



Exercise 4: Solution

Relational Algebra

DBS



Question 1(i)

2

Library database schema:

LIB-MEMBER(ID, name, age)

BOOK(serial#, title, author, year-of-publication)

LOAN(ID, serial#, date-due)

(i) $\pi_{\text{name}}(\sigma_{\text{year-of-publication} < 1960} \text{BOOK} \bowtie \text{LOAN} \bowtie \text{LIB-MEMBER})$

Find names of members who have loaned books published before 1960.

Question 1(ii)

3

Library database schema:

LIB-MEMBER(ID, name, age)

BOOK(serial#, title, author, year-of-publication)

LOAN(ID, serial#, date-due)

(ii) $\pi_{ID}(\sigma_{\text{age} < 21} \text{LIB-MEMBER}) -$
 $\pi_{ID}(\sigma_{\text{author} = \text{"J.K.Rowling"}} \text{BOOK} \bowtie \text{LOAN})$

Find IDs of members under the age of 21 who have not loaned a book by author “J.K.Rowling”.

Question 1(iii)

4

Library database schema:

LIB-MEMBER(ID, name, age)

BOOK(serial#, title, author, year-of-publication)

LOAN(ID, serial#, date-due)

(iii) $\pi_{\text{name}}((\pi_{\text{ID,serial\#}} \text{ LOAN} \div \pi_{\text{serial\#}} (\sigma_{\text{title} = \text{"C Programming"}} \text{ BOOK})) \bowtie \text{ LIB-MEMBER})$

Find names of members who have loaned all books with the title 'C Programming'

Question 2(i)

5

STUDENT(Sid, Sname, Sex, Age, Year, GPA)

DEPT(Dname, Numphds)

PROF(Pname, Dname)

COURSE(Dname, Cno, Cname)

MAJOR(Sid, Dname)

SECTION(Dname, Cno, Sectno, Pname)

ENROLL(Sid, Dname, Cno, Sectno, Grade)

(i) Find the names of **professors** who work in **departments** that have fewer than 50 PhD students.

Answer := $\pi_{\text{Pname}} (\text{PROF} \bowtie (\sigma_{\text{Numphds} < 50} \text{DEPT}))$

Question 2(ii)

6

STUDENT(Sid, Sname, Sex, Age, Year, GPA)

DEPT(Dname, Numphds)

PROF(Pname, Dname)

COURSE(Dname, Cno, Cname)

MAJOR(Sid, Dname)

SECTION(Dname, Cno, Sectno, Pname)

ENROLL(Sid, Dname, Cno, Sectno, Grade)

(ii) Find the name(s) of student(s) with the lowest GPA.

Answer :=

$\pi_{\text{Sname}} (\text{STUDENT} \bowtie_{\text{GPA}=\text{MinGPA}} (\gamma_{\text{MIN}(\text{GPA}) \rightarrow \text{MinGPA}} \text{STUDENT}))$

Question 2(iii)

7

STUDENT(Sid, Sname, Sex, Age, Year, GPA)

DEPT(Dname, Numphds)

PROF(Pname, Dname)

COURSE(Dname, Cno, Cname)

MAJOR(Sid, Dname)

SECTION(Dname, Cno, Sectno, Pname)

ENROLL(Sid, Dname, Cno, Sectno, Grade)

(iii) Find the names and majors of students who have taken the 'Database Systems' course.

$R1 := \pi_{Dname, Cno} (\sigma_{Cname = 'Database Systems'} COURSE)$

$R2 := \pi_{Sid} (R1 \bowtie ENROLL)$

$Answer := \pi_{Sname, Dname} (R2 \bowtie MAJOR \bowtie STUDENT)$

Question 2(iv)

8

STUDENT(Sid, Sname, Sex, Age, Year, GPA)

DEPT(Dname, Numphds)

PROF(Pname, Dname)

COURSE(Dname, Cno, Cname)

MAJOR(Sid, Dname)

SECTION(Dname, Cno, Sectno, Pname)

ENROLL(Sid, Dname, Cno, Sectno, Grade)

(iv) Find the ids, names, and GPAs of the students who have taken all courses from the 'Civil Engineering' department.

$R1 := \pi_{Dname, Cno} (\sigma_{Dname = 'Civil Engineering'} COURSE)$

$R2 := \pi_{Sid, Dname, Cno} ENROLL$

$R3 := R2 \div R1$

$Answer := \pi_{Sid, Sname, GPA} (R3 \bowtie STUDENT)$

Question 3(i)

Find the names of the players who won at least one gold and one silver.

PLAYERS(player-id, name, countryname, age)

EVENTS(event-id, name, eventtype)

RESULTS(player-id, event-id, medal)

$R1 := \pi_{\text{player-id}}(\sigma_{\text{medal} = \text{'gold'}} \text{RESULTS})$

$R2 := \pi_{\text{player-id}}(\sigma_{\text{medal} = \text{'silver'}} \text{RESULTS})$

$R3 := R2 \cap R1$

$\text{Answer} := \pi_{\text{name}}(R3 \bowtie \text{PLAYERS})$

Question 3(ii)

Find the players who did not win a medal.

PLAYERS(player-id, name, countryname, age)

EVENTS(event-id, name, eventtype)

RESULTS(player-id, event-id, medal)

$R1 := \pi_{\text{player-id}} \text{PLAYERS}$

$R2 := \pi_{\text{player-id}} \text{RESULTS}$

$R3 := R1 - R2$

$\text{Answer} := \pi_{\text{name}} (R3 \bowtie \text{PLAYERS})$

Question 3(iii)

Find the names of all the players with the minimum age.

PLAYERS(player-id, name, countryname, age)

EVENTS(event-id, name, eventtype)

RESULTS(player-id, event-id, medal)

$R1 := \pi_{\text{name}} \text{PLAYERS}$

$R2 := \pi_{\text{p1.name}} (\rho_{\text{p1}}(\text{PLAYERS}) \bowtie_{\text{p1.age} > \text{p2.age}} \rho_{\text{p2}}(\text{PLAYERS}))$

Answer := $R1 - R2$

Question 4

Relation $R(A)$ only has one attribute A .

We want to find max value in A .

$S := R$

$R1 := \sigma_{R.A < S.A} (R \times S)$

$\text{Answer} := R - \pi_{R.A} (R1)$