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HW#4 CS143

**PART I**

1. The decomposition is not lossless because the dependencies CD -> E and B -> D are lost. C and D are not in the same relation. Neither are B and D.

2. C -> A
   C -> B

3. A) Yes
   E -> A & A -> BC => E -> ABCE
   E -> ABC & B ->D => E -> ABCDE

   B) Yes
   B -> D => BC -> BCD
   BC -> BCD & CD -> E => BC -> E
   Since E is a key, BC is also a key.

4. R is not BCNF.
   A -> BCDE, F -> F => superkey: AF
   None of A, C, or B is a candidate key, therefore R is not BCNF.

   Decomposition:
   A -> BCDE:
   R1 (A, B, C, D, E); R2 (A, F)

   C -> E:
   R1 (A, B, C, D); R2(C, E); R3(A, F)

   B -> D:
   R1 (A, B, C); R2(B, D); R3(C, E); R4(A, F) – FINAL

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

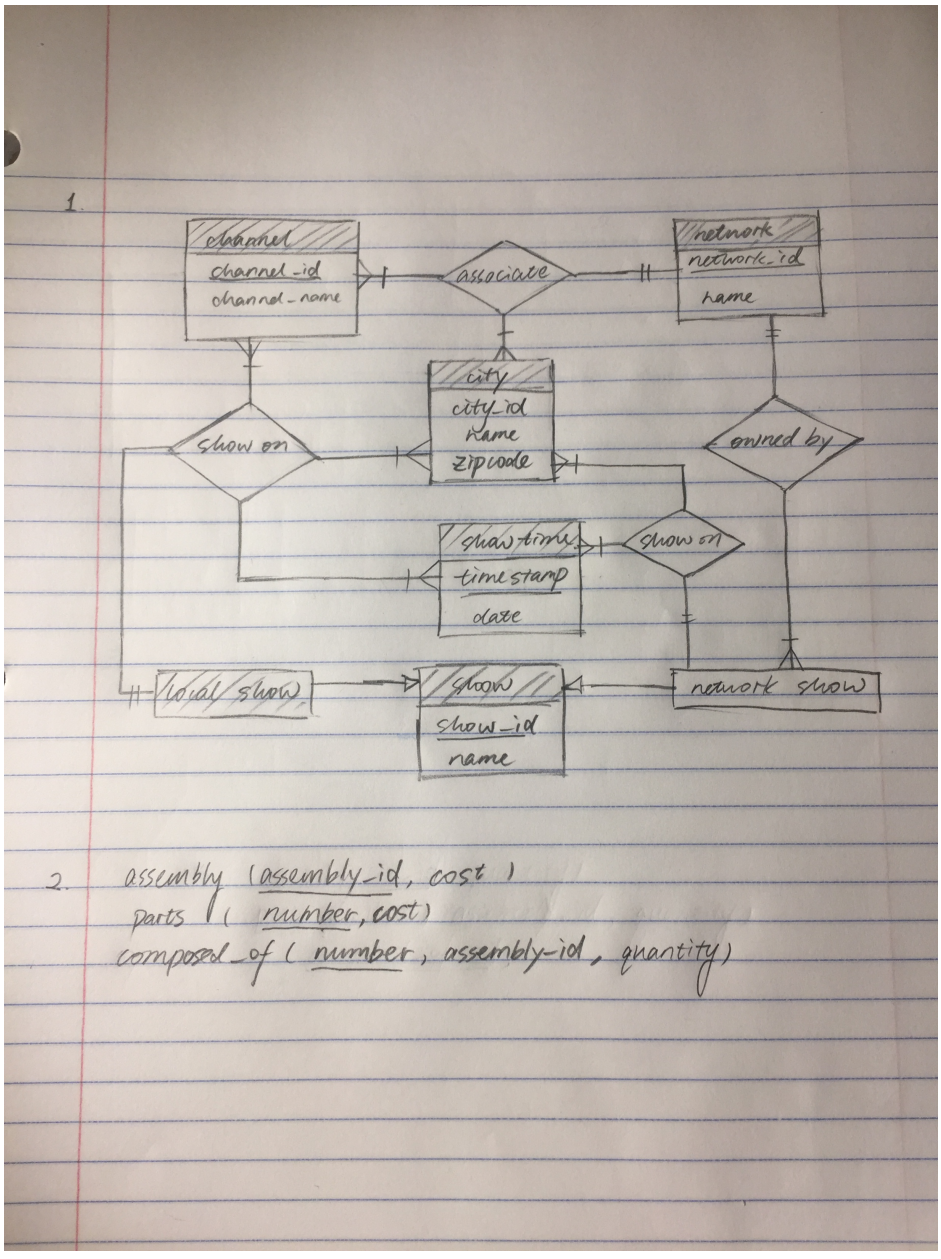
6. R is not 4NF, because neither of the left side of the multivalued dependencies are candidate keys.
   To normalize R, we first decompose R into BCNF:
   AB -> E:
   R1(A, B, E); R2(A, B, C, D, F)

   R1(A, B, E) is BCNF but not 4NF:
   A ->> B:
   R3(A, B); R4(A, E)

R2(A, B, C, D, F) is BCNF but not 4NF:
AB ->> C:
R5(A, B, C); R6(A, B, D, F)

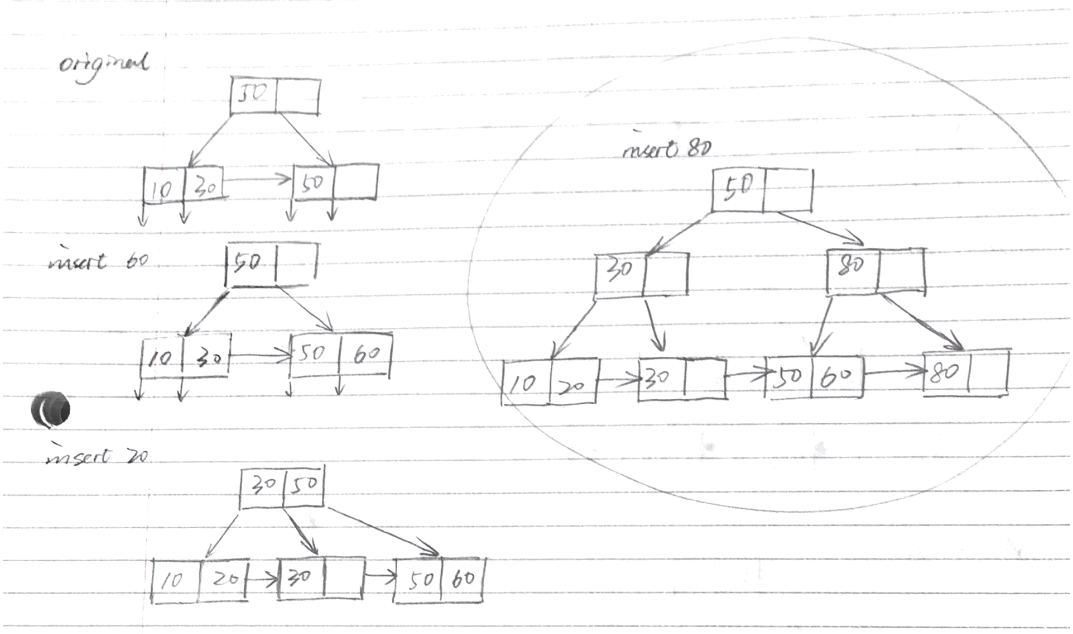
Therefore, the normalized 4NFs are:
R3(A, B); R4(A, E); R5(A, B, C); R6(A, B, D, F)

**PART II**



**PART III**

1)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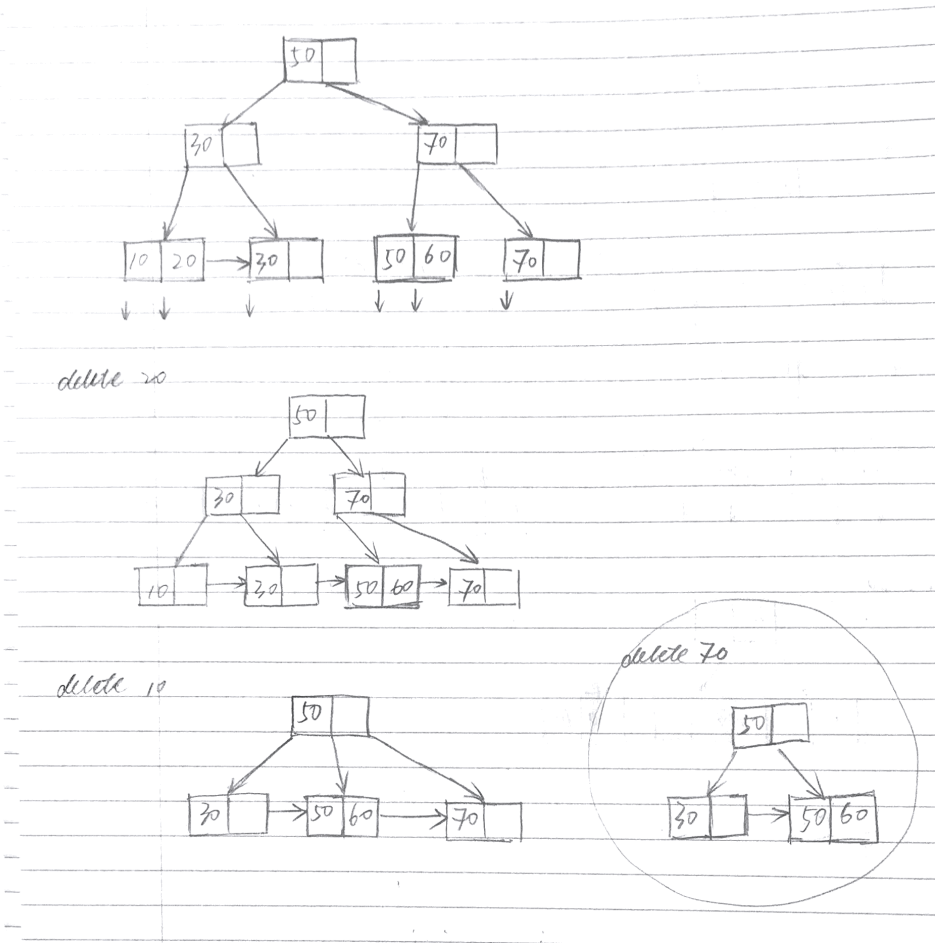
2)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