# **FDs and Normalization Practice Questions Solution**

**Question 1: Prove or disprove the following inference rules for functional dependencies**

(Note: A proof can be made using inference rules. A disproof is performed by giving a counter example that is you have to come up with a relational instance that satisfies the conditions and functional dependencies in the L.H.S of the inference rule and does not satisfy the dependencies on the R.H.S.)

1. {A -> BC, ABC-> D} => {A-> D}
2. A->ABC Augmentation Rule on A->BC

A->D Transitive rule on 1 and ABC->D

1. {A-> C, B-> C} => { A-> B}

|  |  |  |
| --- | --- | --- |
| **A** | **B** | **C** |
| 1 | 3 | 2 |
| 4 | 3 | 2 |
| 1 | 7 | 2 |

1. {A-> B, C-> D} => {AC->BD}
2. AC->BC Augmentation rule on A->B
3. BC->BD Augmentation rule on C->D

AC->BD Transitive rule on 1 and 2

1. {AB -> C, C->A} => {C-> B}

|  |  |  |
| --- | --- | --- |
| **A** | **B** | **C** |
| 1 | 2 | 3 |
| 4 | 5 | 6 |
| 1 | 7 | 3 |

1. {AB-> C, C->D} => {A-> D}

|  |  |  |  |
| --- | --- | --- | --- |
| **A** | **B** | **C** | **D** |
| 1 | 2 | 3 | 4 |
| 5 | 6 | 3 | 4 |

**Question 2: Consider a relation R (A,B,C,D,E), with FDs AB → C, C → A, C → BD, D → E.**

*Use Armstrong’s Inference rules to answer the following*

1. Is the FD: C -> E implied from given FD’s? Show your work.
2. BD->BE Augmentation rule on D->E
3. C->BE Transitive rule on 1 & C->BD
4. C->E Reflexive rule BE->E
5. Is the FD: A -> D implied from given FD’s? Show your work.

AB->BD Transitive rule on AB->C and C->BD

Does not imply A->D

1. Is the FD: ABC -> E implied from given FD’s? Show your work.
2. ABC->C Augmentation rule on AB->C
3. ABC->BD Transitive rule on ABC->C and C->BD
4. BD->BE Augmentation rule on D->E
5. BE->E Reflexive rule from 3
6. BD->E Transitive rule on 3 and 4
7. ABC->BE Transitive rule on 2 and 5
8. Complete the missing values in the table given below. The last column is filled in as an example

a. Consider the attribute subsets, X, in the table below.

b. Compute the attribute closure of each subset X+

c. Determine if the subset, X, is a super key or a key or nothing

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| X | A | B | C | AB | AC | AD | CD | ABC | ABCD |
| X+ | A | B | ABCDE | ABCDE | ABCDE | ADE | ABCDE | ABCDE | ABCD |
| KEY | No key | No key | key | Super Key | Super key | No key | Super key | Super  key | SUPER KEY |

**Question 3: Find out that the following set of functional dependencies for the a relation R(U,V,W,X,Y,Z) are equivalent or not.**

Let F= V->W, VW->X, Y->VX, Y->Z , U->VX, WX-> Z, UW->Y

Let G= V->WX, Y->VZ , U->Y, WX-> Z

Closure of attributes of F using G:

U+={UVWXZY}

V+ = {V, W, X, Z}

W+= {W}

X+={X}

Y+={Y, V, Z, W, X}

Z+= {Z}

VW+= {V, W, X,Z}

Closure of attributes of G using F

U+={UVWXZY}

V+= {V, W, X}

W+= {W}

X+= {X}

Y+={Y, V, X, Z, W}

Z+= {Z}

VW+= {V, W, X}

So both set are equivalent.

**Question 4: Consider the relation R(A,B,C,D,E,F,G,H,I) and a set of functional dependencies:**

FD’s = {AB ->CD, A ->E, B ->FH, C ->G, D ->B, G ->C,H ->I}

1. Find Key for the above relation R?

A+= {A, E}

B+= {B, F, H, I}

C+={C, G}

D+= {B, D, F, H, I}

G+= {C, G}

H+= {H, I}

Candidate keys:

AB+= {A, B, C, D, E, F, H, G, I}

ACD

AGD

**Minimal key=AB**

1. Find a minimal cover for the above set of FD’s?

Step 1: Convert in Canonical form

AB ->C,

AB ->D,

A ->E,

B ->FH,

B ->H,

C ->G,

D ->B,

G ->C,

H ->I

Step 2: Check for redundant FDs

No redundant FD so above is minimal cover.

**Question 5: Consider the following relation R (A,B,C,D)**

|  |  |  |  |
| --- | --- | --- | --- |
| **A** | **B** | **C** | **D** |
| 1 | 3 | 2 | 4 |
| 2 | 3 | 2 | 4 |
| 3 | 1 | 3 | 6 |
| 3 | 1 | 1 | 12 |

**Which of the following dependencies hold on R? Explain your answer.**

1. A->B

Yes

1. A->CD

No

1. B->A

No

1. BCD->A

No

1. AC-> B

Yes

1. BC->D

Yes

1. C->B

Yes

**Question 6:** Consider a relation R (A,B,C,D,E). The following set of five functional dependencies hold on R:

FDs= {A -> D , AB -> C, B -> E, D -> C, E -> A}

We decompose relation R so that one of the new relations is R1(A,B,C). Given the complete set of FD's that hold on R1, also specify all keys for R1. Don't forget that a key must be *minimal.*

FDs of R1

AB->C

A->C Transitive rule on A->D and D->C

B->A from B->E and E->A

Finding key:

A+= {A}

B+= {A, B, C}

C+={C}

AB+= {A, B, C}

AC+= {A, C}

BC+= {A, B, C}

ABC+= {A, B, C}

**Minimal key=B**

**Question 7:** Consider a relation with schema R(A,B,C,D,E,F) and functional dependencies

FDs = {A-> F, A->C, C->D, B->E}

1. What normal form is the relation in? Explain your answer

**Finding key:**

A+= {A, F, C, D}

B+= {B, E}

AB+= {A, F, C, D, B, E}

Key=AB

R (A, B, C, D, E, F)

R is in Fist normal form as there is no composite, multivalued attributes or nested relations.

**ii.** Apply normalization until you cannot decompose the relations further. State the reasons for each decomposition.

All FDs are partially dependent on key so decomposed new relations are

R1 (A, B)

R2 (A, F, C, D)

R3 (B, E)

Relations are in 2nd normal form.

Further decompose R2 because of C->D

R21 (A, F, C)

R22 (C, D)

Relations are in 3rd normal form and BCNF as well.

**Question 8:**

1. Identify the functional dependencies between the attributes.

The attributes are as follows:

|  |
| --- |
| **Movie Nbr, Title, Director ID, Director Name, Studio ID, Studio Name, Studio Location, Studio CEO,**  **Character, Actor ID, Name, Movie Copy Nbr, Movie Copy Type, Movie Rental Price, Copy Rental Status, Copy Return Date** |

Each movie is identified by a

movie number

title

information about the director

the studio that produced the movie.

**MovieNbr-> Title, Director ID, Director Name, Studio ID, Studio Name, Studio Location, Studio CEO,**

**Director ID -> Director Name**

**Studio ID -> Studio Name, Studio Location, Studio CEO,**

Each movie has one or several characters, **MovieNbr -->> Character**

and there is exactly one actor playing the role of each of the characters

**MovieNbr,Character -> ActorID,Name**

(but one actor can play multiple roles in each of the movies). **ActorID ->> Character**

**ActorID-> NAme**

A video store has multiple copies of the same movie, **MovieNbr->> Movie Copy Nbr**

and the store differentiates copies with a movie copy number, which is unique within a single movie but not unique between different movies. **MovieNbr, Movie Copy Nbr**

Each movie copy has a rental status and return date; in addition, each copy has a type (VHS, DVD, or Bluray). **MovieNbr, Movie Copy Nbr 🡪CopyRental Status, CopyReturnDate, MovieCopyType**

**Assumption: MovieCopyNBr cannot separately determine MovieCopytype… depends on Movie**

The rental price depends on the movie and the copy type, but the price is the same for all copies of the sametype.

**MovieNbr, MovieCopyType 🡪MovieRentalPrice**

All dependencies

**MovieNbr-> Title, Director ID, Director Name, Studio ID, Studio Name, Studio Location, Studio CEO,**

**Director ID -> Director Name**

**Studio ID -> Studio Name, Studio Location, Studio CEO,**

**MovieNbr, Character -> ActorID, Name**

**ActorID-> Name**

**MovieNbr, Movie Copy Nbr 🡪CopyRental Status, CopyReturnDate, MovieCopyType**

**MovieNbr, MovieCopyType 🡪MovieRentalPrice**

**Separate Repeating Groups**

**R1: MovieNbr, Title, DirectorID, DirectorName, StudioID, StudioName, StudioLocation, StudioCEO,**

**R2: MovieNbr, Character, Actor ID, Name,**

**R3: MovieNbr , Movie Copy Nbr, Movie Copy Type, Movie Rental Price, Copy Rental Status, Copy Return Date**

**No Partial FD’s**

**Remove transitive X-> A**

**R1: MovieNbr, Title, DirectorID, StudioID**

**R4: DirectorID, DirectorName**

**R5: StudioID, StudioName, StudioLocation, StudioCEO,**

**R2: MovieNbr, Character, Actor ID**

**R6: Actor ID, Name**

**R3: MovieNbr , Movie Copy Nbr, Movie Copy Type, Copy Rental Status, Copy Return Date**

**MovieNbr, MovieCopyType 🡪MovieRentalPrice**

**R7: MovieNbr, MovieCopyType ,MovieRentalPrice**

1. Identify the reasons why this set of data items is not in 3NF and tell what normal form (if any) it is in.

This set of data items is not in any normal form. Because for the data set to be in 1NF, the related data must be in a table and there should be a primary key of the table. As all the attributes are included in a single table so there is no primary key which can uniquely determine the entire tuple.

1. Present the attributes organized into 3NF relations that have been named appropriately.

Movie

**Already given above**