Relational Algebra and Tuple calculus

Overview

Consider the following schema :

Students(tid: integer, sname: string, major: string, onCoop: Boolean, college: string, gpa: real)
Courses(cid: integer, cname: string, hours: integer)
Sections(sid: integer, cid: integer, room: string, block: string, term: string)
Enrollment(sid: integer, tid: integer, grade: real)

And answer the questions

Question 1

Write a relational algebra expression that satisfies this query:

Find the names of all courses that are more than 3 credits :

Answer

$\pi_{cname}(\sigma_{credits>3}(Courses))$

Question 2

Write a relational algebra expression that satisfies this query:

Find the distinct names of all students that took the course with the name "Operating Systems".

Answer

$\pi_{sname}(((\sigma_{cname=\text{“}Operating\ Systems\text{”}}(Courses \bowtie Sections)) \bowtie Enrollments) \bowtie Students)$

Question 3

Write a relational algebra expression that satisfies this query:

How many (distinct) students earned 99 or above in any course during the "Spring" term of 2023.

Answer

$|\sigma_{grade \geq 99 \wedge term = "Spring" \wedge year = 2023}((Enrollments \bowtie Sections) \bowtie Students)|$

Question 4

Write a relational algebra expression that satisfies this query:

Find the number of students per major.

Answer

${}_{major}\mathfrak{F}_{count(*)}(Students)$

Question 5

Write a relational algebra expression that satisfies this query:

How many courses are offered during the "Spring 2023" term that have more than two sections?

Answer

$|\sigma_{count(*)>2}({}_{cid}\mathfrak{F}_{count(sid)}(\sigma_{term="Spring" \wedge year=2023}(Courses \bowtie Sections)))|$

Question 6

Write a relational algebra expression that satisfies this query:

List the names of all students in the college "Khoury" who are on coop.

Answer

$\pi_{sname}(\sigma_{college="Khoury" \wedge onCoop=true}(Students))$

Question 7

Write a tuple relational calculus expression that satisfies this query:

Find the distinct names of all students who major in "Computer Science" .

Answer

$\{s.sname : Students(s) \wedge s.major = \text{“}ComputerScience\text{”}\}$

Question 8

Write the equivalent tuple relational calculus expression for the SQL statement below:

SELECT cname, hours FROM Courses WHERE hours ¡ 4;

Answer

$\{c.cname\ , c.hours : Courses(c) \wedge c.hours < 4\}$

Question 9

Write the equivalent relational algebra expression for the SQL statement below:

SELECT cname, room FROM Courses NATURAL JOIN Sections WHERE block IN ('H','G','F') AND (hours BETWEEN 2 AND 4);

Answer

$\pi_{cname,room}(\sigma_{block\ \in\{'H','G','F'\}\ \wedge\ hours\geq 2\ \wedge\ hours\leq 4}(Courses \bowtie Sections))$

Question 10

Write a single equivalent SQL statement for the relational algebra expression below. You do not have to implement the SQL in an actual database:

$\rho_{KhourySections}(\sigma_{college='khoury'}(Courses \bowtie Sections))$
$\pi_{cname,room}(\sigma_{block\in\{G,F\}} \wedge term =' Spring'(KhourySections))$

Answer

SELECT cname, room FROM (SELECT * FROM Courses JOIN Sections ON Courses.cid = Sections.cid WHERE college = 'Khoury') AS KhourySections WHERE block IN ('F', 'G') AND term = 'Spring';