Assignment 2
Question 1
1)

Given
$F = \{A \to DE, B \to GI, E \to CD, CE \to ADH, H \to G, AH \to I\}$,
derive $A \to I$:

1. $CE \to ADH$ (given)
2. $CE \to AH$ (by F5(Projectivity) from 1)
3. $AH \to I$ (given)
4. $CE \to I$ (by F3(Transitivity) from 2 and 3)
5. $A \to DE$ (given)
6. $A \to E$ (by F5(Projectivity) from 5)
7. $E \to CD$ (given)
8. $E \to C$ (by F5(Projectivity) from 7)
9. $A \to C$ (by F3(Transitivity) from 6 and 8)
10. $AA \to CE$ (by F2((Augmentation) from 6 and 9); that is, $A \to CE$
11. $A \to I$ (by F3(Transitivity) from 10 and 4)

Therefore, $A \to I \in F^+$.

2)

Step 1:
Let $X := \{A, B, E, C, H, J\}$
Step 2:
Try to remove A, H, C
$\{B, E, C, H, J\}^+ = \{A, B, C, D, E, G, H, I, J\}$
Thus $X := \{B, E, C, H, J\}$
$\{B, E, C, J\}^+ = \{A, B, C, D, E, G, H, I, J\}$
Thus $X := \{B, E, C, J\}$
$\{B, E, J\}^+ = \{A, B, C, D, E, G, H, I, J\}$
Thus $X := \{B, E, J\}$
Step 3:
Try to remove B, E, J
$\{E, J\}^+ = \{A, C, D, E, G, H, I, J\}$
$\{B, J\}^+ = \{B, G, I, J\}$
$\{B, E\}^+ = \{A, B, C, D, E, G, H, I\}$
Thus cannot be removed
So $\{B, E, J\}$ is a candidate key for R

3)

1. According to 1):
   We can prove:
   1. $CE \to ADH$ (given)
   2. $CE \to AH$ (by F5(Projectivity) from 1)
   3. $AH \to I$ (given)
   4. $CE \to I$ (by F3(Transitivity) from 2 and 3)
   5. $E \to CD$ (given)
   6. $E \to C$ (by F5(Projectivity) from 5)
   7. $EE \to CE$ (by F2((Augmentation) from 6); that is, $E \to CE$
   8. $E \to I$(by F3 (Transitivity) from 7 and 4)

   Thus:
   The attributes of I are transitively dependent on E.
   Therefore:
   R with respect to F does not satisfies Third Normal Form (3NF)

2. Because:
   $E \to CD \in F^+$ (According to 1))
   $\{B, E, J\}$ is a candidate key for R (According to 2)
   $E \subset BEJ$
   Thus,
   CD is partially dependent on BEJ
   Therefore,
   R with respect to F does not satisfies Second Normal Form (2NF)

3. All of attribute values are atomic
   Therefore,
   R with respect to F satisfies First Normal Form (1NF)

Hence, the highest normal form of R with respect to F is First Normal Form (1NF)

4)

$R = \{A, B, C, D, E, G, H, I, J\}$
$F = \{A \to DE, B \to GI, E \to CD, CE \to ADH, H \to G, AH \to I\}$
Step 1:
$F' = \{A \to D, A \to E, B \to G, B \to I, E \to C, E \to D,$
$CE \to A, CE \to D, CE \to H, H \to G, AH \to I\}$
Step 2:
$CE \to A$
$\{C\}^+ = \{C\}$; thus $C \to A$ is not inferred by F'.
Hence, $CE \to A$ cannot be replaced by $C \to A$.
$\{E\}^+ = \{A, C, D, E, G, H, I\}$; thus $E \to A$ is inferred by F'.
Hence, $CE \to A$ can be replaced by $E \to A$.
$F'' = \{A \to D, A \to E, B \to G, B \to I, E \to C, E \to D,$
$E \to A, CE \to D, CE \to H, H \to G, AH \to I\}$
$CE \to D$

$\{C\}^+ = \{C\}$; thus $C \to D$ is not inferred by F'.
Hence, $CE \to D$ cannot be replaced by $C \to D$.
$\{E\}^+ = \{A, C, D, E, G, H, I\}$; thus $E \to D$ is inferred by F'.
Hence, $CE \to D$ can be replaced by $E \to D$.
$F'' = \{A \to D, A \to E, B \to G, B \to I, E \to C, E \to D,$
$E \to A, E \to D, CE \to H, H \to G, AH \to I\}$

$CE \to H$

$\{C\}^+ = \{C\}$; thus $C \to H$ is not inferred by F'.
Hence, $CE \to A$ cannot be replaced by $C \to H$.
$\{E\}^+ = \{A, C, D, E, G, H, I\}$; thus $E \to H$ is inferred by F'.
Hence, $CE \to H$ can be replaced by $E \to H$.
$F'' = \{A \to D, A \to E, B \to G, B \to I, E \to C, E \to D,$
$E \to A, E \to D, E \to H, H \to G, AH \to I\}$

$AH \to I$

$\{H\}^+ = \{H, G\}$; thus $H \to I$ is not inferred by F'.
Hence, $AH \to I$ cannot be replaced by $H \to I$.
$\{A\}^+ = \{A, C, D, E, G, H, I\}$; thus $A \to I$ is inferred by F'.
Hence, $AH \to I$ can be replaced by $A \to I$.
$F'' = \{A \to D, A \to E, B \to G, B \to I, E \to C, E \to D,$
$E \to A, E \to H, H \to G, A \to I\}$

Step 3:

$A^+|_{F''-\{A \to D\}} = \{A, C, D, E, G, H, I\}$; thus $A \to D$ is inferred by

$F'' - \{A \to D\}$

That is, $A \to D$ is redundant.
Thus, we can remove $A \to D$ from $F''$to obtain F'''.

$A^+|_{F''-\{A \to E\}} = \{A, D\}$; thus $A \to D$ is not inferred by

$F'' - \{A \to E\}$

That is, $A \to E$ is not redundant.
Iteratively,

$F''' = \{A \to E, B \to G, B \to I, E \to C, E \to D,$
$E \to A, E \to H, H \to G, A \to I\}$

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

5)

$R = (A, B, C, D, E, G, H, I, J)$

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

Candidate key: (B, E, J)

$R_1 = (B, G, I)$

$R_2 = (A, E, I)$

$R_3 = (E, C, D, A, H)$

$R_4 = (H, G)$

$R_5 = (B, E, J)$

	A	B	C	D	E	G	H	I	J
(B, G, I)	b	a	b	b	b	a	b	a	b
(A, E, I)	a	b	b	b	a	b	b	a	b
(E, C, D, A, H)	a	b	a	a	a	b	a	b	b
(H, G)	b	b	b	b	b	a	a	b	b
(B, E, J)	b	a	b	b	a	a	b	b	b

According to the rule of testing for the lossless join property:

Base on key (B, E, J):

	A	B	C	D	E	G	H	I	J
(B, G, I)	b	a	b	b	b	a	b	a	b
(A, E, I)	a	b	b	b	a	b	b	a	b
(E, C, D, A, H)	a	b	a	a	a	b	a	b	b
(H, G)	b	b	b	b	b	a	a	b	b
(B, E, J)	a	a	a	a	a	a	a	a	a

Therefore,

The decomposition of R_1, R_2, R_3, R_4, R_5 is lossless-join.

R_1 can infer $F_1 = \{B \to G, B \to I\}$

R_2 can infer $F_2 = \{A \to E, A \to I\}$

R_3 can infer $F_3 = \{E \to C, E \to D, E \to A, E \to H\}$

R_4 can infer $F_4 = \{ H \to G\}$

R_5 can infer $F_5 = \emptyset$

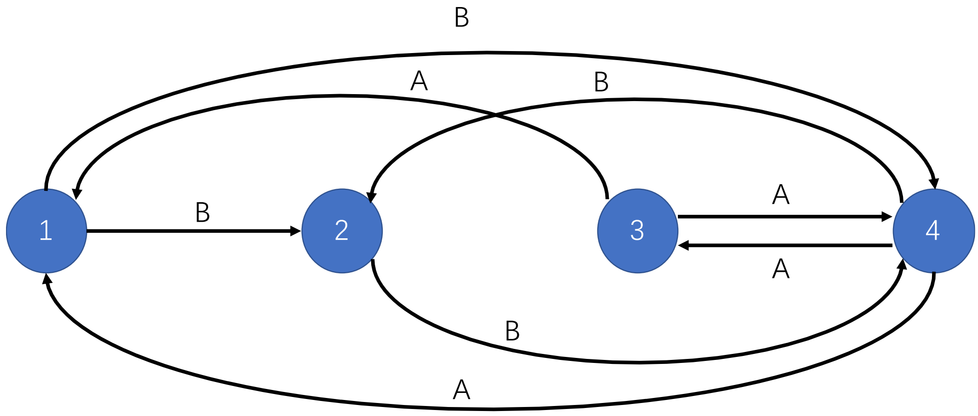
$F^+ = (F_1 \cup F_2 \cup F_3 \cup F_4 \cup F_5)^+$

Therefore,

The decomposition of R_1, R_2, R_3, R_4, R_5 is dependency-preserving.

Question 2

1)



According to the schedule graph, the graph is a cyclic.
Therefore, the transaction schedule is not conflict serializable.

2)

T_1	T_2	T_3	T_4
R(B)			
W(B)			
R(A)			
W(A)			
	R(B)		
	W(B)		
		R(A)	
		W(A)	
			R(A)
			W(A)
			R(B)
			W(B)

3)

T_1	T_2
Write_lock(B)	
Write_lock(A)	
R(B)	
R(A)	
W(B)	
Unlock(B)	
W(A)	Write_lock(B)
Unlock(A)	R(B)
	W(B)
	Unlock(B)