**Assignment 5**

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**Problem 1:**

a)

A+ = A (trivial) BD+ = BD (trivial) ADE+ = ADE (trivial)

B+ = B (trivial) BE+ = BE (trivial) BCD+ = ABCDE (super)

C+ = AC CD+ = ABCDE (super) BCE+ = ABCDE (super)

D+ = D (trivial) CE+ = ACE BDE+ = BDE (trivial)

E+ = E (trivial) DE+ = DE (trivial) CDE+ = ABCDE (super)

AB+ = ABDE ABC+ = ABCDE (super) ABCD+ = ABCDE (super)

AC+ = AC (trivial) ABD+ = ABDE ACDE+ = ABCDE (super)

AD+ = AD (trivial) ABE+ = ABDE ABDE+ = ABDE (trivial)

AE+ = AE (trivial) ACD+ = ABCDE (super) ABCE+ = ABCDE (super)

BC+ = ABCDE (super) ACE+ = ACE (trivial) BCDE+ = ABCDE (super)

Candidate Keys: BC, CD

b)

Violating FDs: AB -> D, AB -> E, C -> A

c)

Relation used for decomposition (step 1): C -> A

R1(A, C)

S1 = {C -> A}

R2(B, C, D, E)

S2 = {BC -> D, CD -> B}

Candidate keys for R2: BCE, CDE

Both FDs in S2 violate BCDF

Relation used for decomposition (step 2): CD -> B

R3(C, D, B)

S3 = {BC - > D, CD -> B}

R4(C, D, E)

S3 = {}

**Final Decomposition:**

**R1(A, C)**

**R3(B, C, D)**

**R4(C, D, E)**

d)

AB -> D, AB -> E, C -> A, CD -> B

e)

s' = {AB -> D, AB -> E, C -> A, CD -> B}

Violating FDs: AB -> E, C -> A

f)

Combining FDs that have the same left side:

AB -> DE, C -> A, CD -> B

Creating relations from FDs:

R1(A, B, D, E)

R2(A, C)

R3(B, C, D)

**Problem 2:**

a)

A+ = A (trivial) BD+ = BD (trivial) ADE+ = ACDE

B+ = B (trivial) BE+ = ABE BCD+ = ABCDE (super)

C+ = C (trivial) CD+ = CDE BCE+ = ABCE

D+ = D (trivial) CE+ = CE (trivial) BDE+ = ABCDE (super)

E+ = E (trivial) DE+ = DE (trivial) CDE+ = CDE (trivial)

AB+ = AB (trivial) ABC+ = ABC (trivial) ABCD+ = ABCDE (super)

AC+ = AC (trivial) ABD+ = ABCDE (super) ACDE+ = ACDE (trivial)

AD+ = ACDE ABE+ = ABE (trivial) ABDE+ = ABCDE (super)

AE+ = AE (trivial) ACD+ = ACDE ABCE+ = ABCE (trivial)

BC+ = BC (trivial) ACE+ = ACE (trivial) BCDE+ = ABCDE (super)

Candidate Keys: ABD, BCD, BDE

b)

Violating FDs: BE -> A, CD -> E, AD -> C

c)

Relation used for decomposition (step 1): BE -> A

R1(A, B, E)

S1 = {BE -> A}

R2(B, C, D, E)

S2 = {CD -> E}

Candidate key for R2: BCD

CD -> E violates BCNF

Relation used for decomposition (step 2): CD -> E

R3(C, D, E)

S3 = {CD -> E}

R4(B, C, D)

S4 = {}

**Final Decomposition:**

**R1(A, B, E)**

**R3(C, D, E)**

**R4(B, C, D)**

d)

S' = {AD -> C, BE -> A, CD -> E}

e)

S' is already in 3NF because the right-hand side of each FD in S' is prime:

For the FD AD -> C, C is in the candidate key BCD, so it is prime.

For the FD BE -> A, A is in the candidate key ABD, so it is prime.

For the FD CD -> E, E is in the candidate key BDE, so it is prime.