6 Databases (TGG)

(*a*) We are given a relational schema $R(A,\ B,\ C, D,\ E)$ and told that the following table represents a legal instance of R.

A	B	C	D	E	*tuple number*
1	2	5	4	3	(#1)
1	4	5	4	4	(#2)
2	4	5	4	5	(#3)
2	5	5	4	3	(#4)

Which of the following sets of functional dependencies *may* hold in R? If a set of dependencies cannot hold, then explain why. You can refer to *tuple numbers* in your explanation.

(*i*) F_1 is the set $\{A \rightarrow D\}$. [2 marks]

(*ii*) F_2 is the set

$$\begin{aligned} A, B &\rightarrow C \\ E &\rightarrow B \\ D, E &\rightarrow A \end{aligned}$$

[2 marks]

(*iii*) F_3 is the set

$$\begin{aligned} A, B &\rightarrow C \\ D, E &\rightarrow C \\ A &\rightarrow D \end{aligned}$$

[4 marks]

(*b*) We are given a relational schema $R(\mathbf{Z},\ \mathbf{W},\ \mathbf{Y})$. Suppose that in some (correct) instance of R the query

$$(\pi_{\mathbf{Z},\mathbf{W}}(R) \bowtie \pi_{\mathbf{Z},\mathbf{Y}}(R)) - R$$

is not empty. What can we conclude about the functional dependency $\mathbf{Z} \rightarrow \mathbf{W}$? Explain your answer. [4 marks]

(*c*) In the process of using functional dependencies to normalise a schema, what is meant by a *lossless join decomposition* and how is such a decomposition guaranteed? [4 marks]

(*d*) In schema normalisation, is Boyce-Codd Normal Form (BCNF) always to be preferred over 3rd Normal Form (3NF)? Explain your answer. [4 marks]