=4.0}(student \bowtie enrollments \bowtie instructors))$

3. Find the names of students and the courses they are enrolled in along with the instructor's name for those who received an **A grade**.

$\Pi_{student.name,\ courses.instructor,\ courses.name}(\sigma_{grade="A"}(student \bowtie enrollments \bowtie courses))$

4. List the names of instructors who are teaching students majoring in **"CS"**.

5. Find the names of students with a **GPA greater than 3.5** and enrolled in courses taught by **"Robert Sinclair"**.

Question 4 **(8 x 4 = 32 Points)**

Employee database:

employee (ID, person_name, street, city)
company (company_name, city)
Works (ID, company_name, salary) → ID is a foreign key referencing the ID of employee, and company_name is a foreign key referencing the company_name of the company table.

For the above schema of the employee database. Give an expression in the relational algebra to express each of the following queries:

1. Find the name of each employee living in Chicago.

2. Find the name of each employee whose salary exceeds $50000.

3. Find the name of each employee who lives in Chicago and whose salary is greater than $50000.

4. Find the ID and name of each employee who does not work for BigBank.

5. Find the ID and name of each employee who works for “BigBank”.

6. Find the ID, name, and city of residence of each employee who works for “BigBank”.

7. Find the ID, name, street address, and city of residence of each employee who works for “BigBank” and earns more than $10000.

8. Find the ID and name of each employee in this database who lives in the same city as the company for which she or he works.

Question 5 **(10 Points)**

Write a relational expression to compute all paths of length 3 for any given directed graph G. Show the working of your RA expression on a real graph of 7 nodes and 7 edges (use your imagination to create the graph)

Question 6 **(10 Points)**

instructor(ID, name, dept_name, salary)

Write a relational algebra query for the above table that computes the maximum salary.