

**Assignment No. 7: The Theory of Database Design**

Solutions due 26 July. Type your solution and upload it to Blackboard as a single file.

**Problem 1.**

1. Does the following relation instance satisfy the functional dependency  $AB \rightarrow C$ ?

$A$	$B$	$C$
1	1	2
1	1	3
1	2	3

2. List *all* the functional dependencies (involving the attributes  $A, B, C$ ) that are satisfied by the following relation instance (include trivial functional dependencies):

$A$	$B$	$C$
1	1	2
1	2	3
1	4	3

**Problem 2.** Assume a schema  $R = (A, B, C)$  and the functional dependencies  $F = \{A \rightarrow B, B \rightarrow C\}$ . Prove that the functional dependency  $AB \rightarrow CB$  is implied by the set  $F$ .

**Problem 3.** Consider the schema  $R = (A, B, C)$  and the set of functional dependencies  $F = \{A \rightarrow B, BC \rightarrow A\}$ .

1. Use the method described in Page 277 of the class notes to generate  $F^+$ ; i.e., the set of all functional dependencies that are implied by  $F$ . Indicate the functional dependencies that are trivial.
2. By examining  $F^+$ , find all the *superkeys* and then the *candidate keys* of  $R$ . (Hint:  $K$  is a superkey of  $R$  iff  $K \rightarrow R$ .)

**Problem 4.** Consider this relation schema with 7 attributes ( $P$  is abbreviation for patient and  $D$  is abbreviation for doctor)

$$Visit = (Date, Pno, Pname, Dno, Dname, Diagnosis, Cost)$$

and this set of 4 functional dependencies

$$F = \{Pno \rightarrow Pname, Dno \rightarrow Dname, Diagnosis \rightarrow Cost, (Date, Pno) \rightarrow (Dno, Diagnosis)\}$$

1. Find a key of  $Visit$  by discovering a set of attributes whose attribute closure is all the attributes of  $V$ .
2. Is  $Visit$  in BCNF (under  $F$ )? Why?
3. Is  $V_1 = (Date, Pno, Pname)$  in BCNF? Why?
4. Is  $V_2 = (Date, Dno, Dname, Diagnosis, Cost)$  in BCNF? Why?
5. Is  $V_1$  and  $V_2$  a lossless-join decomposition of  $Visit$  (under  $F$ )? Why?
6. Using the normalization algorithm, find a lossless-join decomposition of  $V$  into BCNF relation schemas (under  $F$ ).

**Problem 5.** Consider a database for surgery appointments. The patient is given an appointment at a specific time and date and at a particular surgery location. On each date for which there are appointments, one surgeon is assigned to a specific surgery location for that entire day. Initially, the following relation schema is proposed:  $R = (Sno, Sname, Pno, Pname, Date, Time, Loc)$ , where  $Sno$  is surgeon identification number,  $Sname$  is surgeon name,  $Pno$  is patient identification number,  $Pname$  is patient name,  $Date$  is appointment date,  $Time$  is appointment time, and  $Loc$  is surgery location.

1. List the functional dependencies that denote the information given above.
2. Describe the negative aspects of the initial relation.
3. Using the normalization algorithm, find a lossless-join decomposition of  $R$  into BCNF relations schemas (under the set of functional dependencies listed earlier).