

## 2007 Paper 6 Question 8

### Databases

(a) Define the notion of a *functional dependency*. [2 marks]

(b) Consider the following “rule” for functional dependencies.

$$\text{if } A \rightarrow B \text{ and } B, C \rightarrow D, \text{ then } A, C \rightarrow D.$$

Either prove this rule is correct, or present a counter-example showing that the rule is false. [4 marks]

(c) The *union rule for functional dependencies* states that if  $F \models X \rightarrow Y$  and  $F \models X \rightarrow Z$ , then  $F \models X \rightarrow Y \cup Z$  (this can also be written as  $F \models X \rightarrow Y, Z$ ).

Prove this rule using only Armstrong’s axioms. [4 marks]

(d) Suppose that  $R(A, B, C)$  is a relational schema. Write a relational algebra query that evaluates to the empty set exactly when the functional dependency  $B \rightarrow C$  holds on  $R$ . [4 marks]

(e) The schema  $R(A, B, C, D, E)$  has the following functional dependencies.

$$A \rightarrow B, C$$

$$C, D \rightarrow E$$

$$B \rightarrow D$$

$$E \rightarrow A$$

Is  $D, E$  a candidate key for  $R$ ? Explain your answer. [6 marks]