3.1.1

Social security numbers are a unique identifier.
Street addresses can be the same as long as not
in same city and state. Phone number can
be the same unless in same area code.

3.2.1

R(A,B,C,D)

a) C→A

b) AB, BC, BD

c) ABC, ABD, BCD, ABCD

FDS

AB →C

C →D

D → A

_____

C →A

$ABC^+ →ABCD$ super

$ABD^+ →ABDC$ super

$BCD^+ →BCDA$ super

A→A

B→B

C→CDA

D→DA

$\widehat{AB→ABCD}$

AC→ACD

AD→AD

$\widehat{BC→BCDA}$

$\widehat{BD→BDAC}$

CD→CDA

ACD→ACD

3.2.2 ;; T(A,B,C,D)

a) AB→D, AD→C, AD→D, BC→A,
~~AD~~ ~~CD→A~~, CD→B

b) AB, AD, BC, CD

c) ABC, ABD, ACD, BCD, ABCD

AB→C

BC→D

CD→A

AD→B

_____

AB→D

AD→C

AD→D

BC→A

CD→B   ✓

$A^+=A$

$B^+=B$

$C^+=C$

$D^+=D$

$AB^+=ABCD$

$AC^+=AC$

$AD^+=ADBC$

$BC^+=BCDA$

$BD^+=BD$

$CD^+=CDAB$

$ABC^+=ABCD$

$ABD^+=ABDC$

$ACD^+=ACDB$

$BCD^+=BCDA$

3.2.4

a) If A→B then B→A

If attr A is SSN and B is name, B→A would not be valid as many people have the same name and different SSN.

b) If AB→C, and A→C, then B→C

If attr A is SSN and B is gender and C is name, B→C would not be valid as SSN and gender can uniquely identify someone's name, but gender (B) can't.

c) If AB→C then A→C or B→C.

If attr A is latitude and B is longitude. together AB can determine C a point on the world map, but not separately.

3.2.10   A,C   R(A,B,C,D,E)   S(A,B,C)

a) AB→DE, C→E, D→C, E→A

$\boxed{AB \to C, BC \to A}$

$A^+ = A$ 　　　$AC^+ = ACE$

$B^+ = B$ 　　　$BC^+ = BCEAD$

$C^+ = CE$ 　　$ABC^+ = ABCDE$

$AB^+ = ABDEC$

c) AB→D, AC→E, BC→D, D→A, E→B

$A^+ = A$ 　　$AC^+ = ACEBD$ 　　$\boxed{AC \to B}$

$B^+ = B$ 　　$BC^+ = BCDAE$

$C^+ = C$ 　　$AB^+ = ABD$

　　　　　　$ABC^+ = ABCDE$

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3.3.1

b) $R(A, B, C, D)$ FDs
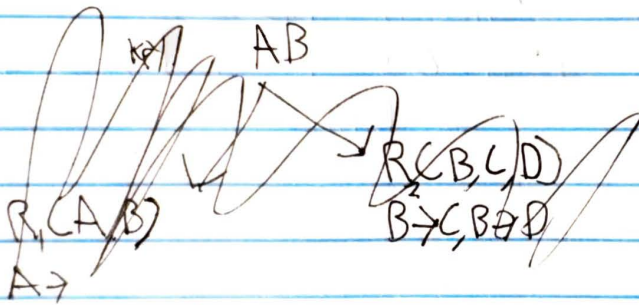$B \rightarrow C$ violation $B \rightarrow C, D$ violation
$B \rightarrow D$ violation

i)
$A^+ = A$ $\boxed{AB^+ = ABCD}$ key $BD^+ = BDC$ violation $ACD^+ = ACD$
$B^+ = BCD$ violation $AC^+ = AC$ $CD^+ = CD$ $BCD^+ = BCD$
$C^+ = C$ $AD^+ = AD$ $ABC^+ = ABCD$ $ABCD^+ = ABCD$ key
$D^+ = D$ $BC^+ = BCD$ violation $ABD^+ = ABDC$ proper key

~~AABDTMABVDM~~

AB
$R_1(A, B)$ → $R_2(B, C, D)$
$A \rightarrow$ $B \rightarrow C, B \rightarrow D$

ii) $B \rightarrow C$
(A, B, C, D)

$R_1 = \{B, C, D\}$ $R_2 = \{B, A\}$ BCNF
A, B

d) $R(A, B, C, D)$ $A \rightarrow B, B \rightarrow C, C \rightarrow D, D \rightarrow A$
loop

$A^+ = ABCD$ $AB^+ =$ $BD^+ =$ $A \rightarrow C, A \rightarrow D$
$B^+ = BCDA$ $AC^+ =$ $DC^+ =$ $ACD^+ =$
$C^+ = CDAB$ $AD^+ =$ $ABC^+ =$ $BCD^+ =$
$D^+ = DABC$ $BC^+ =$ $ABD^+ =$

i) No violation   ii) Relation is BCNF

3.3.4

$R(A, B, C)$ FDs

$A \rightarrow B$

$S(A, B)$ $4(B, C)$

S   9

a_1 b_1 $b1$ 4

a_2 b_2 b_2 c_2

a_3 b_3 b_3 c_3

natural join   • theta join filtered

a_1 b_1 c_1 • if C was part of key, so duplicates

a_2 b_2 c_2 an BCNF violations

a_3 b_3 c_3