Tutorial 3: Relational Algebra (Solutions)

CS3402 Database Systems

Question 1

- Consider two tables T1 and T2 shown below; show the results of the following operations.

  a) $T1 \times T2$

  b) $T1 \bowtie_{T1.P=T2.A} T2$

  c) $T1 \bowtie_{T1.R>T2.R} T2$

  d) $T1 * T2$

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Question 1(a) (Answer) (1/9)

- T1 × T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6

Question 1(a) (Answer) (2/9)

- T1 × T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6
10	a	5	25	c	3

Question 1(a) (Answer) (3/9)

- T1 × T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6
10	a	5	25	c	3
10	a	5	10	b	5

Question 1(a) (Answer) (4/9)

- T1 × T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6
10	a	5	25	c	3
10	a	5	10	b	5
15	b	8	10	b	6

Question 1(a) (Answer) (5/9)

- T1 $\times$ T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6
10	a	5	25	c	3
10	a	5	10	b	5
15	b	8	10	b	6
15	b	8	25	c	3

Question 1(a) (Answer) (6/9)

- T1 × T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6
10	a	5	25	c	3
10	a	5	10	b	5
15	b	8	10	b	6
15	b	8	25	c	3
15	b	8	10	b	5

Question 1(a) (Answer) (7/9)

- T1 × T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6
10	a	5	25	c	3
10	a	5	10	b	5
15	b	8	10	b	6
15	b	8	25	c	3
15	b	8	10	b	5
25	a	6	10	b	6

Question 1(a) (Answer) (8/9)

- T1 $\times$ T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6
10	a	5	25	c	3
10	a	5	10	b	5
15	b	8	10	b	6
15	b	8	25	c	3
15	b	8	10	b	5
25	a	6	10	b	6
25	a	6	25	c	3

Question 1(a) (Answer) (9/9)

- T1 $\times$ T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6
10	a	5	25	c	3
10	a	5	10	b	5
15	b	8	10	b	6
15	b	8	25	c	3
15	b	8	10	b	5
25	a	6	10	b	6
25	a	6	25	c	3
25	a	6	10	b	5

Question 1(b) (Answer) (1/9)

- T1 $\bowtie_{T1.P=T2.A}$ T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6

T1.P=T2.A? Yes

Question 1(b) (Answer) (2/9)

- T1 $\bowtie_{T1.P=T2.A}$ T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6

T1.P=T2.A? No

Question 1(b) (Answer) (3/9)

- T1 $\bowtie_{T1.P=T2.A}$ T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6
10	a	5	10	b	5

T1.P=T2.A? Yes

Question 1(b) (Answer) (4/9)

- T1 $\bowtie_{T1.P=T2.A}$ T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6
10	a	5	10	b	5

T1.P=T2.A? No

Question 1(b) (Answer) (5/9)

- T1 $\bowtie_{T1.P=T2.A}$ T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6
10	a	5	10	b	5

T1.P=T2.A? No

Question 1(b) (Answer) (6/9)

- $T1 \bowtie_{T1.P=T2.A} T2$

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6
10	a	5	10	b	5

T1.P=T2.A? No

Question 1(b) (Answer) (7/9)

- T1 $\bowtie_{T1.P=T2.A}$ T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6
10	a	5	10	b	5

T1.P=T2.A? No

Question 1(b) (Answer) (8/9)

- T1 $\bowtie_{T1.P=T2.A}$ T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6
10	a	5	10	b	5
25	a	6	25	c	3

T1.P=T2.A? Yes

Question 1(b) (Answer) (9/9)

- T1 $\bowtie_{T1.P=T2.A}$ T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	10	b	6
10	a	5	10	b	5
25	a	6	25	c	3

T1.P=T2.A? No

- T1 $\bowtie_{T1.R>T2.R}$ T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2

T1.R>T2.R? No

Question 1(c) (Answer) (2/9)

- $T1 \bowtie_{T1.R>T2.R} T2$

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	25	c	3

T1.R>T2.R? Yes

Question 1(c) (Answer) (3/9)

- $T1 \bowtie_{T1.R>T2.R} T2$

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	25	c	3

T1.R>T2.R? No

Question 1(c) (Answer) (4/9)

- T1 $\bowtie_{T1.R>T2.R}$ T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	25	c	3
15	b	8	10	b	6

T1.R>T2.R? Yes

Question 1(c) (Answer) (5/9)

- T1 ⋈$_{T1.R>T2.R}$T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	25	c	3
15	b	8	10	b	6
15	b	8	25	c	3

T1.R>T2.R? Yes

Question 1(c) (Answer) (6/9)

- T1 $\bowtie_{T1.R > T2.R}$ T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	25	c	3
15	b	8	10	b	6
15	b	8	25	c	3
15	b	8	10	b	5

T1.R>T2.R? Yes

Question 1(c) (Answer) (7/9)

- T1 $\bowtie_{T1.R>T2.R}$ T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R1	A	B	R2
10	a	5	25	c	3
15	b	8	10	b	6
15	b	8	25	c	3
15	b	8	10	b	5

T1.R>T2.R? No

Question 1(c) (Answer) (8/9)

- $T1 \bowtie_{T1.R>T2.R} T2$

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

T1.R>T2.R? Yes

Result

P	Q	R1	A	B	R2
10	a	5	25	c	3
15	b	8	10	b	6
15	b	8	25	c	3
15	b	8	10	b	5
25	a	6	25	c	3

Question 1(c) (Answer) (9/9)

- T1 $\bowtie_{T1.R>T2.R}$ T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

T1.R>T2.R? Yes

Result

P	Q	R1	A	B	R2
10	a	5	25	c	3
15	b	8	10	b	6
15	b	8	25	c	3
15	b	8	10	b	5
25	a	6	25	c	3
25	a	6	10	b	5

Question 1(d) (Answer) (1/9)

- T1∗T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R	A	B

T1.R=T2.R? No

Question 1(d) (Answer) (2/9)

- T1∗T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R	A	B

T1.R=T2.R? No

Question 1(d) (Answer) (3/9)

- T1∗T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R	A	B
10	a	5	10	b

T1.R=T2.R? Yes

Question 1(d) (Answer) (4/9)

- T1*T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R	A	B
10	a	5	10	b

T1.R=T2.R? No

Question 1(d) (Answer) (5/9)

- T1*T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R	A	B
10	a	5	10	b

T1.R=T2.R? No

Question 1(d) (Answer) (6/9)

- T1*T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R	A	B
10	a	5	10	b

T1.R=T2.R? No

Question 1(d) (Answer) (7/9)

- T1*T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R	A	B
10	a	5	10	b
25	a	6	10	b

T1.R=T2.R? Yes

Question 1(d) (Answer) (8/9)

- T1*T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R	A	B
10	a	5	10	b
25	a	6	10	b

T1.R=T2.R? No

Question 1(d) (Answer) (9/9)

- T1*T2

T1

P	Q	R
10	a	5
15	b	8
25	a	6

T2

A	B	R
10	b	6
25	c	3
10	b	5

Result

P	Q	R	A	B
10	a	5	10	b
25	a	6	10	b

T1.R=T2.R? No

Question 2 (1/2)

- Consider the COMPANY relational schema shown below; specify the following queries in relational algebra.
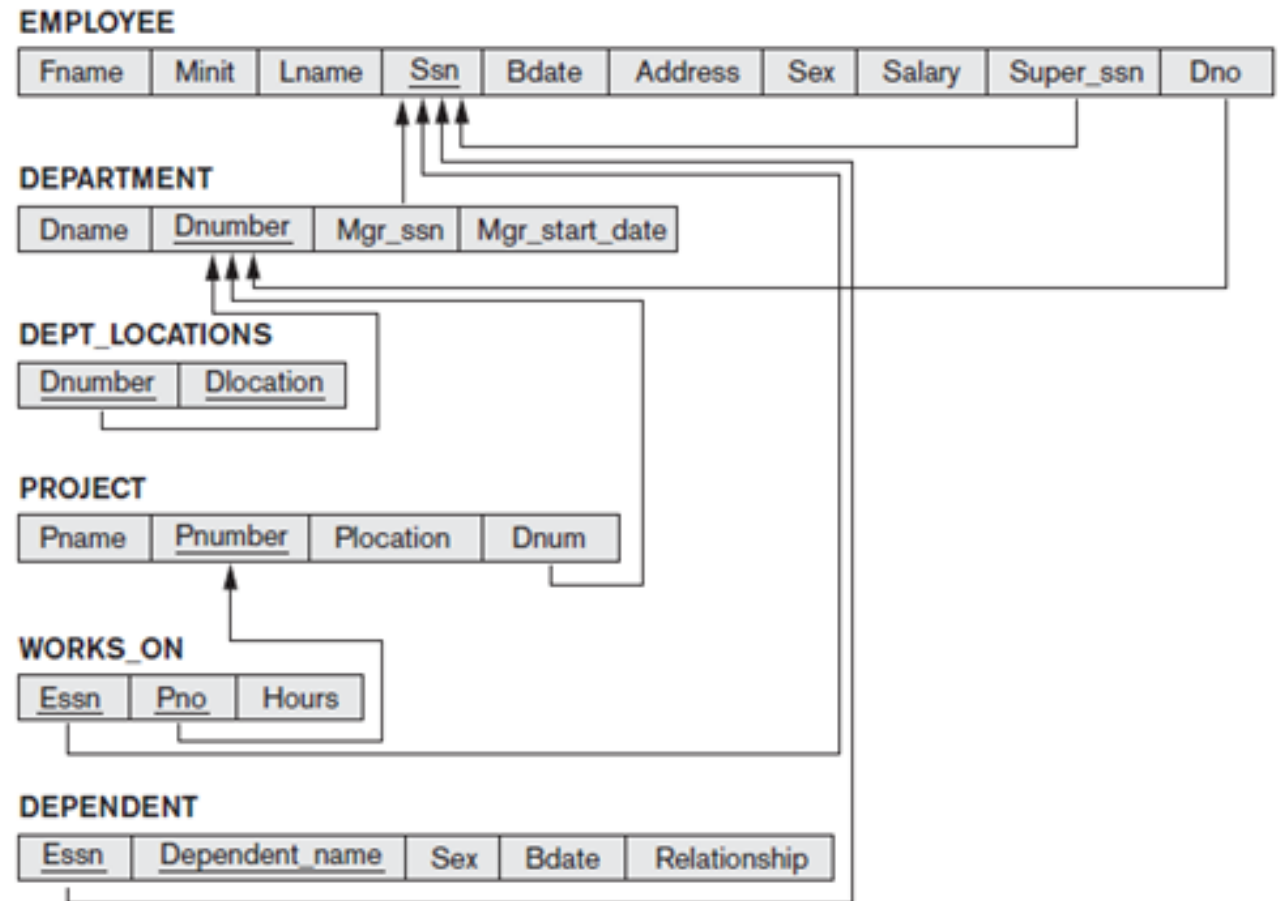
Question 2 (2/2)

a) Find the Ssn (social security number) of all employees who are not supervisors

b) Find the Ssn of all employees who either work in department number 5 or directly supervise an employee who works in department number 5

c) List the names and numbers of all departments locating in 'Houston'

d) List the first names of all employees who have a dependent with the same first name as themselves

e) Retrieve the salary of all employees in department number 5 who work more than 10 hours on the project named 'ProjectX'

Question 2(a) (Answer)

- Find the Ssn (social security number) of all employees who are not supervisors
- π_{Ssn} (EMPLOYEE) $- \pi_{Super\_ssn}$ (EMPLOYEE)
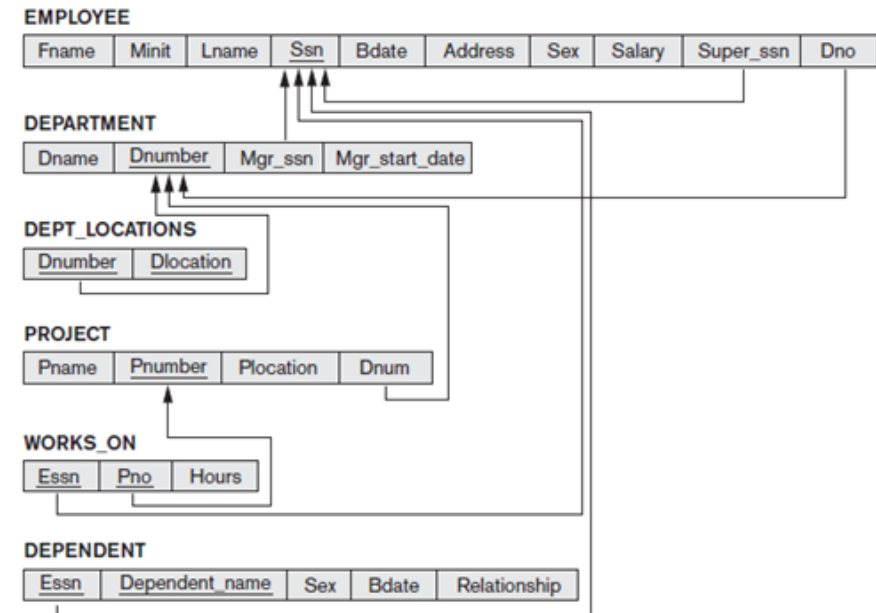
Question 2(b) (Answer)

- Find the Ssn of all employees who either work in department number 5 or directly supervise an employee who works in department number 5

- $\pi_{Ssn} \ (\sigma_{Dno=5} \ (\text{EMPLOYEE})) \ \cup \ \pi_{Super\_ssn} \ (\sigma_{Dno=5} \ (\text{EMPLOYEE}))$
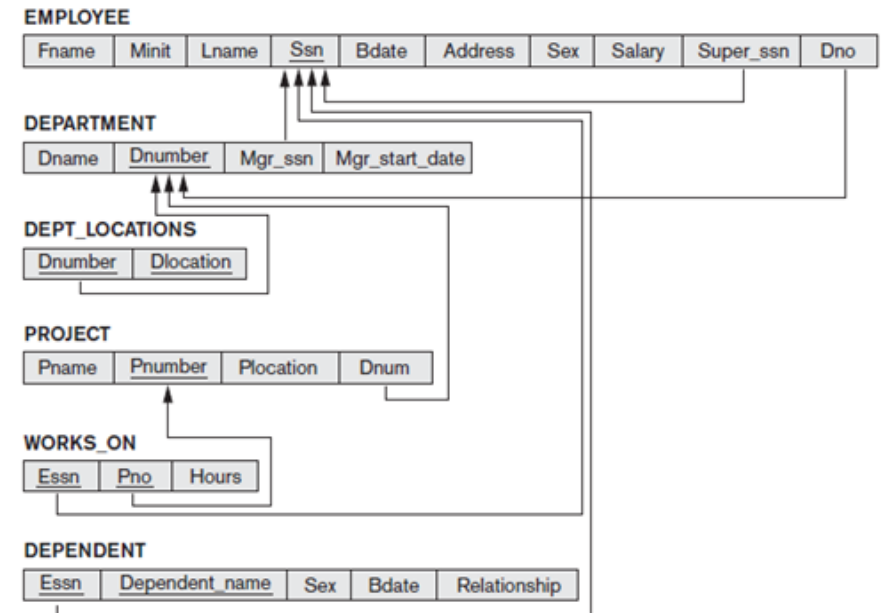
Question 2(c) (Answer)

- List the names and numbers of all departments locating in 'Houston'
- $\pi_{\text{Dname,Dnumber}} \left(\sigma_{\text{Dlocation='Houston'}} \left(\text{DEPARTMENT} * \text{DEPT\_LOCATIONS} \right) \right)$
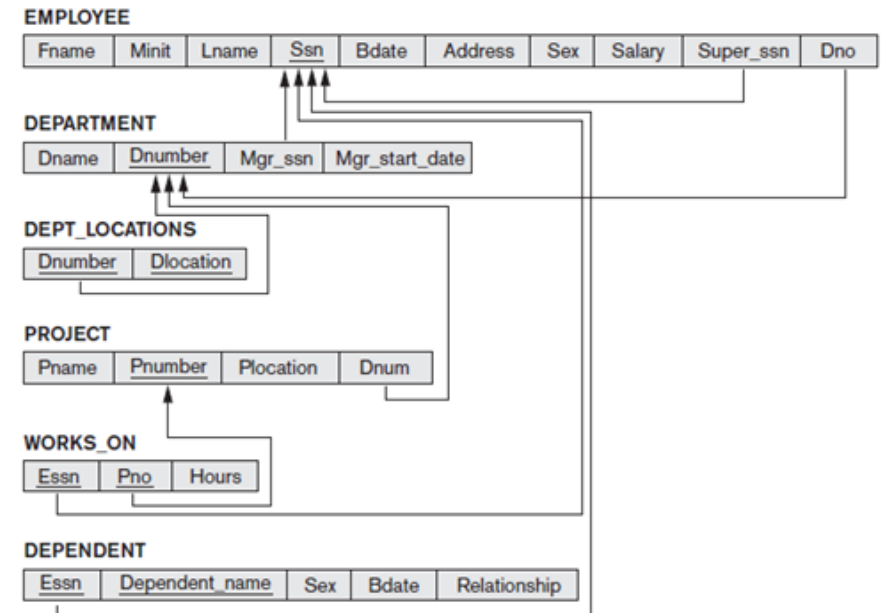
Question 2(d) (Answer)

- List the first names of all employees who have a dependent with the same first name (i.e., dependent_name) as themselves

- π_{Fname} (EMPLOYEE $\bowtie_{Ssn=Essn \textbf{ AND } Fname=Dependent\_name}$ DEPENDENT)
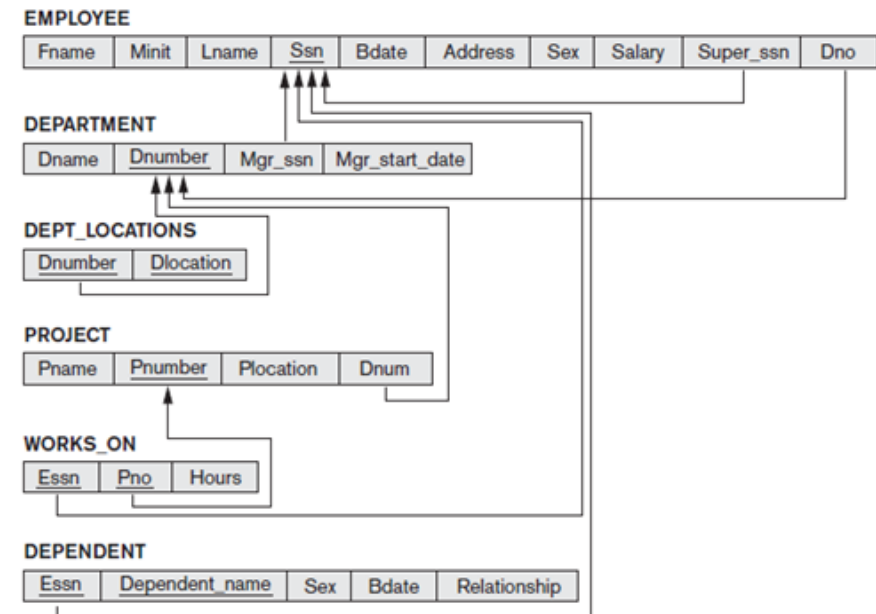
Question 2(e) (Answer)

- Retrieve the salary of all employees in department number 5 who work more than 10 hours on the project named 'ProjectX'

- WORK5_10 ← WORKS_ON $\bowtie_{\text{Pnumber=Pno AND Dnum=5 AND Hours>10}}$ PROJECT

- PROJECTX5_10 ← $\sigma_{\text{Pname='ProjectX'}}$ (WORK5_10)

- π_{Salary} (PROJECTX5_10 $\bowtie_{\text{Essn=Ssn}}$ EMPLOYEE)

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date

DEPT_LOCATIONS

Dnumber	Dlocation

PROJECT

Pname	Pnumber	Plocation	Dnum

WORKS_ON

Essn	Pno	Hours

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship