Qusetion 1

1) J do not appear on either side of functional dependency

$\Rightarrow J \notin F$

$\therefore C \rightarrow J \notin F^+$

2) $F' = \{AB \rightarrow C,\ AB \rightarrow E,\ D \rightarrow G,\ D \rightarrow H,\ E \rightarrow B,\ E \rightarrow C,\ E \rightarrow D,$
$C \rightarrow D,\ C \rightarrow I,\ H \rightarrow G,\ EH \rightarrow I\ \}$

Appearred on the lift side $L = \{A, B, C, D, E, H\}$

Right side $R = \{B, C, D, E, G, H, I\}$.

$\therefore$ all condidate key must in lude $\{A, J\}$

$\because \{A, J\}^+ \not\rightarrow R$. $\therefore \{A, J\}$ is not the only condidate key.

$\because (AB)^+ = ABCDEGHI \qquad (AC)^+ = ACDI$

$(AD)^+ = ADGH \qquad (AE)^+ = AEBCDGHI$

$(AH)^+ = AHG$

$\therefore$ All candidate keys are ABJ / AEJ

3) $F' = \{AB \rightarrow C,\ AB \rightarrow E,\ D \rightarrow G,\ D \rightarrow H,\ E \rightarrow B,\ E \rightarrow C,\ E \rightarrow D,\ C \rightarrow D,\ C \rightarrow I,\ H \rightarrow G,$
$EH \rightarrow I\}$.

$AB \rightarrow C$

$A^+ = \{A\}, B^+ = \{B\}$ $\therefore$ $AB \rightarrow C$ connot be replaced, as same as $AB \rightarrow E$

$EH \rightarrow I$

$E^+ = \{E, B, C, D, G, H, I\}$ $\therefore$ EH can be replaced by $E \rightarrow I$

$F'' = \{AB \rightarrow C,\ AB \rightarrow E,\ D \rightarrow G,\ D \rightarrow H,\ E \rightarrow B,\ E \rightarrow C,\ E \rightarrow D,\ E \rightarrow I,\ C \rightarrow D,\ C \rightarrow I,$
$H \rightarrow G\}$

$(AB)^+ |_{F'' - \{AB \rightarrow C\}} = \{A, B, E, C, D, I, G, H, I\}$ rehmove

$(AB)^+ |_{F'' - \{AB \rightarrow E\}} = \{A, B, C, D, I, G, H\}$

$D^+ |_{F'' - \{D \rightarrow G\}} = \{D, H, G\}$ remove

$D^+|F'' - \{D \to H\} = \{D, G\}$

$E^+|F'' - \{E \to B\} = \{E, C, D, I, G, H\}$

$E^+|F'' - \{E \to C\} = \{E, B, D, I, G, H\}$

$E^+|F'' - \{E \to D\} = \{E, B, C, D, I, G, H\}$ remove

$E^+|F'' - \{E \to I\} = \{E, B, C, D, I, G, H\}$ remove

$C^+|F'' - \{C \to D\} = \{C, I\}$

$C^+|F'' - \{C \to I\} = \{C, D, G, H\}$

$H^+|F'' - \{H \to G\} = \{H\}$

Thus, $AB \to C$, $D \to G$, $E \to D$ and $E \to I$ can be removed from F_m'.

$F_{min} = \{AB \to E, D \to H, E \to B, E \to C, C \to D, C \to I, H \to G\}$

4) $F_{min} = \{AB \to E, D \to H, E \to B, E \to C, C \to D, C \to I, H \to G\}$

From $AB \to E$, derive $R_1(A, B, E)$

From $D \to H$, derive $R_2(D, H)$

From $E \to B, E \to C$, derive $R_3(E, B, C)$

From $C \to D$, $C \to I$, derive $R_4(C, D, I)$

From $H \to G$, derive $R_5(H, G)$

None of the relation shemas contains a key of R, add one relation schema $R_6(A, B, J)$

	A	B	C	D	E	G	H	I	J
$R_1(A,B,E)$	a	a	b	b	a	b	b	b	b
$R_2(D,H)$	b	b	b	a	b	b	a	b	b
$R_3(E,B,C)$	b	a	a	b	a	b	b	b	b
$R_4(C,D,I)$	b	b	a	a	b	b	b	a	b
$R_5(H,G)$	b	b	b	b	b	a	a	b	b
$R_6(A,B,J)$	a	a	b	b	b	b	b	b	a

	A	B	C	D	E	G	H	I	J
$R_1(A,B,E)$	a	a	a	a	a	a	a	a	b
$R_2(D,H)$	b	b	b	a	b	b	a	b	b
$R_3(E,B,C)$	b	a	a	b	a	b	b	b	b
$R_4(C,D,I)$	b	b	a	a	b	b	a	a	b
$R_5(H,G)$	b	b	b	b	b	a	a	b	b
$R_6(A,B,J)$	a	a	a	a	a	a	a	a	a

Qusetion 2

1) 96 super keys can be found for R.

(A, B, J, C)   (A, B, J, D)   (A, B, J, H)

(A, B, J, I)   (A, E, J, C)

2) $F_{min} = \{AB \to E, D \to H, E \to B, E \to C, C \to D, C \to I, H \to G\}$

prime attributes $\{A, B, E, J\}$

$\therefore$ Non-prime attribute C is functionally determined by E.

1NF is the highest normal form of R with respect to F.

3) $F_{min} = \{AB \to E, D \to H, E \to B, E \to C, C \to D, C \to I, H \to G\}$

$R_1 = \{ABCDE\} \Rightarrow AB \to E, E \to B, E \to C, C \to D$

$R_2 = \{EGH\} \Rightarrow H \to G$

$R_3 = \{EIJ\}$

Since can not lanuch $D \to H$, $C \to I$

$\therefore$ Not dependency-preserving

4)

	A	B	C	D	E	G	H	I	J
R_1(ABCDE)	a	a	a	a	a	b	b	b	b
R_2(EGH)	b	b	b	b	a	a	a	b	b
R_3(EIJ)	b	b	b	b	a	b	b	a	a

	A	B	C	D	E	G	H	I	J
R_1{ABCDE}	a	a	a	a	a	a	a	a	b
R_2{EGH}	b	a	a	a	a	a	a	a	b
R_3{EIJ}	b	a	a	a	a	a	a	a	a

∴ Not lossless-join

5) $F_{min} = \{AB \to E,\ D \to H,\ E \to B,\ E \to C,\ C \to D,\ C \to I,\ H \to G\}$

Consider $AB \to E$ for F_{min} : $R_1(A, B, E)$, $R_2'(A, B, C, D, G, H, I, J)$

Consider $E \to B$ for R_1 : $R_{11}(A, B)$ $R_{12}(E, B)$

Consider $D \to H$ for R_2' : $R_2(D, H)$ $R_3'(A, B, C, D, G, I, J)$

Consider $C \to D$ and $C \to I$ for R_3' : $R_3(C, D, I)$, $R_4(A, B, C, G, J)$

One of the possible lossless-join decompositions to BCNF is: R_{11}, R_{12}, R_2, R_3, R_4.

	A	B	C	D	E	G	H	I	J
$R_{11}(A, B)$	a	a	b	b	b		b	b	b
$R_{12}(B, E)$	b	a	b	b	a		b	b	b
$R_2(D, H)$	b	b	b	a	b		a	b	b
$R_3(C, D, I)$	b	b	a	a	b		b	a	b
$R_4(A, B, C, G, J)$	a	a	a	b	b	a	b	b	a

	A	B	C	D	E	G	H	I	J
$R_{11}(A,B)$	a	a	b	b	a	b	b	b	b
$R_{12}(B,E)$	b	a	b	b	a	b	b	b	b
$R_2(D,H)$	b	b	b	a	b	b	a	b	b
$R_3(C,D,I)$	b	b	a	a	b	b	a	a	b
$R_4(A,B,C,G,J)$	a	a	a	a	a	a	a	a	a

since. lossless-join decomposition.