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CS143 Homework #6

1. Yes, the decomposition is lossless, since the A that is shared and joined between the functional dependencies is a unique key; it is able to obtain (A, D, E) from R1(A, D, E).

2. B is always constant, A has some variation, C has the most variation. Therefore, our functional dependencies could be (A→B) and (C→A). Basically, we let the most varying variable choose the next most varying variable.

3. (a) One-to-one relationship between Student and Class:
   sid → dept, cnum
   dept, cnum -> sid

   (b) Many-to-one relationship between Student and Class
   sid → dept, cnum
   (This means a student necessarily takes just one class)

4. (a) Yes, E is a key, since {E}+ = {ABCDE}

   (b) Yes, BC is a key, since {BC}+ = {ABCDE}

5. No, this is not BCNF, since
   {A}+ = {BCDE} not BCNF
   {C}+ = {E} not BCNF
   {B}+ = {BD}

   R(A,B,C,D,E,F)

   R1(C,E)
   R2(A,B,C,D,F) => R3(B,D)
   R4(A,B,C,F) =>
   R5(A,B,C)
   R6(A,F)

   So we're using R1, R3, R5, and R6 with the functional dependencies shown above.

6. Since A maps to B,C, the D could still be any combination. And we know that there are d1, d2, and d3. Therefore, we'll need all of these:

   (a, b1, c1, d1)
   (a, b1, c1, d2)
   (a, b1, c1, d3)
   (a, b2, c2, d2)
   (a, b2, c2, d1)
   (a, b2, c2, d3)
   (a, b3, c3, d3)
   (a, b3, c3, d1)
   (a, b3, c3, d2)

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7. This is not in 4NF, since we don't have X→Y and X->>Y, where X is key

First, check for BCNF.

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R1(A,B,E) =>      R3(A,B)
                  R4(A,E)
R2(A,B,C,D,F) =>  R5(A,B,C) =>      R7(A,B)
                                    R8(A,C)
                  R6(A,B,D,F) =>    R9(A,B)
                                    R10(A,D,F)
```

Notice that R3=R7=R9. Finally, we end up with R3, R4, R8, R8, and R10 with the functional dependencies shown above.

To get it to 4NF, we had to BCNF it first then check for MVDs such that all conditions hold.