Question 1

1) Candidate keys: $K1=\{E,J\}$, $K2=\{I,J\}$
prime attributes: E, I, J
non-prime attributes: A, B, C, D, G, H

2) total number of super keys: $2^6 \times 3 = 192$
e.g. ① HIJ ② GIJ ③ AIJ ④ BIJ ⑤ CIJ

3) highest normal form: 1NF
Obviously, R satisfies with 1NF
for $k1=\{E,J\}$, $E \to GH$ (partial function dependency)
$\Rightarrow$ R does not satisfy with 2NF
$\Rightarrow$ highest normal form: 1NF

4) $F_m = \{G \to B, H \to A, H \to C, H \to D, IJ \to E\}$

5) $R1=\{ABE\}$ $R2=\{CDH\}$ $R3=\{EGHIJ\}$
$\pi_{R1} = \emptyset$ $\pi_{R2} = \{H \to CD, C \to D\}$ $\pi_{R3} = \{IJ \to EG, E \to GHI, G \to H\}$
$F' = \pi_{R1} \cup \pi_{R2} \cup \pi_{R3} \Rightarrow F'^{+} = \{CDEGHIJ\}$
due to $F^{+} = \{ABCDEGHIJ\}$ $F'^{+} \neq F^{+}$
so the decomposition is not dependency preserving

6)

| | A | B | C | D | E | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|
| R1 | a | a | ~~a~~ | ~~a~~ | $a_2$ | ~~a~~ | ~~a~~ | ~~a~~ | b |
| R2 | ~~b~~ | b | a | a | b | b | $a_4$ | b | b |
| R3 | ~~b~~ | ~~b~~ | ~~b~~ | ~~b~~ | a | a | $a_4$ | a | a |

① $H \not\to CD$
② $E \to GHI$
③ $G \to BH$
④ $H \to ACD$

After that, R3 is entirely a's
so, the decomposion is lossless join

7) $D=\{R\}$ $F=\{EC \to B, C \to D, G \to BH, H \to ACD, E \to GHJ, IJ \to EG\}$
① $D=\{R1, R2\}$ $EC \to B \Rightarrow R1=\{BCE\}$ $R2=\{ACDEGHIJ\}$
② $D=\{R1, R21, R22\}$ $C \to D \Rightarrow R1=\{BCE\}$ $R21=\{CD\}$, $R22=\{ACEGHIJ\}$
③ $D=\{R1, R21, R31, R32\}$ $H \to A \Rightarrow \cdots R31=\{AH\}$ $R32=\{CEGHIJ\}$
④ $D=\{R1, R21, R31, R41, R42\}$ $H \to C \Rightarrow \cdots R41=\{CH\}$ $R42=\{EGHIJ\}$
⑤ $D=\{R1, R21, R31, R41, R51, R52\}$ $G \to H \Rightarrow \cdots R51=\{GH\}$ $R52=\{EGIJ\}$
⑥ $D=\{R1, R21, R31, R41, R51, R61, R62\}$ $E \to G \Rightarrow \cdots R61=\{EG\}$ $R62=\{EIJ\}$
so the result of decomposition is
$R=\{\{BCE\}, \{CD\}, \{AH\}, \{CH\}, \{GH\}, \{EG\}, \{EIJ\}\}$

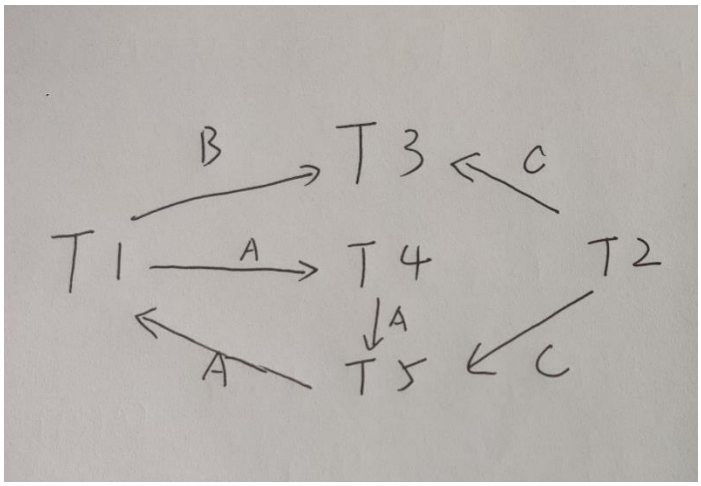
Question 2

1)

redo: T1, T5

undo: T3, T4

2)




3)

| | t1 | t2 | t3 | t4 | t5 | t6 | t7 | t8 | t9 | t10 | t11 | t12 | t13 | t14 | t15 | t16 | t17 | t18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | | | R(A) | | | | R(B) | | W(A) | | | | | | W(B) | | | |
| T2 | R(C) | | | | W(C) | | | | | | | | | | | | | |
| T3 | | R(B) | | | | | | | | R(C) | | | | | | W(B) | W(C) | |
| T4 | | | | R(D) | | | | | | | | W(D) | R(A) | | | | | W(A) |
| T5 | | | | | | R(C) | | R(A) | | | W(C) | | | W(A) | | | | |

Lock in red and unlock in blue

Compared with the given schedule, only the order of t10 and T11 operations has been switched

4)

| | t1 | t2 | t3 | t4 | t5 | t6 | t7 | t8 | t9 | t10 | t11 | t12 | t13 | t14 | t15 | t16 | t17 | t18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | | | R(A) | | | | R(B) | W(A) | | | | | | | W(B) | | | |
| T2 | R(C) | | | | W(C) | | | | | | | | | | | | | |
| T3 | | R(B) | | | | | | | | | R(C) | | | | | W(B) | W(C) | |
| T4 | | | | R(D) | | | | | | | | W(D) | R(A) | | | | | W(A) |
| T5 | | | | | | R(C) | | | R(A) | W(C) | | | | W(A) | | | | |

Lock in red and unlock in blue

Compared with the given schedule, only the order of t8 and t9 operations has been switched