COMP 306: Database Management Systems
Spring 2023 - Week 9 - PS Questions

Question 1. Consider the relation R(A,B,C,D,E) and the set of functional dependencies $\mathcal{F} = \{AB \to C, AE \to D, D \to B\}$. For each of the following FDs, determine if they can be inferred from $\mathcal{F}$. If they can, derive them step by step (you are NOT allowed to use closures, you must derive them step by step using inference rules). If not, explain why not.

(a) $AD \to C$

(b) $ABC \to D$

(c) $ADE \to BC$

Question 2. Consider the relation R(A,B,C,D,E) and the set of functional dependencies $\mathcal{F} = \{A \to C, CD \to E, DE \to B\}$.

(a) Find the attribute closure of each attribute by itself: A, B, C, D, E. Based on the closures you found, argue if any of them qualify as a candidate key for the relation.

(b) Does AD qualify as a candidate key for the relation? Explain.

(c) Does ABE qualify as a candidate key for the relation? Explain.

Question 3. Consider the relation R(A,B,C,D,E,I) and the set of functional dependencies $\mathcal{F} = \{A \to C, AB \to C, C \to DI, CD \to I, EI \to CD\}$.

(a) Find the minimal cover of $\mathcal{F}$. Show your work.

(b) Based on the minimal cover you found, propose a candidate key for R. Justify your choice.

Question 4. Consider the relation R(A,B,C,D,E,F) with the following set of functional dependencies. Assume there are no set-valued attributes.

$$A \to B$$

$$B \to CD$$

$$E \to F$$

$$D \to A$$

(a) Show that AE qualifies as a key for R.

(b) In the rest of the question, assume AE is the key of R. Find all violations of 1NF, 2NF, 3NF, and BCNF (if any). Clearly mark which violation is for which normal form.

(c) Overall, which normal form is R in? If R is not in any normal form, write "none".

(d) Does R satisfy 2NF? If not, decompose it to achieve 2NF.

(e) Does your result from part d satisfy 3NF? If not, decompose it to achieve 3NF.

(f) Does your result from part e satisfy BCNF? If not, decompose it to achieve BCNF.

(g) Consider the relations obtained at the end of part f. Is this set of relations a dependency-preserving decomposition of R according to the functional dependencies given in the question? Why or why not?

(h) Consider the relations obtained at the end of part f. Is this set of relations a lossless decomposition of R? Why or why not?

Question 5. Consider the following set $\mathcal{F}$ of functional dependencies for relation R:

R(Stud_SSN, Course_no, Grade, Course_name, Stud_name, Course_Instr)

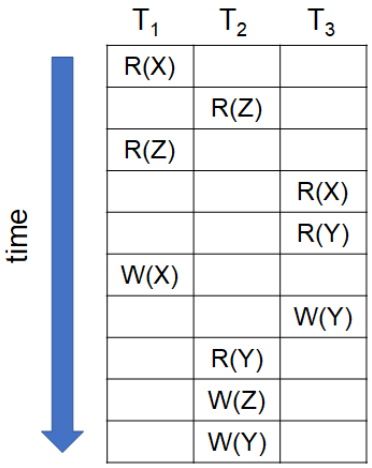
$\mathcal{F}$ = { (Stud_SSN, Course_no) → Grade, Course_name, Stud_name, Course_Instr
Stud_SSN → Stud_name
Course_no → Course_name, Course_Instr }

(a) Find the minimal cover of $\mathcal{F}$. Explain briefly. (If you include a full derivation, that's fine, but a brief justification is sufficient for this question.)

(b) Apply the relational synthesis algorithm to produce 3NF relations.

(c) Does your result from part (b) satisfy BCNF? If not, describe the violation.

Question 6. Consider the following schedule with three transactions (T_1, T_2, T_3) and three database objects: X, Y, Z.



T_1	T_2	T_3
R(X)		
	R(Z)	
R(Z)		
		R(X)
		R(Y)
W(X)		
		W(Y)
	R(Y)	
	W(Z)	
	W(Y)	

(a) Add exactly one read action to this schedule to cause a R-W conflict concerning object X.

(b) Draw the dependency graph of this schedule with all necessary edges. On each edge, write which database object is causing that edge.

(c) Is this schedule conflict serializable? If so, find the equivalent serial schedule (use the swapping method or explain intuitively how you arrived at the serial schedule). If not, explain why the schedule is not conflict serializable.