Question 5

a) After the fault is identified and the database is restarted, the database goes through 3 recovery stages.

- Stage 1: Constructing the REDO list
  - The REDO list is constructed using the processes that reached the commit point after the checkpoint and before the system failure. The processes are stored with their after-images.
  - In this case, the processes would be T2, T5, T8, T10.

- Stage 2: Constructing the UNDO list
  - The UNDO list is constructed using the processes that were being processed after the checkpoint but never reached a commit point before the failure. The processes are stored along with their before-images.
  - In this case, the processes would be T1, T4, T7, T9, T11.

- Stage 3: roll forward with REDO list and roll back with UNDO list
  - Once the lists are constructed and compiled with their before and after images, the data is either
    - Rolled forward with the REDO list and after images. This rewrites the data that was already committed into the database. This lets the database recover without re-running all the processes that had already been completed.
    - Rolled back with the UNDO list and before images. This returns the data back to its original form, before the checkpoint using the before-images. This fixes and corrupted or lost data.

b)

i)

TIME	TRANS	ACTION	A	B	C	D	E	F	G	H
0	T1	Read A	S(T1)							
1	T2	Read B		S(T2)						
2	T1	Read C			S(T1)					
3	T4	Read D				S(T4)				
4	T5	Read A	S(T1,T5)							
5	T2	Read E					S(T2)			
6	T2	Update E					X(T2)			
7	T3	Read F						S(T3)		
8	T2	Read F						S(T2,T3)		
9	T5	Update A	T5 wait T1							
10	T1	Commit	X(T5)		remove shared					
11	T6	Read A	T6 wait T5							
12	T5	Rollback	S(T6)							
13	T6	Read C			S(T6)					
14	T6	Update C			X(T6)					
15	T7	Read G							S(T7)	
16	T8	Read H								S(T8)
17	T9	Read G							S(T7,T9)	
18	T9	Update G							T9 wait T7	
19	T8	Read E					T8 wait T2			
20	T7	Commit							X(T9)	
21	T9	Read H								S(T8,T9)

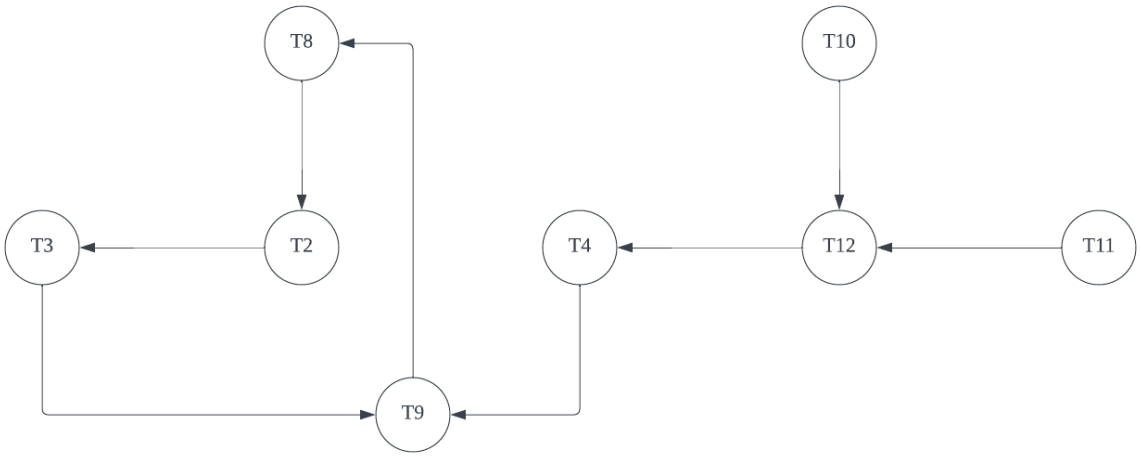
22	T3	Read G							T3 wait T9	
23	T10	Read A	S(T6,T10)							
24	T9	Update H								T9 wait T8
25	T6	Commit	S(T10)		Remove Lock					
26	T11	Read C			S(T11)					
27	T12	Read D				S(T4,T12)				
28	T12	Read C			S(T11,T12)					
29	T2	Update F						T2 wait T3		
30	T11	Update C			T11 wait T12					
31	T12	Read A	S(T10,T12)							
32	T10	Update A	T10 wait T12							
33	T12	Update D				T12 wait T4				
34	T4	Read G							T4 wait T9	

NOTE: the red text is for my convenience

ii)

Item A: T10 waiting on T12
Item B: Shared lock by T2
Item C: T11 waiting on T12
Item D: T12 waiting on T4
Item E: T8 waiting on T2
Item F: T2 waiting on T3
Item G: T3 and T4 waiting on T9. T3 and T4 both want a shared lock
Item H: T9 waiting on T8

iii)



iv)

Deadlock exists

T8 → T2

T2 → T3

T3 → T9

T9 → T8