

1a) $C \rightarrow D, C \rightarrow A, B \rightarrow C$

LHS/none	Both	RHS
B	C	A, D

i) $\frac{B^+}{BCDA}$ candidate key: B

ii) Since key is singular it is 2NF.

FD $C \rightarrow D$ has non prime attribute on the RHS and the LHS is a Superkey.

That makes $C \rightarrow D$ is a 3NF violation
(R, F) is in 2NF but not 3NF.

iii) BCNF violation: $C \rightarrow D$, LHS is not Superkey
 C^+/CDA

$R = \frac{C}{X} \frac{D}{Y} \frac{AB}{Z}$
 $R_1(CD) \leftarrow R \rightarrow R_2(CAB)$

$F_1 = C \rightarrow D$

$F_2 = C \rightarrow A, D \rightarrow C$

LHS/none	Both	RHS
C		D

LHS/none	Both	RHS
B	C	A

$\frac{C^+}{CD}$ candidate key: C

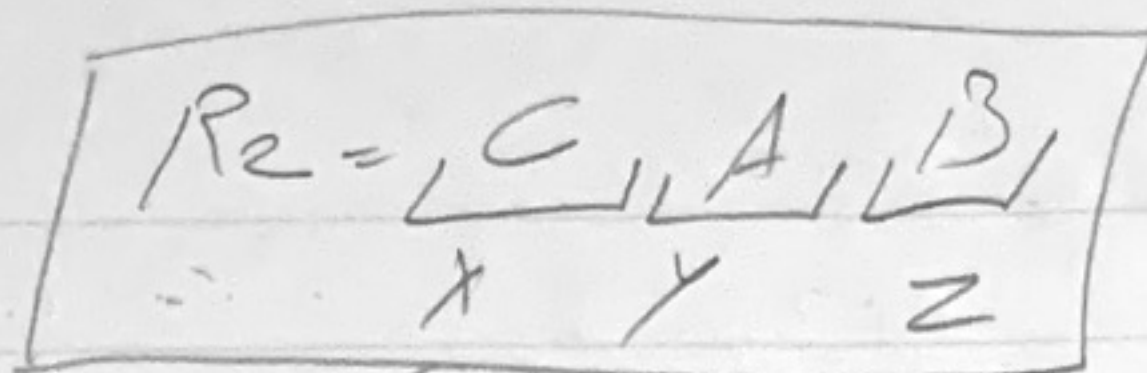
$\frac{B^+}{BCA}$ candidate key: B

BCNF violation: none

BCNF violation: $C \rightarrow A$

C^+/CA

1a iii continued



$R_3 = DA$

$F_3 = D \rightarrow A$

$R_4 = DB$

$F_4 = \emptyset$

Candidate key = DB

BCNF violation: none

LHS/none	both	RHS
D		A

$\frac{D^+}{DA}$ Candidate key: D

BCNF violation: none

15) $B \rightarrow C, D \rightarrow A$

if

LHS/none	both	RHS
BD		CA

$\frac{BD^+}{BDCA}$

Candidate Key: BD

ii) B and D are prime attribute and CA are non prime we also obtain $BD \rightarrow CA$ where BD is a candidate key and CA is non prime
 Therefore $BD \rightarrow CA$ is a 2NF violation

Q5)
 i) BCNF violation: $B \rightarrow C$ because LHS is not superkey $\frac{B^+}{BC}$

$$R = \frac{B}{X} \frac{C}{Y} \frac{AD}{Z}$$

$$R_1 = BC$$

$$F_1 = B \rightarrow C$$

LHS/none	both	RHS
B		C

$$\frac{B^+}{BC} \quad CK = B$$

BCNF violation: none

$$R_2 = B A D$$

$$F_2 = D \rightarrow A$$

LHS/none	both	RHS
D		A

$$D^+ / DA$$

BCNF violation: $D \rightarrow A$

$$R_2 = \frac{D}{X} \frac{A}{Y} \frac{B}{Z}$$

$$R_3 = DA$$

$$F_3 = D \rightarrow A$$

LHS/none	both	RHS
D		A

$$D^+ / DA \quad CK = D$$

BCNF violation: none

$$R_4 = D B$$

$$F_4 = \emptyset$$

$$CK = DB$$

BCNF violation: none

Decomposed relation:

$$BC, DA, DB$$

1c) $ABC \rightarrow D, D \rightarrow A$

i- LHS / here | both | RHS
BC | AD

$$\frac{BC^+}{BC} \times \frac{BCA^+}{BCAD} \vee \frac{BCD^+}{BCDA}$$

CH: BCA, BCI

ii) All attributes are prime, (R, F) is in 3NF. The LHS of the FD $D \rightarrow A$ is not a superkey. Therefore, it is a BCNF violation.

(R, F) is in 3NF but not in BCNF

iii) BCNF violation: $D \rightarrow A$ D^+ / DA

$$R = \frac{D}{x} \quad \frac{A}{y} \quad \frac{BC}{z}$$

$$R_1 = DA$$

$$F_1 = D \rightarrow A$$

$$R_2 = DBC$$

$$F_2 = \emptyset$$

$$\frac{\text{LHS / here} \mid \text{here} \mid \text{RHS}}{D \mid A}$$

$$D^+ / DA \quad CH = D$$

BCNF violation here

$$CH: DBC$$

BCNF violation here

Decomposed: DA, DBC
relations

1d) $AB \rightarrow C, AB \rightarrow D, C \rightarrow A, D \rightarrow B$

i- LHS/none | both | RHS
AB, C, D

$\frac{AB^+}{ABCD} \quad \frac{BC^+}{BCAD} \quad \frac{CD^+}{CDAB} \quad \frac{AD^+}{ADBC}$ OK: AB, BC, AD, CD

ii- All attributes are prime, therefore (R, F) is in 3NF. The LHS of the FD $C \rightarrow A$ is not a superkey. Therefore, it is a BCNF violation.

(R, F) is in 3NF but not in BCNF.

iii) BCNF violation: $C \rightarrow A$ $\frac{C^+}{CA}$

$R = \underbrace{C}_X, \underbrace{A}_Y, \underbrace{BD}_Z$

$R_1 = CA$

$F_1 = C \rightarrow A$

LHS/none | both | RHS
C | A

$\frac{C^+}{CA} \quad CA=C$

BCNF violation none

$R_2 = C BD$

$F_2 = D \rightarrow B$

LHS/none | both | RHS
D | B

D^+/DB

BCNF violation: $D \rightarrow B$

$R_2 = \underbrace{D}_X, \underbrace{B}_Y, \underbrace{C}_Z$