5.11
a) No violation, integrity is retained.
b) Dnum = 2 does not exist. This can be solved by adding a foreign key referencing the department table, so the operation does not execute.
c) Dnum = 4 already exists, this is already enforced since Dnum is the primary key. Additionally, the Mgr_ssn: 943775543 does not exist in the employee table, thus not a valid employee, this can be enforced with Mgr_ssn being a foreign key referencing SSN in the employee table.
d) The ESSN: 677678989, does not exist in the employee table, this can be fixed by using a foreign key to refer to SSN in employee. Also Pno cannot be NULL since it is part of the primary key, this must have a unique value.
e) No violation.
f) No violation
g) Integrity violated because ESSN in Works_on and Dependent both refer to SSN in Employee (ESSN in both tables are foreign keys referencing SSN), deleting that employee leaves 2 foreign keys with no primary to refer to. To fix this a CASCADE or RESTRICT operation can be implemented in the SQL command to either delete all referencing tuples or keep all the data.
h) Integrity violated, Pno in Works_on is a foreign key referencing Pnumber in Project. To fix this we can add the CASCADE or RESTRICT function.
i) No violation
j) The SSN 943775543 does not exist in the SSN attribute column. This is already enforced and would not execute anyways,
k) No violation.

5.13
The candidate key should be unique so we have a few options as stated below

- -Univ_Section#
- -Composite keys, there can be many, but just to name a few:
  - -(Course#, Room#, Time_period)
  - -(Course#, Instructor_name, Time_period)
  - -(Building_code, Room#, Time_period)

5.14

Foreign Key	Referencing Primary Key
Order# in ORDER_ITEM	Order# in ORDER
Item# in ORDER_ITEM	Item# in ITEM
Order# in SHIPMENT	Order# in ORDER
Warehouse# in SHIPMENT	Wharehouse# in WHAREHOUSE
Cust# in ORDER	Cust# in CUSTOMER

A possible constraint can be that a City can be added ORDER and Cust# can be added to WHAREHOUSE, then in CUSTOMER, Cust# and City can be used as a composite primary key so orders can be shipped from the closest possible wharehouse.

8.15

Query 1:

Fname	Lname	Address
John	Smith	731 Fondren, Houston, TX
Franklin	Wong	638 Voss, Houston, TX
Ramesh	Narayan	975 Fire Oak, Humble, TX
Joyce	English	5631 Rice, Houston, TX

Query 2:

Pnumber	Dnum	Lname	Address	Bdate
10	4	Wallace	291 Berry, Bellaire, TX	1941-06-20
30	4	Wallace	291 Berry, Bellaire, TX	1941-06-20

Query 3:

Empty/null result

Query 4:

Pno
1
2

Query 5:

Lname	Fname
Smith	John
Wong	Franklin

Query 6:

Lname	Fname
Narayan	Ramesh
Zelaya	Alicia
Borg	James
English	Joyce
Jabber	Ahmed

Query 7:

Lname	Fname
Wong	Franklink
Wallace	Jennifer

8.16

a)

$emp1 \leftarrow employee \bowtie_{ssn=essn} works\_on \bowtie_{Pno=pnumber} project$

$emp2 \leftarrow \sigma_{(dno=5 \text{ and } pname='ProductX' \text{ and } hours>10.0)} (emp1)$

$fin\_ans \leftarrow \pi_{fname,minit,lname}(emp2)$

b)

$emp\_deps ,\_ employee \bowtie_{(ssn=essn \text{ and } fname = dependent\_name)} dependent$

$fin\_ans \leftarrow \pi_{(fname,minitlname)}(emp\_deps)$

c)

$wong\_SSN \leftarrow \pi_{ssn}(\sigma_{l(name='Wong' \text{and } fname='Franklin')}(employee))$

$fin\_ans \leftarrow \pi_{fname,minit,lname}(employee \bowtie_{superssn=ssn} wong\_ssn)$

d)

$hours(pno,total\_hours) \leftarrow {}_{pno}F_{sum\ hours}(works\_on)$

$fin\_ans \leftarrow \pi_{pname,total\_hours}(hours \bowtie_{pno=pnumber} project)$

e)

$emp\_proj(ssn,pnumber) \leftarrow \pi_{essn,pno}(works\_on)$

$proj \leftarrow \pi_{pnumber} projects$

$fin\_ans \leftarrow \pi_{fname,minit,lname}((emp\_proj / proj) * employees)$

f)

$emp\_proj(ssn) \leftarrow \pi_{essn}(works\_on)$

$emp\_proj\_names \leftarrow emp\_proj * employee$

$fin\_ans \leftarrow \pi_{fname,minit,lname}(employees – emp\_proj\_names)$

g)

$dept\_avgsal(dnumber, avgsal) \leftarrow {}_{dno}F_{avg\ salary}(employee)$

$fin\_ans \leftarrow \pi_{dname,avgsal}(dep\_avgsal * department)$

h)

$ans \leftarrow F_{avg\ salary} (\sigma_{sex='female'}(employee))$

i)

emps_houston <- $\pi_{fname,minit,lname,address}(\sigma_{plocation='Houston'}(employee *_{(ssn),(essn)} works\_on *_{(pno),(pnumber)} project))$

dept_houston <- $\pi_{fname,minit,lname,address}(\sigma_{dlocation='Houston'}(employee *_{(dno),(dnumber)} dept\_location))$

ans <- emps_houston – dept_houston

j)

dept_mgrs(ssn) <- π_{mgrssn}(department)
emps_with_deps(ssn) <- π_{essn}(dependent)
ans <- $\pi_{fname,minit,lname}$(employee *(dept_mgrs – emps_with_deps))

8.19

a)

W2_info <- $\pi_{Warehouse\# = \text{“W2”}}$ (Shipment)
ans <- $\sigma_{Order\#,\ Ship\_date}$ (W2_info)

b)

JoseLopez <- $\pi_{Cname = \text{“Jose Lopez”}}$ (Order $\bowtie$ Customer)
ans <- $\sigma_{Order\#,\ Warehouse\#}$ (Shipment $\bowtie$ JoseLopez)

c)

ans <- Cname **F** count (order#) as #ofOrders, avg(Ord_Amt) as Avg_Order_Amt (Customer $\bowtie$ Order)

d)

ans <- $\pi_{Order\#}(\sigma_{(shipdate - Odate \geq 30}$(ORDER $\bowtie$ SHIPMENT))

e)

NY_WH $\leftarrow$ $\pi_{City = \text{"New York"}}$ (Warehouse)
ans $\leftarrow$ $\sigma_{\ Order\#,\ Warehouse\#}$ (Shipment) $\div$ $\sigma_{Warehouse\#}$ (NY_WH)

8.22

a)

P	Q	R	A	B	C
10	a	5	10	b	6
10	a	5	10	b	5
25	a	6	25	c	3

b)

P	Q	R	A	B	C
15	b	8	10	b	6
15	b	8	10	b	5

c)

P	Q	R	A	B	C
10	a	5	10	b	6
10	a	5	10	b	5
15	b	8	NULL	NULL	NULL
25	a	6	25	c	3

d)

P	Q	R	A	B	C
NULL	NULL	NULL	25	c	3
15	b	8	10	b	6
15	b	8	10	b	5

e)

P	Q	R
10	a	5
15	b	8
25	a	6
10	b	6
25	c	3
10	b	5

f)

P	Q	R	A	B	C
10	a	5	10	b	5