1. Consider the universal relation $R = \{A, B, C, D, E, F, G, H, I, J\}$ and the set of functional dependencies $F = \{AB \to C, A \to DE, B \to F, F \to GH, D \to IJ\}$. What is the key for R? Decompose R into 2NF, then 3NF relation

$AB \to C$ Full
$A \to D$ Partial
$A \to E$ "
$B \to F$ "
$F \to G$ Full
$F \to H$ "
$D \to I$ "
$D \to J$ "

$AB^+ = \{ABCDEFGHIJ\}$
AB is the only candidate key
Non prime attributes $= \{CDEFGHIJ\}$
Prime attributes $= \{AB\}$

To convert to 2NF, decompose R as

$R_1(A^*, B^*, C)$
$R_2(A^*, D, E, I, J)$
$R_3(B^*, F, G, H)$

There are transitive dependencies in the above relation. So to convert to 3NF, decompose as:

$R_1(A^*, B^*, C)$
$R_{22}(A^*, D, E)$
$R_{..}(A, D^*, I, J)$

$R_{32} = \{B^*, F\}$

$R_{33} = \{F^*, G, H\}$

2. Given the relation $R = \{A, B, C, D, E\}$ and correspond set $F = \{A \to BC, CD \to E, B \to D, E \to A\}$

Find out the candidate keys of relation, R.

$A \to BC$
$CD \to E$
$B \to D$
$E \to A$

$A^+ = \{ABCDE\}$ $\quad$ $BC^+ = \{BCDEA\}$

$B^+ = \{BD\}$

$E^+ = \{ABCDE\}$

$CD^+ = \{CDEAB\}$

$BD^+ = \{BD\}$

~~Candidate keys are~~ $\{A^+, \cancel{D}, E^+, CD^+, BC$

Candidate keys $= \{A, E, CD, BC\}$

3. Consider the 2 sets of F.D

$F = \{A \to C, AC \to D, E \to AD, E \to H\}$

$G = \{A \to CD, E \to AH\}$

Check whether or not they are equivalent.

$F = \{A \to C, AC \to D, E \to AD, E \to H\}$

Find G^+ (ie; A^+ & E^+)

$A^+ = \{ACD\}$

$E^+ = \{ADHCE\}$

$\cancel{A \to C}$ $A \to CD$

$E \to AH$

So F covers G.

Find F^+ $G = \{A \to CD, E \to AH\}$

$A^+ = \{ACD\}$

$AC^+ = \{ACD\}$

$E^+ = \{AHCDE\}$

$A \to C$ $\cancel{A \to}$ $AC \to D$

$E \to AD$ $E \to H$

So G covers F

As F covers G and G covers F, F and G are equivalent

4. Consider the relation Stud (Sno, Sname, Cno, Cname)

Find closure of (Sno, Cno). Given FD are:

a) Sno → Sname

b) Cno → Cname

$(Sno, Cno)^+ = \{Sno, Cno, Sname, Cname$.

~~tt.~~ It is a candidate key.

5. Let R be a relation

$R = (A, B, C, D, E, F)$ having FD:

$A \rightarrow BC$

$B \rightarrow E$

$C \rightarrow EF$

$E \rightarrow CF$

Find closure ~~of~~ of (A, B)

$(A, B)^+ = \{ABCEF\}$

6. Consider the relation:

SP (Sno, Sname, Pno, Qty)

FD of above relation:

$(Sno, Pno) \rightarrow Qty$

$(Sname, Pno) \rightarrow Qty$

$Sno \rightarrow Sname$

$Sname \rightarrow Sno$

Is this relation in 3NF. Check for it to be in BCNF. Sname is considered unique for each Sno.

$(Sno, \cancel{Sname}\ Pno)^+ = \{Sno, Pno, Qty, Sname\}$

~~Sno~~, $(Sname, Pno)^+ = \{Sname, Pno, Qty, Sno\}$

Canditate keys: (Sno, Pno) & (Sname, Pno).
Prime attributes: Sno, Pno, Sname.
Non-prime attribute: Qty.
The relation is in 2NF as no
non-prime attribute depends partially on
a key.
Qty depends on a full key.
There is no transitive dependencies. So the
relation is in 3NF.
It is not in BCNF as ~~Sname~~
Sno → Sname
Sname → Sno
Sno and Sname are not superkeys.
To convert to BCNF, decompose as.
R_1 (Sno*, ~~Sname~~ Pno*, Qty)
R_2 (Sno*, Sname)
OR
R_1 (Sno*, Pno*, Qty)
R_2 (Sname*, Sno)
OR
R_1 (Sname*, Pno, Qty)
R_2 (Sname*, Sno)

7. For the given relation R, which of the FDs are satisfied:

Relation R

X	Y	Z
1	4	2
1	5	3
1	6	3
3	2	2

a) $XY \rightarrow Z$ and $Z \rightarrow Y$

b) $YZ \rightarrow X$ and $Y \rightarrow Z$

c) $YZ \rightarrow X$ and $X \rightarrow Z$

d) $XZ \rightarrow Y$ & $Y \rightarrow Z$

a) $XY \rightarrow Z$ is satisfied but not $Z \rightarrow Y$

b) $YZ \rightarrow X$ ~~is~~ " ~~but~~ and $Y \rightarrow Z$ are satisfied

c) $YZ \rightarrow X$ is satisfied but not $X \rightarrow Z$

d) $XZ \rightarrow Y$ is not satisfied. but $Y \rightarrow Z$ is satisfied.

8. Compute closure of F of FDs

$R = \{A, B, C, D, E\}$

$A \rightarrow BC$, $CD \rightarrow E$, $B \rightarrow D$, $E \rightarrow A$.

List candidate keys for R.

$A^+ = \{ABCDE\}$

$B^+ = \{BD\}$

~~$C^+ = \{$~~ $CD^+ = \{CDEAB\}$

$E^+ = \{EABCD\}$

~~$AB^+ = \{ABE$~~

$BC^+ = \{BCDEA\}$

Candidate keys $= \{A, E, BC, CD\}$

9. Given two sets of FD F_1 and F_2. Are they equivalent.

F_1 : $A \to B$, $AB \to C$, $D \to AC$, $D \to E$

F_2 : $A \to BC$, $D \to AE$

To check if F_1 cover F_2

~~$A^+ = \{$~~ A^+ ~~wit~~ wrt F_1

$A^+ = \{ABC\}$

$D^+ = \{DACEB\}$

$A \to BC$ and $D \to BC$ are derivable from A^+ and D^+. Hence, F_1 covers F_2

To check if F_2 cover F_1

$A^+ = \{ABC\}$

$AB^+ = \{ABC\}$

$D^+ = \{DAEBC\}$

~~B~~ $A \to B$

$AB \to C$

$D \to AC$, $D \to E$ are derivable.

Hence F_2 covers F_1.

F_1 and F_2 are equivalent.

10. Consider the schema $S = \{v_1, w_1, x_1, y_1, z_1)$ say the FD hold.

$$Z \rightarrow V$$
$$W \rightarrow Y$$
$$XY \rightarrow Z$$
$$U \rightarrow \cancel{WZ}\ WX$$

State whether the following decomposition of schema, S, is lossless join decomposition. Justify the answer.

$S_1 = (V, W, X)$
$S_2 = (V, Y, Z)$

	$v(A_1)$	$w(A_2)$	$x(A_3)$	$Y(A_4)$	$Z(A_5)$
$S_1 = (v, w, x)$	a_1	a_2	a_3	b_{14}	b_{15}
$S_2 (v, y, z)$	a_1	b_{22}	b_{23}	a_4	a_5

$$Z \rightarrow V$$

~~1. Consider the following 2 sets of FD~~
~~$F = \{A \to C,\ AC \to D,\ E \to AD,\ E \to H\}$ and~~
~~$G = \{A \to CD,\ E$~~

11. Prove that any relation schema with two attributes is in BCNF.

Consider the schema $R = \{A, B\}$ with 2 attributes.

The possible non-trivial FDs are:

$\{A\} \to B$

and $B \to A$

There are 4 cases:

i) No FD holds in R. Then, key is $\{A, B\}$ and relation satisfies BCNF

ii) Only $A \to B$ holds. key is A and relation satisfies BCNF

iii) Only $B \to A$ holds, key is B and relation satisfies BCNF

iv) Both $A \to B$ and $B \to A$ hold. There are 2 keys A and B & relation satisfies BCNF.

Any relation with 2 attributes is in BCNF

12. For a relation, $R(A, B, C, D, E, F)$ the set of FDs, F is given as follows:

$F = \{AB \to C,\ C \to A,\ BC \to D,\ ACD \to B,$
$BE \to C,\ CE \to FA,\ CF \to BD,\ D \to E\}$

Find a non-redundant cover for F. Is this the only non-redundant cover? Also find its canonical cover.

$F' = F - \{AB \to C\} \cup \{A \to B\}$

$A^+ = \{AC\}$

$F' = \{F - \{AB \to B\}\} \cup \{X - \{B\} \to A\}$

$= \{B \to C, \ldots\}$

~~$B^+ = \{BCADEFABD\}$~~

$A^+ =$

Remove $ACD \to B$ from F and take

$ACD^+ = \{ACDEFAB\}$

So $ACD \to B$ is redundant

Non-redundant cover:

$F = \{AB \to C, C \to A, BC \to D,$ ~~$ACD \to B$~~, $D \to E,$
$BE \to C, CE \to FA, CF \to BD\}$

Canonical cover

To check if A is redundant in $AB \to C$

$F = \{F - \{AB \to C\}\} + \{B \to C\}$

$= \{B \to C, C \to A, BC \to D, BE \to C, CE \to FA,$
$CF \to BD, D \to E\}$

Now take B^+. if B^+ contains A then A is redundant

$B^+ = \{BCDEFA\}$

Hence ~~B is r~~

$B \to A$ $\quad B \to C$

~~$AB \to C$~~

B is redundant

$F = \{B \to C, C \to A, BC \to D, BE \to C, \cancel{E} \to F; CE \to A,$
$CF \to B, CF \to D, D \to E\}$

~~$C^+ = \{$~~ Check if B is redunt in $BC \to D$

$C^+ = \{C A D E F \cancel{A} B\}$

$C \to B$

Hence B is redundant

$F = \{B \to C, C \to A, C \to D, BE \to C, CE \to F, CE \to A,$
$CF \to B, CF \to D, D \to E\}$

Check if B is redundant in $BE \to C$

$E^+ = \{E C A F B D\}$

Hence B is redundant

$F = \{B \to C, C \to A, C \to D, E \to C, CE \to F, CE \to A,$
$CF \to B, CF \to D, D \to E\}$

$CE \to F$

$C^+ = \{C F A D B E\}$ CAD EF

$F = \{B \to C, C \to A, C \to D, E \to C, C \to F, C \to A, C \to B,$
$C \to D, D \to E\}$

$= \{B \to C, C \to A, C \to D, E \to C, C \to F, \cancel{B} C \to B, D \to E\}$

is the minimal cover

13. Find BCNF Decomposition :

Shipping (Ship , Capacity , Date, Cargo , Value)

Ship → Capacity

Ship, Date → Cargo

Cargo, Capacity → Value .

Specify key .

Key is Ship , Date .

R_1 (Ship*, Date*, Cargo)

R_2 (Ship*, Capacity)

R_3 (Cargo*, Capacity*, Value) .

14. For R = {A, B,