1.
   a.
      i. Names of suppliers if they sell a red part for less than 100
      ii. Does not return anything because first, Π_{sid} projects the sids only. Once sids are projected, we cannot project the names from that relation because the relation contains only sids.
      iii. Names of suppliers if they sell a red part for less than 100 and a green part for less than 100
      iv. ID of suppliers that sell red part for less than 100 and green part for less than 100
      v. Names of suppliers that sell a red part for less than 100 and a green part for less than 100

b.

i. $\Pi_{sname}(\Pi_{sid}(\sigma_{color='red'}(Parts) \bowtie Catalog) \bowtie Suppliers)$

ii. $R1 = (\sigma_{color='red'}(Parts) \bowtie Catalog)$

R2 = $(\sigma_{color='green'}(Parts) \bowtie Catalog))$

R3 = Π_{sid} (R1 ∪ R2)

iii. $\Pi_{sid}((\sigma_{color='red'}(Parts) \bowtie Catalog) \cup (\sigma_{address='1065\ Military\ Trail'}(Suppliers) \bowtie Catalog))$

iv. R1 = $(\Pi_{sid}(\sigma_{color='red'}(Parts) \bowtie Catalog)$

R2 = $(\Pi_{sid}(\sigma_{color='green'}(Parts) \bowtie Catalog)$

R3 = R1 ∩ R2

v. $\Pi_{sid,\ pid}(Parts \bowtie Catalog)/\Pi_{pid}(Parts)$

vi. R1 = $\Pi_{sid,\ pid}(Catalog)$

R2 = $\Pi_{pid}(\sigma_{color='red'}(Parts))$

R3 = R1/R2

vii. $\Pi_{sid,\ pid}(Catalog)/(\Pi_{pid}(\sigma_{color='red'}(Parts)) \cup \Pi_{pid}(\sigma_{color='green'}(Parts)))$

viii. $R1 = (\Pi_{sid,\ pid}(Catalog))/(\Pi_{pid}(\sigma_{color='red'}(Parts))$

$R2 = (\Pi_{sid,\ pid}(Catalog))/(\Pi_{pid}(\sigma_{color='green'}(Parts))$

$R3 = R1 \cup R2$

ix. $R1 = \Pi_{sid,\ pid,\ cost}((Parts \bowtie Catalog) \bowtie Suppliers)$

$R2 = \rho_{R2(sid2,\ pid2,\ cost2)}(R1)$

$R3 = R1 \bowtie_{cost > cost2\ AND\ pid = pid2} R2$

$R4 = \Pi_{pid,\ pid2}(R3)$

x. $R1 = \Pi_{sid,\ pid}(Catalog)$

$R2 = \rho_{R2}(R1)$

$R3 = R1 \bowtie_{R1.pid = R2.pid\ AND\ R1.sid! = R2.sid} R2$

$R4 = \Pi_{R1.pid}(R3)$

xi. $R1 = \Pi_{pid,\ cost}(Parts \bowtie Catalog \bowtie \sigma_{sname='Canada\ Suppliers'}(Suppliers))$

$R2 = \rho_{R2(pid2,\ cost2)}(R1)$

$R3 = \Pi_{pid,\ cost}(R1 \bowtie_{cost < cost2} R2)$

$R4 = \Pi_{pid}(R1 - R3)$

xii. $R1 = \Pi_{pid,\ sid}(\sigma_{cost < 200}(Catalog))$

$R2 = \Pi_{sid}(Suppliers)$

$R3 = R1/R2$

2. (a)

i. $\Pi_{eid}(\sigma_{aname='boeing}(Aircraft) \bowtie Certified))$

ii. R1= $(\sigma_{aname='boeing' AND Aircraft.aid=Certified.aid}\ Aircraft \bowtie Certified$

R2= R1 $\bowtie$ $_{\text{Employees.eid=R1.eid}}$Employees

R3= Π_{ename} R2

iii. $\Pi_{aid}(Aircraft \bowtie_{crusingrange >= distance}(\sigma_{from='Bonn' AND to='Madras'}(Flights)))$

iv. R1 = (σ $_{\text{salary>100000 AND distance<cruisingrange}}$Employees $\bowtie$ Certified $\bowtie$ Aircraft $\bowtie$ Flights)

R2 = Π $_{\text{flno}}$(R1)

v. $R1 = \Pi_{ename}(Employees \bowtie Certified \bowtie \sigma_{cruisingrange > 3000}(Aircraft))$

$R2 = \Pi_{ename}(Employees \bowtie Certified \bowtie \sigma_{name='boeing}(Aircraft))$

$R3 = R1 - R2$

vi. R1 = $\rho E1\ (Employees)$

R2 = $\rho E2\ (Employees)$

R3 = Π $_{\text{E2.eid}}$ ($E1$ $\bowtie$ $_{\text{E1.salary>E2.salary}}$ E2)

R4 = Π $_{\text{eid}}$E1

R5 = R4-R3

vii. $R1 = Employees$

$R2 = \rho_{R2(eid2,\ ename2,\ salary2)}(Employees)$

$R3 = (R1 \bowtie_{salary< salary2} R2)$

$R4 = R1 - R3$

$R5 = R1 - R4$

$R6 = \rho_{R6(eid6,\ ename6,\ salary6)}(R5)$

$R7 = \Pi_{eid,\ ename,\ salary}(R5 \bowtie_{salary< salary6} R6)$

$R8 = \Pi_{eids}(R5 - R7)$

viii. No relational algebra because there is no way to use count in RA.

ix. $R1 = \Pi_{eid,\ aid}((Employees \bowtie Certified) \bowtie Aircraft)$

$R2 = \rho_{R2(eid2,\ aid2)}(R1)$

$R3 = \rho_{R3(eid3,\ aid3)}(R1)$

$R4 = \rho_{R3(eid4,\ aid4)}(R1)$

$R5 = R1 \bowtie_{aid\ !=\ aid2\ AND\ eid=eid2} R2$

$R6 = R5 \bowtie_{aid\ !=\ aid2\ AND\ aid2\ !=\ aid3\ AND\ eid=eid3} R3$

$R7 = R6 \bowtie_{aid\ !=\ aid2\ AND\ aid2\ !=\ aid3\ AND\ aid3\ !=\ aid4\ AND\ eid=eid4} R4$

$R8 = \Pi_{eid}(R6 - R7)$

x. No relational algebra because there is no way to use sum in RA

3. (a)

i

ii. SELECT Suppliers.sid FROM Parts, Catalog WHERE color = ‘red’
UNION
SELECT Suppliers.sid FROM Parts, Catalog WHERE color = ‘green’

iii

iv. SELECT Suppliers.sid FROM Parts, Catalog WHERE color = ‘red’
INTERSECT
SELECT Suppliers.sid FROM Parts, Catalog WHERE color = ‘green’

v.

vi. SELECT Catalog.sid FROM Catalog WHERE NOT EXISTS (SELECT Parts.pid FROM Parts WHERE Parts.color=’red’ AND NOT EXISTS (SELECT Catalog2.sid FROM Catalog2 WHERE Catalog2.sid=Catalog.sid AND Catalog2.pid=Parts.pid))

vii

viii. SELECT Catalog.sid FROM Catalog WHERE NOT EXISTS (SELECT Parts.pid FROM Parts WHERE Parts.color=’red’ AND NOT EXISTS (SELECT Catalog2.sid FROM Catalog2 WHERE Catalog2.sid=Catalog.sid AND Catalog2.pid=Parts.pid))
UNION
SELECT Catalog.sid FROM Catalog WHERE NOT EXISTS (SELECT Parts.pid FROM Parts WHERE Parts.color=’green’ AND NOT EXISTS (SELECT Catalog3.sid FROM Catalog3 WHERE Catalog3.sid=Catalog.sid AND Catalog3.pid=Parts.pid))

ix

x. SELECT Catalog.pid FROM Catalog WHERE EXISTS (SELECT Catalog2.sid FROM Catalog2 WHERE Catalog2.sid != Catalog.sid AND Catalog2.pid = Catalog.pid)

xi

xii. SELECT Catalog.pid FROM Catalog WHERE Catalog.cost<200 AND NOT EXISTS (SELECT Catalog2.pid FROM Catalog2 WHERE Catalog2.pid=Catalog.pid AND Catalog2.sid=Suppliers.sid)

3. (b)

i

ii. SELECT ename FROM Aircraft, Certified, Employees WHERE Aircraft.aid=Certified.aid AND Employees.eid = Certified.eid AND aname='boeing'

iii

iv. SELECT Flights.flno FROM Employees, Aircraft, Certified, Flights WHERE Employees.salary > 100,000 AND Flights.distance < Aircraft.cruisingrange AND Certified.aid = Aircraft.aid AND Certified.eid = Employees.eid

v

vi. SELECT Employees.eid FROM Employees WHERE Employees.salary = (SELECT MAX Employees1.salary FROM Employees1)

vii

viii.

ix

x. SELECT SUM (Employees.salary) FROM Employees