1

a)

First, we split the right hand side of the final FD into C->A and C->D

$F \quad \{BC \rightarrow A, AB \rightarrow C, C \rightarrow D, C \rightarrow A\}$

X	X^+	Key?
A	A	
B	B	
C	A, C, D	
D	D	
AB	A, B, C, D	yes
AC	A, C, D	
AD	A, D	
BC	A,B, C, D	yes
BD	B, D	
CD	A, C, D	
ABC	A, B, C, D	SK
ABD	A, B, C, D	SK
ACD	A, C, D	
BCD	A, B, C, D	SK

Keys are AB and BC.

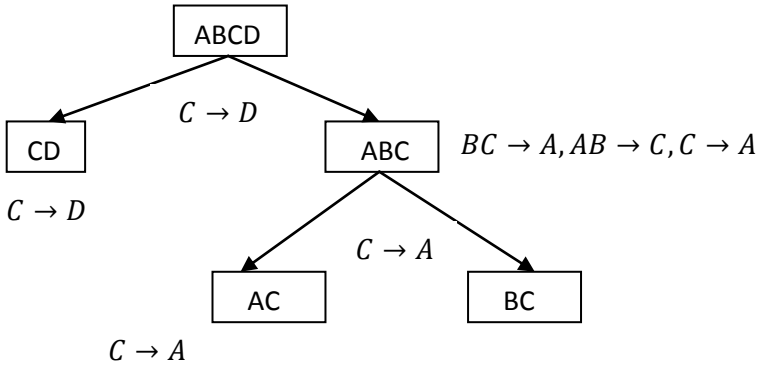
b)

$F^+ \quad \{BC \rightarrow A, C \rightarrow A, C \rightarrow D, AB \rightarrow C, AB \rightarrow D, BC \rightarrow D\}$

R is not in BCNF because at least one of the FDs, eg. $C \rightarrow A$ violates BCNF.

R is not in 3NF because D is not part of a key.

Decompose R based on $C \rightarrow D$:



CD is BCNF, but ABC is not, because the keys are AB and BC, and C does not contain any of the keys. Hence C->A is a BCNF violation, and we split again around it, obtaining AC and BC.

2

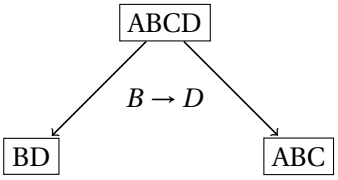
a)
$F = \{AB \to C, B \to D\}$

X	X^+	Key?
A	A	
B	B, D	
C	C	
D	D	
AB	A, B, C, D	yes
AC	A, C	
AD	A, D	
BC	B, C, D	
BD	B, D	
CD	C, D	
ABC	A, B, C, D	SK
ABD	A, B, C, D	SK
ACD	A, C, D	
BCD	B, C, D	

b)

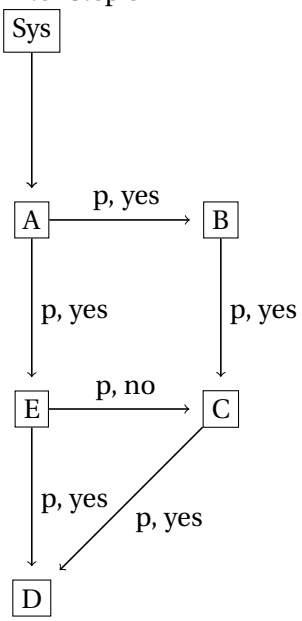
R is not in BCNF because at least one of the FDs, eg. $B \to D$ violates BCNF. R is not in 3NF because D is not part of any key.

$F^+ = \{AB \to C, B \to D\}$



3

After Step 5



After Step 6