**Question1**

1. No,According to R’s FD set F={ABCE,DGH,EBCD, CDI, HG, EHI} ={C,G,H,I,D},which isn’t include J.

In conclusion,”CJ” does not belong to

1. Candidate key: {A,B,J},{A,E,J}
2. R= {A,B,C,D,E,G,H,I,J}

Set F ={ ABCE,DGH,EBCD, CDI, HG, EHI }

Step1:Reduce right side

F’ ={ ABC , ABE, DG, DH, EB, EC, ED, CD, CI, HG, EHI }

Step2:Reduce left side

For ABC

={A},thus, AC is not inferred by F’.Hence, ABC can not be replaced by AC

={B},thus, BC is not inferred by F’.Hence, ABC can not be replaced by BC

For ABE

={A},thus, AE is not inferred by F’.Hence, ABE can not be replaced by AE

={B},thus, BE is not inferred by F’.Hence, ABE can not be replaced by BE

For EHI

={B,C,D,E,G,H,I},thus, EI is inferred by F’.Hence, EHI can not be replaced by EI

={G,H},thus, HI is not inferred by F’.Hence, EHI can not be replaced by HI

In conclusion,

F’’={ABC , ABE, DG, DH, EB, EC, ED, CD, CI, HG, EI }

Step3:Remove redundant FDs

={A,B,C,D,E,G,H,I},thus ABC is redundant.Hence,we can remove ABC from F’’ to obtain F’’’.

={A,B,C,D,G,H,I},thus ABE is not inferred by F’’-{ABE},which shows that ABE is not redundant.

={D,G,H},thus DG is redundant.Thus,

we can remove DG from F’’ to obtain F’’’.

={D,G},thus DH is not inferred by F’’-{DH},which shows that DH is not redundant.

={E,C,D,G,H,I},thus EB is not inferred by F’’-{EB},which shows that EB is not redundant.

={E,B,D,G,H,I},thus EC is not inferred by F’’-{EC},which shows that EC is not redundant.

={E,B,C,D,G,H,I},thus ED is redundant.

Thus,we can remove ED from F’’ to obtain F’’’.

={C,I},thus CD is not inferred by F’’-{CD},which shows that CD is not redundant.

={C,D,H,G},thus CI is not inferred by F’’-{CI},which shows that CI is not redundant.

={H},thus HG is not inferred by F’’-{HG},which shows that HG is not redundant.

={E,B,C,D,G,H,I},thus EI is redundant.

Thus,we can remove EI from F’’ to obtain F’’’.

In conclusion

F’’’={ ABE, DH, EB, EC, CD, CI, HG }

(4)

From part(3) we have the minimal cover:

F’’’={ ABE, DH, EB, EC, CD, CI, HG }

So,we can decompose R into

|  |  |
| --- | --- |
| Decompositions | Inferred from |
| ={A,B,E} | ABE |
| ={D,H} | DH |
| ={B,C,E} | EB, EC, |
| ={C,D,I} | CD, CI |
| ={H,G} | HG |
| ={A,B,J} | Nothing to infer J,  A,B,J is super key |

It is obvious that the decompositions are dependency-preserving since all of which are inferred from the minimal cover F’’’

To prove the lossless-join we need to draw this table below ,we fill up “a” in the light of to

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E | G | H | I | J |
|  | a | a |  |  | a |  |  |  |  |
|  |  |  |  | a |  |  | a |  |  |
|  |  | a | a |  | a |  |  |  |  |
|  |  |  | a | a |  |  |  | a |  |
|  |  |  |  |  |  | a | a |  |  |
|  | a | a |  |  |  |  |  |  | a |

The column A and B have ‘a’ in and then,we seek a FD which contain A and B in the left side,obviously ABE is we looking for.Therefore,we can change the table.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E | G | H | I | J |
|  | a | a |  |  | a |  |  |  |  |
|  |  |  |  | a |  |  | a |  |  |
|  |  | a | a |  | a |  |  |  |  |
|  |  |  | a | a |  |  |  | a |  |
|  |  |  |  |  |  | a | a |  |  |
|  | a | a |  |  | a |  |  |  | a |

We can redo the same thing .This time we look at the column E,we can use EC to change this table

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E | G | H | I | J |
|  | a | a |  |  | a |  |  |  |  |
|  |  |  |  | a |  |  | a |  |  |
|  |  | a | a |  | a |  |  |  |  |
|  |  |  | a | a |  |  |  | a |  |
|  |  |  |  |  |  | a | a |  |  |
|  | a | a | a |  | a |  |  |  | a |

Iteratively, for andwe use CD, CI to fill up ‘a’

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E | G | H | I | J |
|  | a | a |  |  | a |  |  |  |  |
|  |  |  |  | a |  |  | a |  |  |
|  |  | a | a |  | a |  |  |  |  |
|  |  |  | a | a |  |  |  | a |  |
|  |  |  |  |  |  | a | a |  |  |
|  | a | a | a | a | a |  |  | a | a |

Iteratively, for and we use DH fill up ‘a’

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E | G | H | I | J |
|  | a | a |  |  | a |  |  |  |  |
|  |  |  |  | a |  |  | a |  |  |
|  |  | a | a |  | a |  |  |  |  |
|  |  |  | a | a |  |  |  | a |  |
|  |  |  |  |  |  | a | a |  |  |
|  | a | a | a | a | a |  | a | a | a |

Iteratively, for and we use HG fill up ‘a’

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E | G | H | I | J |
|  | a | a |  |  | a |  |  |  |  |
|  |  |  |  | a |  |  | a |  |  |
|  |  | a | a |  | a |  |  |  |  |
|  |  |  | a | a |  |  |  | a |  |
|  |  |  |  |  |  | a | a |  |  |
|  | a | a | a | a | a | a | a | a | a |

For row ,this row can be filled up with ‘a’ in all columns

Hence,this decomposition is lossless-join

**Question2**

1. The number of super keys is 96.

List 5 of them: {A,B,J},{A,B,C,J},{A,B,D,J},{A,E,J},{A,E,C,J}

1. 2NF

* Every attributes in R are atomic and all non-prime attributes are fully functionally dependent on the relation keys.But for FDs EBCD and CD,where exist ECD,CE.Hence the attributes of D are transitively dependent on E.Thus,R is not satisfy 3NF .Hence,the highest normal form of R with respect to F is 2NF.

1. No,from Question1 Part(3),we can have minimal cover F’’’ = { ABE, DH, EB, EC, CD, CI, HG },it is obvious that function dependency DH and CI cannot be preserved after this decomposition because , and don’t have C and I or D and H at same time.
2. To prove the lossless-join we need to draw this table below ,we fill up “a” according to ,,

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E | G | H | I | J |
|  | a | a | a | a | a |  |  |  |  |
|  |  |  |  |  | a | a | a |  |  |
|  |  |  |  |  | a |  |  | a | a |

Firstly,we seek for column E ,and we use EBCD to fill up ‘a’ in this table

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E | G | H | I | J |
|  | a | a | a | a | a |  |  |  |  |
|  |  | A | a | a | a | a | a |  |  |
|  |  | a | a | a | a |  |  | a | a |

And then, we seek for column C, and we use CI to fill up ‘a’ in this table

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E | G | H | I | J |
|  | a | a | a | a | a |  |  | a |  |
|  |  | a | a | a | a | a | a | a |  |
|  |  | a | a | a | a |  |  | a | a |

And then, we seek for column D, and we use DH to fill up ‘a’ in this table

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E | G | H | I | J |
|  | a | a | a | a | a | a | a | a |  |
|  |  | a | a | a | a | a | a | a |  |
|  |  | a | a | a | a | a | a | a | a |

Finally,we cannot find any rows which can be filled up with ‘a’ in all columns.Hence, this decomposition is not lossless-join.

1. From Question1 Part4 we have such 3NF decomposition:

={A,B,E},={D,H},={B,C,E},={C,D,I},={H,G} ={A,B,J}

Which is dependency-preserving and lossless-join.

For ={A,B,E}, ABE is non-trivial and AB is superkey

For ={D,H}, DH is non-trivial and D is superkey

For ={E,C,B}, EB and EC are non-trivial and E is superkey

For ={C,D,I}, CD, CI are non-trivial and C is superkey

For ={G,H}, HG is non-trivial and H is superkey

Thus,each FD in this decomposition are non-trivial and left-side is superkey.Hence,this decomposition can satisfy BCNF