National University of Computer and Emerging Sciences, Lahore Campus

Course:	**Database Systems**	**Course Code:**	**CS2005**
Program:	**BS (Computer Science)**	**Semester:**	**Spring 2024**
Out Date:	**18-Mar-2024**	**Total Marks:**	
	Fri 29-Mar-2024 *(Start of Lab)*		
Due Date:	~~**Wed 27-Mar-2024 *(start of class)***~~	**Weight:**	
Section	**BCS-4A, BCS-4B**	**Page(s):**	**1**
Assignment:	**4 (FDs & NFs) - SOLUTION**		

Instructions:

- This assignment is an individual assignment.
- Clearly mention any assumption you have made.
- You are required to submit the hard copy of your assignment at the start of your class.
- For any query, please contact your TA.

TOPIC: Functional Dependencies and Normal Forms

Q1. Consider a relation R (A, B, C, D, E, F, G) with FDs= {AB →C, D→ E, C→ A, B→G, C→DF, C→ BD, E→AB, A→DE, D→ E}. Which of the following FDs may or may not hold over schema R? Give valid reason.

i. A →G **ii.** C → E **iii.** CG → E **iv.** B→A **v.** CGE → A

Holding FD: A→G, CGE→A, C->E, CG→E

Not Holding FD:, B→A

Q2. Consider two sets of FDs, F and G. F = {A→B, B→C, AC→D} and G = {A→B, B→C, A→D}. Check whether they are equivalent. Show all steps.

Not equivalent

Q3. Consider the relation R (A, B, C, D, E, F, G, H, I) and a set of FDs F = {AB→CD, A→E, B→FH, C→G, D→B, G→C, H→I}. Compute the minimal cover for *F* (i.e., *Fc*). Also find all possible Keys (i.e., minimal of super keys) of R.

i. Find Key for the above relation R?

keys are AB & AD.

ii. Find a minimal cover for the above set of FD's?

Step 1: Convert in Canonical form

AB ->C,

AB ->D,

A ->E,

B ->F,

B ->H,

C ->G,

D ->B,

G ->C,

H ->I

Step 2: Check for redundant FDs

No redundant FD so above is minimal cover. i.e.

F_c = {AB→CD, A→E, B→FH, C→G, D→B, G→C, H→I}

Q4. Consider the relation R (A, B, C, D) and a set of FDs F = {AB→D, BC→A, D→C}. Find all possible Keys of R.

AB, BC , BD

Q5. Consider a relation schema *R (A, B, C, D, E)* with FDs *F = {A → E, E → BD}*.

a. Identify the best normal form that R satisfies (1NF, 2NF, 3NF, or BCNF). Justify your answer.
1NF. As it can not be 2NF because we have a partial dependency A → E. AC is the candidate key and in this partial
dependency we have a non prime on rhs not being derived by a candidate key (AC).
This FD violates 2NF because A is a proper subset of candidate key and E is non prime.

b. Decompose the relation R into a 2NF schema if it is not in 2NF. *(Remove 2NF violations only, in this part)*
R1:{ A, B, D , E} ; R2{A,C}
F1 = {A → E, E → BD} -> Functional dependencies of R1
F2={} -> Functional dependencies of R2

c. Check whether your answer to part (b) is in 3NF. If not, decompose it into a 3NF schema.
F1 = {A → E, E → BD} -> Functional dependencies of R1
F2={} -> Functional dependencies of R2
Since R2 has no fds and has only two keys so it is in BCNF
Since in R1 E->BD is transitive dependency (violates 3NF rules)
Converting R1 into 3NF
F1 = {A → E, E → BD} -> Functional dependencies of R1
R1:{ A, B, D , E}
R11:{ B,D,E} R12:{A, E}

F11 = {E → BD} -> Functional dependencies of R11
F12 = {A → E} -> Functional dependencies of R12

Final relations
R11:{ B,D,E} R12:{A, E} R2{A,C}

d. Check whether your answer to part (c) is in BCNF. If not, decompose it into a BCNF schema.
It is in BCNF as well as all fds l.h.s are keys/super keys .

Q6. Consider the relation R *(A, B, C, D, E, H)*, with FDs F= {A→BC, B→CE, A→E, AC→H, D→B}. Key of this relation is {AD}. Identify the best normal form that R satisfies (1NF, 2NF, 3NF, or BCNF). Justify your answer. If R is not in BCNF, decompose it into a set of BCNF relations and show your steps. Indicate which dependencies if any are not preserved by the BCNF decomposition.
A -> E FD violates 2NF because A is a proper subset of candidate key AD and E is non prime.
D -> B FD violates 2NF because D is a proper subset of candidate key AD and B is non prime.
A->BC FD violates 2NF because A is a proper subset of candidate key AD and B and C are both non prime.
R1{A,B,C,E,H} R2 {D,B} R3{A,D}
F1{A->BCEH, B->CE }
F2{ D->B}
F3{ }
It is not in 3NF as R1 has a transitive dependency B->CE as both are non-prime .
R11{B,C,E} R12{A,B,H} R2 {D,B} R3{A,D}
It is already in BCNF as the lhs of all fds is a super key .

Q7. Use your knowledge and intuition to determine FDs. Address (street_address, city, state, zip).
street_address, city, state → zip
zip → city
zip → state
zip, state → zip – This is a trivial FD

Q8. consider the following relation schema. DISK_DRIVE (Serial_number, Manufacturer, Model, Batch, Capacity, Retailer)
Example: Disk_drive ('1978619', 'WesternDigital', 'A2235X', '765234', 500, 'CompUSA')
Write each of the following dependencies as an FD:

a. The manufacturer and serial number uniquely identifies the drive.
Serial_number, Manufacturer - > Serial_number, Manufacturer, Model, Batch, Capacity, Retailer

b. A model number is registered by a manufacturer and therefore can't be used by another manufacturer.
Model -> Manufacturer

c. All disk drives in a particular batch are the same model.
Batch -> Model

d. All disk drives of a certain model of a particular manufacturer have exactly the same capacity
Model, Manufacturer -> Capacity