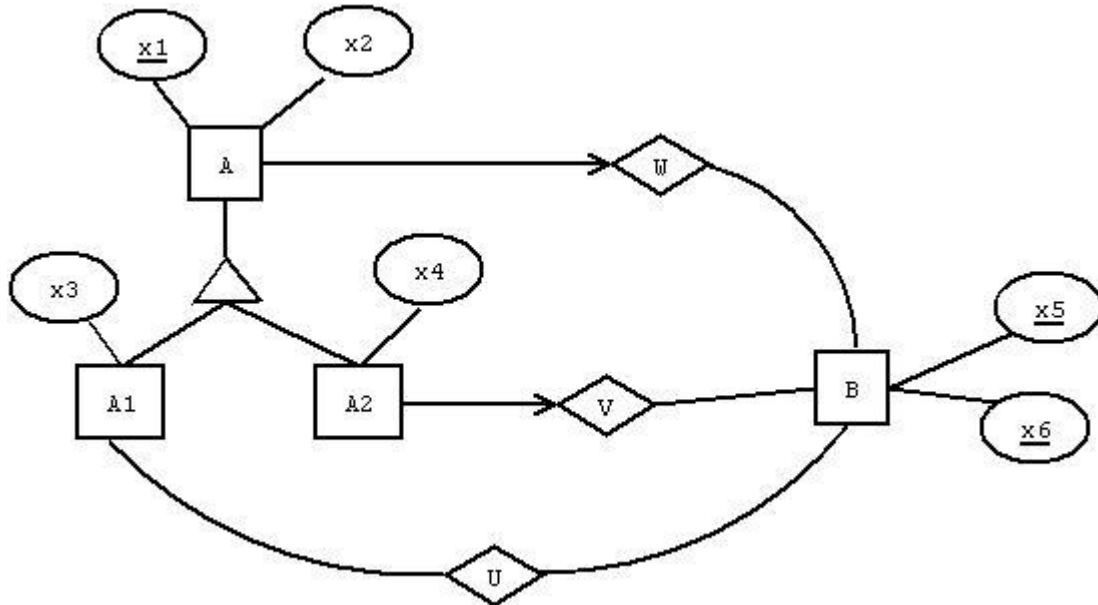


**CPSC 304 Midterm 1**  
**May 2010**  
**Total: 15 points**  
**Time allowed: 60 minutes**

**Question 1 (6 points)**

a) (3 points) Draw an ER diagram for the following scenario:

- Entity set A has two attributes x1 and x2, with x1 being the primary key.
- In addition, A has two sub-classes A1 and A2, which are non-covering and may overlap. A1 has an extra attribute x3, and A2 has an extra attribute x4.
- Entity set B has two attributes x5 and x6. The primary key consists of both attributes.
- There is a relationship set U, which is many-to-many from A1 to B.
- There is a relationship set V, which is 1-to-many from B to A2
- There is a relationship set W, which is 1-to-many from B to A.



b) (3 points) The optimal set of relations (i.e., from the normalization standpoint and having a minimum number of relations) for the scenario in part a) consists of 5 relations. Specify the relational schema for the 5 relations.

$A(\underline{x1}, x2, Wx5, Wx6)$

$A1(\underline{x1}, x3)$

$A2(\underline{x1}, x4, Vx5, Vx6)$

$B(\underline{x5}, \underline{x6})$

$U(\underline{x1}, \underline{x5}, \underline{x6})$

**Question 2 (3 points)** Consider the following relation instance  $R(X,Y,Z)$ :

X	Y	Z
1	a	100
2	b	200
3	a	200
2	b	100

Of all the 6 possible FDs:

- $X \rightarrow Y$ ,
- $X \rightarrow Z$ ,
- $Y \rightarrow X$ ,
- $Y \rightarrow Z$ ,
- $Z \rightarrow X$ , and
- $Z \rightarrow Y$

which ones are invalidated by the given instance? For each invalidated FD, identify a pair of tuples violating the dependency.

$X \rightarrow Z$ , because of the second and fourth tuples

$Y \rightarrow X$ , because of the first and third tuples

$Y \rightarrow Z$ , because of the first and third tuples, or the second and the fourth

$Z \rightarrow X$ , because of the second and third tuples, or the first and the fourth

$Z \rightarrow Y$ , because of the second and third tuples, or the first and the fourth

**Question 3 (6 points)** Consider the relation scheme  $R(A, B, C, D)$  which satisfies the following functional dependencies:

- (FD1)  $A B \rightarrow C$
- (FD2)  $B C \rightarrow D$
- (FD3)  $C D \rightarrow A$

a) Identify all the candidate keys of  $R$ .

$AB, BC$ .

b) Pick any one of the keys above and give a formal proof showing that it is a superkey, using Armstrong's axioms, the union and/or the decomposition rule.

1.  $AB \rightarrow BC$  (augmentation on FD1)

2.  $AB \rightarrow D$  (transitivity on FD2 and 1)

3.  $AB \rightarrow BCD$  (union on 1 and 2)

4.  $AB \rightarrow ABCD$  (augmentation on 3)

Thus,  $AB$  is a superkey.

c) Is  $R$  in BCNF? Explain your answer.

No, FD3 is not a candidate key.

--- The End ---