

# Practice 7

## Question 1

Consider a relation  $R(A, B, C, D, E, G, H, I, J)$  and its FD set  $F = \{A \rightarrow EI, BC \rightarrow DEG, CEH \rightarrow GJ, D \rightarrow CJ, DHJ \rightarrow AB\}$

Regarding the following questions. Give and justify your answers if the question is specified.

- 1) Check if  $BD \rightarrow G$ . Justify your answer. (1 mark)
- 2) Find all the candidate keys for  $R$ . (2 mark)
- 3) Determine the highest normal form of  $R$  with respect to  $F$ . Justify your answer. (2 marks)
- 4) Find a minimal cover  $F_m$  for  $F$ . (2 marks)
- 5) Regarding  $F$ , does the decomposition  $R_1 = \{ABDE\}$ ,  $R_2 = \{CEHJ\}$ ,  $R_3 = \{AGI\}$  of  $R$  satisfy the lossless join property? Please justify your answer. (2 marks)
- 6) Provide a step-by-step lossless decomposition of  $R$  into BCNF normal form. (3 marks)

## Question 2

Consider the following query:

P1, P2, P3, P4, P3, P1, P5, P2, P3, P6, P7, P5, P2, P1.

(The user is trying to read page 1 from disk, then page 2, page 3, ...)

Assume there are 4 buffers in the buffer pool.

- 1) Sketch the process of how blocks are replaced in the First In First Out (FIFO) policy. (2 marks)
- 2) Sketch the process of how blocks are replaced in the Least Recently Used (LRU) policy. (2 marks)
- 3) Between FIFO and LRU policies, which one performs better in the given query? Why? (2 marks)

### Question 3

Consider the schedule below. Here,  $R(*)$  and  $W(*)$  stand for 'Read' and 'Write', respectively.  $T_1$ ,  $T_2$ ,  $T_3$  and  $T_4$  represent four transactions and  $t_i$  represents a time slot.

	$t_1$	$t_2$	$t_3$	$t_4$	$t_5$	$t_6$	$t_7$	$t_8$	$t_9$	$t_{10}$	$t_{11}$	$t_{12}$	$t_{13}$	$t_{14}$	$t_{15}$	$t_{16}$
$T_1$	R(A)					W(C)						R(A)			W(A)	
$T_2$				R(B)			R(C)	W(B)		W(A)						
$T_3$		R(B)	R(D)								W(B)		W(D)			
$T_4$					R(C)				W(C)					R(D)		W(D)

**Each transaction begins at the time slot of its first operation and commits right after its last operation (same time slot).**

Regarding the following questions. Give and justify your answers.

- 1) Assume a checkpoint is made between  $t_4$  and  $t_5$ , what should be done to the four transactions when the crash happens between  $t_{11}$  and  $t_{12}$ . (2 marks)
- 2) Is the transaction schedule conflict serializable? Give the full precedence graph to justify your answer. (2 marks)
- 3) Construct a schedule (which is different from above) of these four transactions which **causes** deadlock when using two-phase locking protocol. You should clearly indicate all the locks and the corresponding unlocks in your schedule. If no such schedule exists, explain why. (4 marks)