# CS43002: Database Management Systems

## Mid-semester Examination, Spring 2016

**Time= 2 hrs. Marks: 40. Answer all five questions.**

**1.** Consider a database used to record the marks that students get in different exams of different course offerings. (a) Construct and E-R diagram that models exams as entities, and uses a *ternary* relation for the database, (b) Construct and alternative E-R diagram that makes use only *binary* relationship between students and course offerings. Make sure you can represent the marks that a student gets in different exams in a course offering.                    [ 3 + 3 ]

**2.** Consider the following relational schema:                    [ 4 + 4 ]

```
Product(maker, model, type)

PC(model, speed, ram, hd, rd, price)

Laptop(model, speed, ram, hd, screen, price)

Printer(model, color, type, price)
```

Write (a) Relational Algebra, and (b) SQL queries for the following. You may use intermediate relations.

(i) Find model number of all color laser printers.

(ii) Find those makers that makes Laptops but not PCs.

(iii) Find those pair of PC models that have both the same speed and ram. A pair should be listed only once, i.e. *(i, j)* and not *(j, i)*.

(iv) Find those disk sizes that occur in two or more PC.

**3.** Let *R(a, b, c), S(b, c, d)* and *T(d, e)* be three relations. Write (a) domain relational algebra (DRC) statements and (b) single datalog rules, for each of the following natural joins.                    [ 3 + 3 ]

(i) $R \bowtie S$                    (ii) $S \bowtie T$                    (iii) $( R \bowtie S ) \bowtie T$

**4.1**. Suppose functional dependencies (FD's) $A_1A_2...A_n \rightarrow B_1B_2...B_m$ and $C_1C_2...C_k \rightarrow D_1D_2...D_j$ holds for a relation. Show that the FD: $A_1A_2...A_nC_1C_2...C_k \rightarrow B_1B_2...B_mD_1D_2....D_j$ also holds. In the above, we should remove one copy of attributes that appears in both As and Cs and among Bs and Ds.                    [ 4 ]

**4.2**. Consider the relation with schema *R (A, B, C, D)* and FD's : $AB \rightarrow C, C \rightarrow D, D \rightarrow A.$                    [ 3 + 3 ]

(a) What are the non-trivial FD's that follow from the given FD's? Restrict yourself to FD's with single attributes on the right hand side. Show your derivation.

(b) What are the candidate keys of *R*? Justify.

**5.1**. Consider the relational schema $R\ (A,\ B,\ C,\ D)$ with FD's $A \to B$, $B \to C$, $C \to D$, and $D \to A$.

(a) Indicate all the FDs that create BCNF violations of $R$. Do not forget to consider FD's that are not in the given set, but follow from them. However, it is not necessary to give violations that have more than one attribute on the right side. Show derivations.

(b) Decompose the relation $R$ into collection of relations that are in BCNF. Show steps.       [ 3 + 2 ]

**5.2**. A functional dependency $\alpha \to \beta$ is called a partial dependency if there is a proper subset $\gamma$ of $\alpha$, such that $\gamma \to \beta$. We say that $\beta$ is partially dependent on $\alpha$. A relational schema $R$ is in second normal form (2NF) if each attribute $A$ in $R$ meets one of the following criterion:

- it appears in a candidate key
- it is not partially dependent on a candidate key

Show that every 3NF schema is in 2NF.       [ 5 ]


------------ **BEST WISHES** ------------