

Q1 B,D
Q2 C,E
Q3 A,E
Q4 C

Q5

(5 Points)

$$\frac{\rho(v1, \sigma_{\text{disease}='Botulism'}(vaccination))}{\rho(v2, v1)} \\ \Pi_{vaccName}(v1) - \Pi_{v1.vaccName}(v1 \bowtie_{v1.waitperiod > v2.waitperiod} v2)$$

OR (3 Points)

```
SELECT vaccName
FROM Vaccination
WHERE disease = 'Botulism'
      AND waitperiod <= ALL ( select waitperiod
                              FROM Vaccination
                              WHERE disease = 'Botulism' )
```

```
SELECT vaccName
FROM Vaccination
WHERE disease = 'Botulism'
      AND waitperiod <= ( select min(waitperiod)
                          FROM Vaccination
                          WHERE disease = 'Botulism' )
```

Q6 (6 Points)

```
SELECT s.cowid
FROM vaccinationSchedule s, vaccination v
WHERE s.vaccName = v.vaccName
AND v.disease = 'Botulism'
AND NOT EXISTS
(
    SELECT s2.cowid
    FROM vaccinationSchedule s2, vaccination v2
    WHERE s2.vaccName = v2.vaccName
        AND v2.disease = 'Mastitis'
        AND s2.cowid = s.cowid
)
```

OR (4 Points)

```
SELECT s.cowid
FROM vaccinationSchedule s, vaccination v
WHERE s.vaccName = v.vaccName
AND v.disease = 'Botulism'
AND s.cowid NOT IN
(
    SELECT s2.cowid
    FROM vaccinationSchedule s2, vaccination v2
    WHERE s2.vaccName = v2.vaccName
        AND v2.disease = 'Mastitis'
)
```

Q7 (8 Points)

```
SELECT c.cowid, c.breed
FROM cow c, (SELECT cowid, sum(qty)dqty
             FROM MilkingSchedule
             GROUP BY cowid, milkdate
            ) m
WHERE c.cowid = m.cowid
      AND c.breed IN ('Shorthorn', 'Holstein')
GROUP BY cowid, breed
HAVING avg(dqty) >= ALL
(
  SELECT avg(dqty)
  FROM Cow C,
       (SELECT cowid, sum(qty)dqty
        FROM MilkingSchedule
        GROUP BY cowid, milkdate
       ) M
  WHERE C.cowid = M.cid
        AND c.breed IN ('Shorthorn', 'Holstein')
  GROUP BY cowid
)
```

OR (4 Points)

```
SELECT cowid, breed, avg(m.dqty)
FROM cow c, (SELECT cowid, sum(qty)dqty
             FROM MilkingSchedule
             GROUP BY cowid, milkdate
            ) m
WHERE c.cowid = m.cowid
      AND c.breed IN ('Shorthorn', 'Holstein')
GROUP BY cowid, breed
HAVING avg(dqty) >= 20
```

Q8 (11 Points)

(1) $4000 / 20 \times 0.75 = 150$ records per page.

(2) $100 \text{ cows} \times 2 \text{ times a day} = 200$ per **milkDate** (i.e per data entry)

(3) Index entry size = $4 + 5 \times 200 = 1004$

$4000 / 1004 \times 0.75 = \text{approx } 3$ data entries per index leaf page

(4) Number of records in a day inserted into **milkingSchedule** (from ANS(2)) = 200

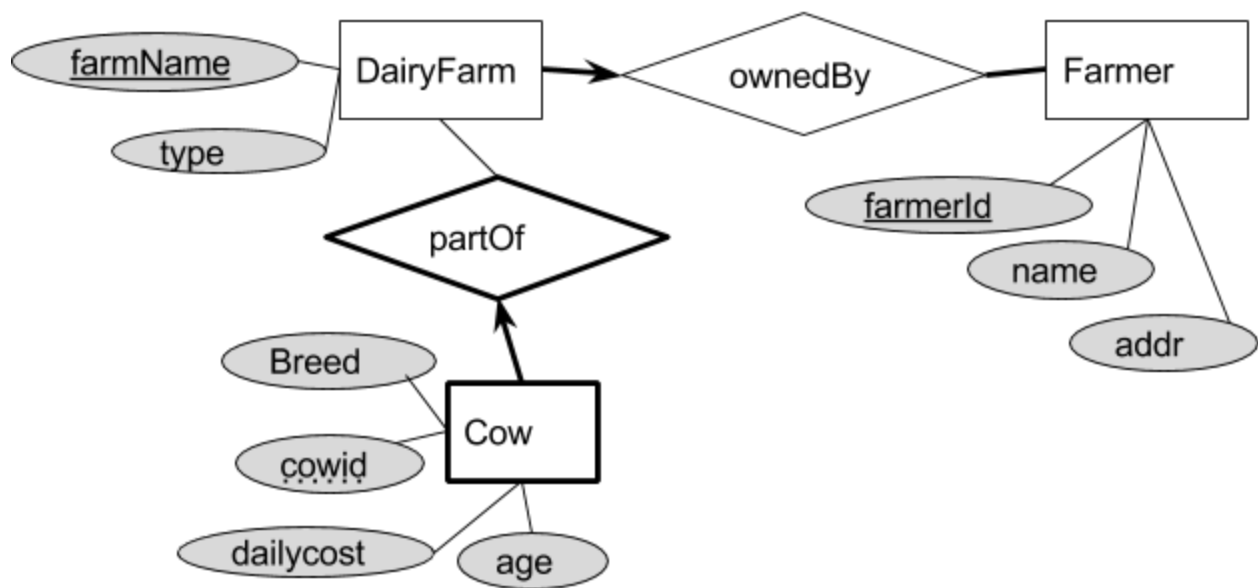
Therefore a query for a specific **milkDate** may have to access 200 different data pages on a worst case.

From ANS(1), each day's milking activity requires $200 / 150 = 4/3$ pages.

Number of days to get to 200 pages = $200 / (4/3) = 150$ days. (or 151 days accounting for the IO of the index leaf page itself)

Q9

Joe's Dairy Farm



```
Cow(cowId, farmName, dailycost, Breed, age) farmName Ref DairyFarm
DairyFarm(farmName, type, farmerId) farmerId Ref Farmer
Farmer(farmerId, name, addr)
milkingSchedule(cowId, farmName, qty, purity, milkDate, partOfDay)
cowId, farmName Ref Cow
vaccinationSchedule(cowId, farmName, vaccName, vaccDate) cowId, farmName
Ref Cow, vaccName Ref vaccination
```