COMPUTER SCIENCE

Database Management System

Transaction & Concurrency Control

Transaction Concept Part-1

Lecture_1

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01 NF Decomposition

02 Transaction Concept

RDBMS Concept

FD Concept & its type

Attribute closure

Super key

Candidate key

Finding Multiple C.K

Membership set

Equality b/w 2 FD set

Minimal Cover.

Properties of Decomposition

- Lossless Join
- Dependency Preserving

Normal Form Concept

- 2NF, 3NF, BCNF

2NF Decomposition

3NF Decomposition

DBMS

(a) CC & Enjoying Concept

(b) CC

(c) C

(d) Doubt

Normal Forms

2NF :

then R is Not in 2NF.

2NF Decomposition.

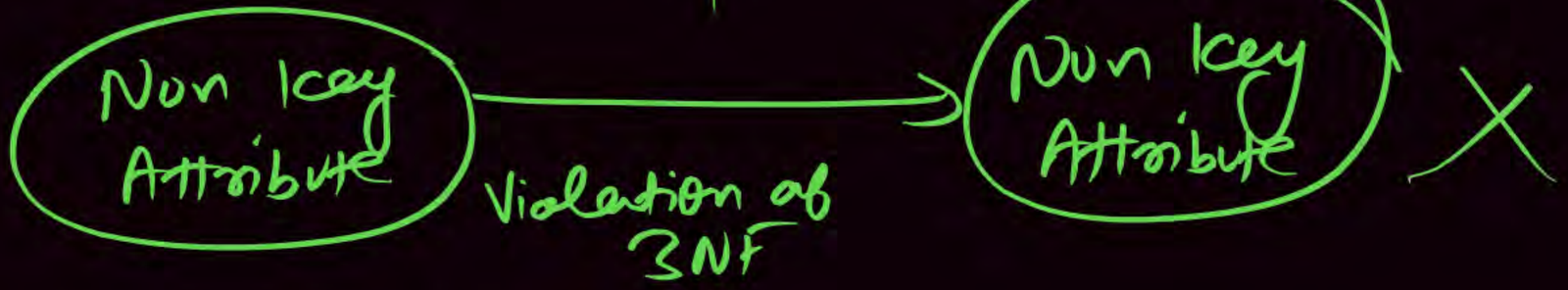
3NF

X : Super key
(or)
y : Key / Prime Attribute

3NF Decomposition

Nk → N.K

2NF & R



R(ABCDE) {A→B, B→C, C→D, D→E}

Candidate key = {A}

Non key Attribute = {B, C, D, E}

Check 3NF ?

X → Y

X: Not Super key

Y: Not Prime

B→C

C→D

D→E

Not in 3NF

3NF Decomposition

Q. In a relational data model, which one of the following statements is TRUE?

[GATE 2022]
2 marks.

A. A relation with only two attributes is always in BCNF. (Binary Relation)

B. If all attributes of a relation are prime attributes, then the relation is in BCNF.

C. Every relation has at least one non-prime attribute. → NO

D. BCNF decompositions always preserve functional dependencies.

Ans (A)

@

R(AB)
A → B

Candidate key = {A}

BCNF

X: Super key

R(AB)
B → A)

C.k : B

BCNF

X: Super key

R(AB) {A → B, B → A}

C.k : {A, B}

BCNF.

A & B in A → B, B → A

Super key

(8) R(ABCD) {A→B, B→C, C→A}

Candidate key = {AD, BD, CD}

Prime Attribute = {A, B, C, D}

Check BCNF

A→B
B→C
C→A

} X is Not Super key

R is in 3NF
But Not BCNF.

Q. Which of the following statement is/are true? (MSQ)

A. Second normal form (2NF) have transitive dependency.

B. No relation can be in both BCNF and 3NF.

C. Second normal form(2NF) does not have partial dependency.

D. In BCNF lossless join & dependency – preserving decomposition is always possible.

Q.

Let R(A, B, C, D, E, P, G) be a relational schema in which the following functional dependencies are known to hold:

$AB \rightarrow CD$, $DE \rightarrow P$, $C \rightarrow E$, $P \rightarrow C$ and $B \rightarrow G$.

The relational schema R is

[GATE 2008]
2 marks
& ISRO: 3 marks)

(A) In BCNF

(B) In 3NF, but not in BCNF

(C) In 2NF, but not in 3NF

(D) Not in 2NF

Q

Consider the following statements: [MSQ]

S_1: If every attribute is prime attribute in R, then Relation R will always be in BCNF.

S_2: Any Relation with two Attribute is in 3 NF and 2 NF.

S_3: If every key of relation R is a simple candidate key (No composite key) then the relation R not always in NF.

S_4: In BCNF there is always a lossless join and Dependency Preserving Decomposition.

Which of the above statement are incorrect

A S_1

B S_2

C S_3

D S_4

Q

The relation scheme student Performance (name, courseNO, rollNo, grade) has the following functional dependencies:

[2004: 2 Marks]

name, courseNo → grade

RollNo, courseNo → grade

name → rollNo

rollNO → name

The highest normal form of this relation scheme is

A 2 NF

B 3 NF

C BCNF

D 4 NF

Normal Form Decomposition

3NF Decomposition

Q. R (ABCD) {AB → CD, D → A}

Key Attribute.

Candidate key = [AB, DB]

Non Prime Attribute = [C]

3NF ?

YES

NO

Check 3NF:

AB → CD ✓ 3NF [AB is Super key]

D → A ✓ 3NF [D is Not Super key But A is key/Prime Attribute]

R is in 3NF.

3NF Decomposition

Q R (ABCDEFGH) {A→BC, B→DEF, DE→AGH}

Candidate key = [A, DE, B]

Check 3NF ?

A → BC ; A is Super key

B → DEF ; B is Super key

DE → AGH ; DE is Super key

R is in 3NF

3NF

X → Y

X: Super key

(or)

Y: Key / Prime Attribute

Q

R(ABCDE) {AB → C, C → D, B → E}

Decompose into 2NF, 3NF, BCNF

Candidate key = [AB]

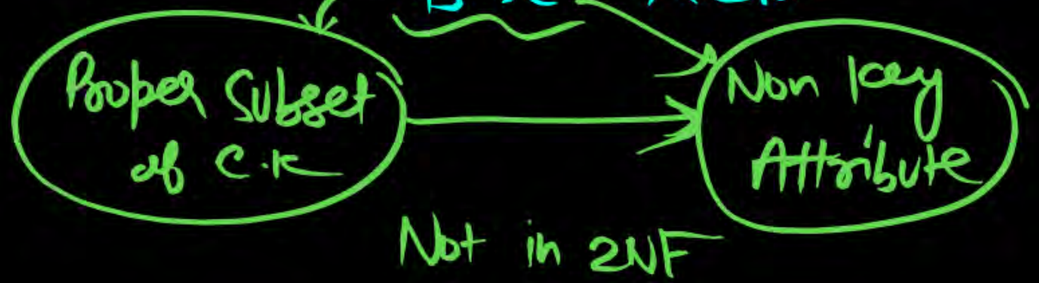
Non key Attribute = [C, D, E]

Check 2NF ?

AB → C ✓2NF

C → D ✓2NF

B → E X 2NF

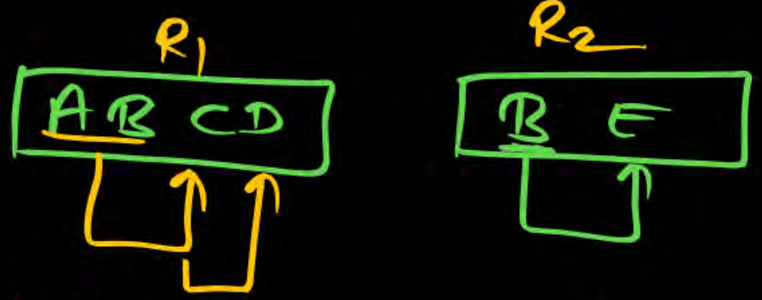


Not in 2NF

2NF Decomposition

$(B)^+ = [BE]$

R(ABCDE)



Check 3NF :

C → D

Non key → Non key

Not in 3NF

C : Not Subset key (or) D : Not Prime / Not key Attribute

3NF Decomposition

Q

R(ABCDE) $\{AB \rightarrow C, C \rightarrow D, B \rightarrow E\}$

Decompose into 2NF, 3NF, BCNF

$R_1(ABC)$ $R_2(CD)$ $R_3(BE)$

$R_1(ABC) \cap R_2(CD) = C$

$(C)^+ = [CD]$ Super key of R_2

$R_{12}(ABCD) \cap R_3(BE) = B$

$(B)^+ = [BE]$ Super key of R_3

$R_{123}(ABCDE)$ Lossless Join

$AB \rightarrow C$ ✓ R_1

$C \rightarrow D$ ✓ R_2

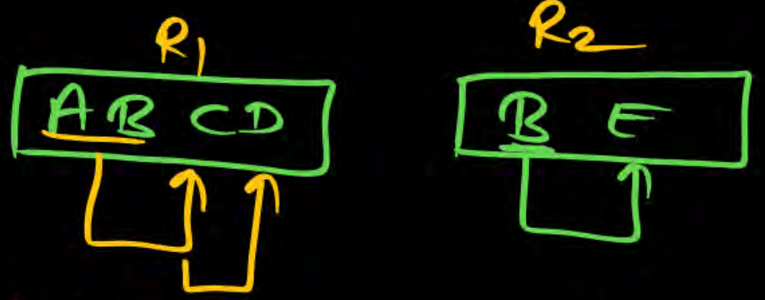
$B \rightarrow E$ ✓ R_3

} & Dep. Preserved

2NF Decomposition

$(B)^+ = [BE]$

$R(ABCDE)$



Check 3NF:

$C \rightarrow D$

Non key → Non key

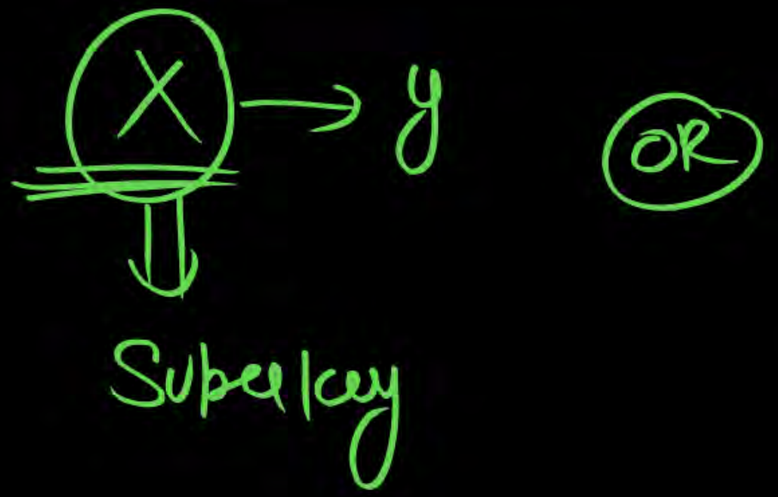
Not in 3NF.

C: Not Super key (or) D: Not Prime / Not key Attribute

3NF Decomposition

Boyce – Codd Normal Form

Definition: A relation schema R is in BCNF if whenever a nontrivial functional dependency $X \rightarrow A$ holds in R, then X is a superkey of R.



R is in 2NF, & 3NF

&

Every Non Trivial $X \rightarrow y$

BCNF Check : X: Super key.

But if Relation R is Not in BCNF

BCNF Decomposition

BCNF Decomposition

Step By Step. 2NF → 3NF → BCNF.

Q

R(ABCDE) {A → B, B → C, C → D, D → E}

Candidate key = [A]

Non key Attribute = (B, C, D, E)

Check 2NF ? R is in 2NF ✓

Check 3NF ?

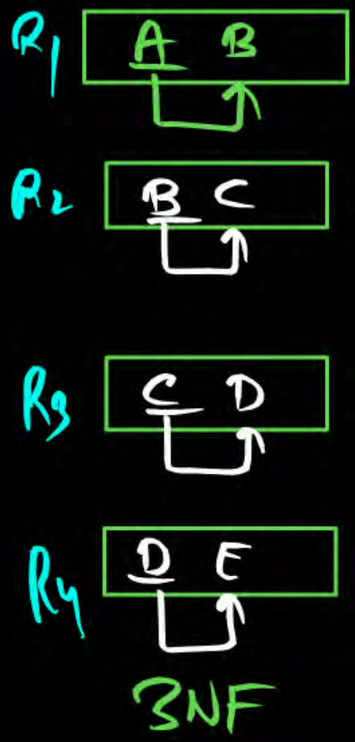
B → C ✗ 3NF

C → D ✗ 3NF

D → E ✗ 3NF

(X: Not Super key & Y: Non Prime Attribute)

3NF Decomposition



3NF

Check BCNF ?

R1, R2, R3 R4 is in BCNF

Bz In every X → Y

X: Super key

So R is in BCNF

BCNF Decomposition

Q.1 R(ABCDE) {A → B, B → C, C → D, D → E}

Step By Step.

$R_1(AB)$ $R_2(BC)$ $R_3(CD)$ $R_4(DE)$

$R_1(AB) \cap R_2(BC) = B \Rightarrow [B]^+ = [BCDE]$

Subset key of R_2.

$R_{12}(ABC) \cap R_3(CD) = [C] = [C]^+ = [CDE]$

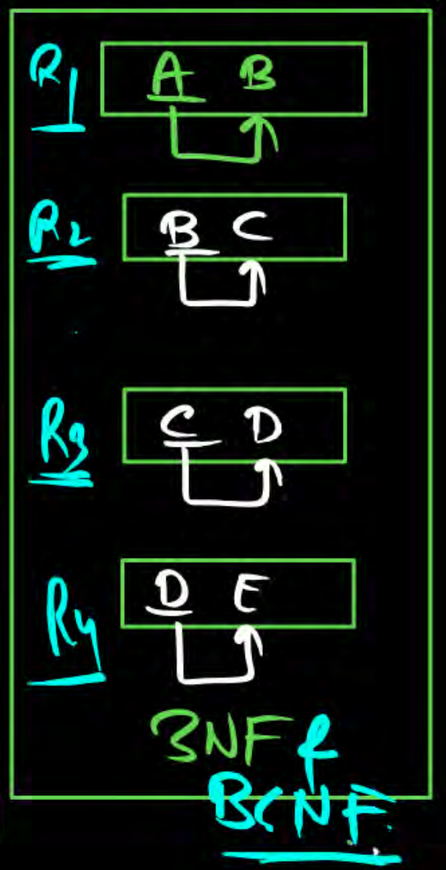
Subset key of R_3

$R_{123}(ABCD) \cap R_4(DE) = (D]$

$(D]^+ = [DE)$ Subset key of R_4

$R_{1234}[ABCDE]$ Lossless.

3NF Decomposition



Check BCNF ?

R_1, R_2, R_3, R_4 is in BCNF

BCNF In every $X \rightarrow Y$

X: Subset key

So R is in BCNF + Lossless + Dep. Preserved.

Note

More than One BCNF Decomposition may be Possible (Due to Multiple Minimal Cover)

BCNF Decomposition

Directly BCNF Decomposition

Q.1 R(ABCDE) $\{A \to B, B \to C, C \to D, D \to E\}$

Candidate key = (A)

Check BCNF ?

$B \to C$ Violate BCNF

$C \to D$ Violate BCNF

$D \to E$ Violate BCNF

X: Not Super key

BCNF Decomposition:

① $B \to C$

✗ $C \to D$

② $D \to E$

$R_1(A\ B\ C\ D\ E)$

R_2 [B C]

R_3 [D E]

BCNF Decomposition

$R_1(ABD)$

$R_2(BC)$

$R_3(DE)$

BCNF Decomposition

Directly BCNF Decomposition

Q.1 R(ABCDE) $\{A \to B, B \to C, C \to D, D \to E\}$

Candidate key = {A}

Check BCNF ?

$B \to C$ Violate BCNF

$C \to D$ Violate BCNF

$D \to E$ Violate BCNF

X: Not Super key

BCNF Decomposition:

② $B \to C$

① $C \to D$

× $D \to E$

$R(A\,B\,C\,D\,E)$

R_2 (C D)

R_3 (B C)

BCNF Decomposition

$R_1(ABE)$

$R_2(CD)$

$R_3(BC)$

BCNF Decomposition

Directly BCNF Decomposition

Q.1 R(ABCDE) $\{A \to B, B \to C, C \to D, D \to E\}$

Candidate key = (A)

Check BCNF ?

$B \to C$ Violate BCNF

$C \to D$ Violate BCNF

$D \to E$ Violate BCNF

X: Not Super key

BCNF Decomposition:

③ $B \to C$

② $C \to D$

① $D \to E$

R(A B C D E)

R_2 D E

R_3 C D

R_4 B C

BCNF Decomposition

R_1(AB)
R_2(BC)
R_3(CD)
R_4(DE)

Lossless + D.P

(a) Maza Aaya

(b) cc

(c) c

(d) Doubt

BCNF Decomposition

Q.2 R(ABCD) $\{AB \rightarrow CD, D \rightarrow A\}$

Candidate key = [AB, DB]

Check BCNF ?

$D \rightarrow A$ (Violate BCNF)

(∵ D is Not Super key)

$R_1(BCD) \cap R_2(DA) = [D]^+ = [DA]$

Super key of R_2

Lossless Join

BCNF Decomposition

$R_1(ABCD)$

① $D \rightarrow A$

R_2 | D A

$R_1(BCD)$

$R_2(DA)$

BCNF + Lossless + Dependency Not Preserved

BCNF Decomposition

Q.3 R(ABCDE) {A → B, BC → D, D → E}

Candidate key = [AC]

Check BCNF

A → B, BC → D, D → E } Violate BCNF Because X → y, X: Not super key.

(I) BCNF Decomposition

R(A B C D E)

① A → B

BC → D

② D → E

R2 [A B]

R3 [D E]

BCNF Decomposition: R1(A C D), R2(A B), R3(D E)

(II) BCNF Decomposition

② A → B

① BC → D

✗ D → E

R1(A B C D E)

R2 [B C D]

R3 [A B]

R1(A C E), R2(B C D), R3(A B)

(III)

③ A → B

② BC → D

① D → E

R1(A B C D E)

R2 [D E]

R3 [B C D]

R4 [A B]

BCNF Dec.: R1(AC), R2(DE), R3(BCD), R4(AB)

BCNF Decomposition

Q R(ABCDEFG) $\{A \rightarrow BF, F \rightarrow DEG, A \rightarrow D\}$

Minimal Cover

$A \rightarrow B$, $A \rightarrow F$, $F \rightarrow D$ $F \rightarrow E$ $F \rightarrow G$, $A \rightarrow D$

$(A)^+ = [ABFDE]$

$A \rightarrow D$ is extra FD.

BCNF Decomposition

Q R(ABCDEFG) {A → BF, F → DEG, A → D}

[A → BF, F → DEG]

Candidate key = AC

Check BCNF:

A → BF
F → DEG
[Violation of BCNF.]
[∵ X is Not Super key]

BCNF Decomposition

① A → BF
✗ F → DEG

R_1(ABCDEFG)

R_2(ABF)

R_1(ACDEG)
R_2(ABF)

BCNF Decomposition

R_1(ABCDEFG)

② A → BF
① F → DEG

R_2(FDEG)

R_3(ABF)

R_1(AC)
R_2(EDEG)
R_3(ABF)

BCNF + Lossless + D.P

Q

R(ABCDEFGHIJ) $\{AB \rightarrow C, A \rightarrow DE, B \rightarrow F, F \rightarrow GH, D \rightarrow IJ\}$

H.W

① Step by Step

② Directly BCNF

Q.1

Relation R is decomposed using a set of functional dependencies, F, and relation S is decomposed using another set of functional dependencies, G. One decomposition is definitely BCNF, the other is definitely 3NF, but it is not know which is which. To make a guaranteed identification, which one of the following tests should be used on the decompositions? (Assume that the closures of F and G are available).

[2002: 2 Marks]

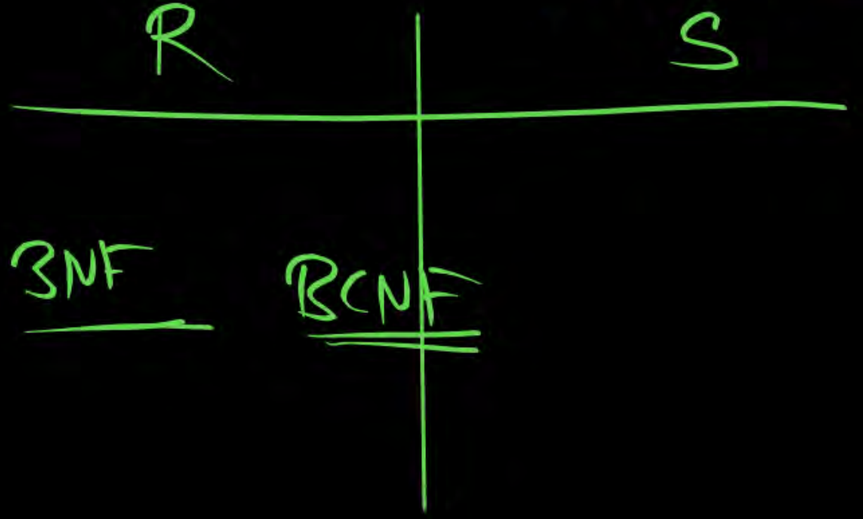
A. Dependency-preservation

B. Lossless-join

C. BCNF definition

D. 3 NF definition

Ans (C).



10th Pass

12th Pass (already 10, 12 Pass)

① 10th

② 12th

KBC Hot Seat 7Cr.

No Life Line

Only 1 Choice

Q

Which of the following relational schema with given FD's follows is/are in BCNF?

A. R(ABCDE) and FD's are $\{A \rightarrow B, B \rightarrow C, C \rightarrow D, D \rightarrow E, C \rightarrow A\}$

B. R(ABCDE) and FD's are $\{A \rightarrow B, C \rightarrow D, D \rightarrow E\}$

C. R(ABCD) and FD's are $\{A \rightarrow B, B \rightarrow C, C \rightarrow D, D \rightarrow A\}$

D. R(ABCD) and FD's are $\{A \rightarrow B, B \rightarrow C, C \rightarrow A\}$

Q

Consider the following Relation:

R(ABCDEFG) with FD set of Relation R {A → B, C → D, E → FG}. What is the minimum number of relations required to decompose into BCNF which satisfy lossless join and Dependency preserving decomposition _____

Q

The relation scheme student Performance (name, courseNO, rollNo, grade) has the following functional dependencies:

[2004: 2 Marks]

Super key

{ name, courseNo → grade

RollNo, courseNo → grade

name → rollNo (Prime)

rollNO → name (Prime)

Key [(nameCno, RollnoCno)]

The highest normal form of this relation scheme is

A 2 NF

B 3 NF

C BCNF

D 4 NF

Ans (B).

Q.

Relation R has eight attributes ABCDEFGH. Fields of R contain only atomic values.

$F = \{CH \rightarrow G, A \rightarrow BC, B \rightarrow CFH, E \rightarrow A, F \rightarrow EG\}$ is a set of functional dependencies (FDs) so that F^+ is exactly the set of FDs that hold for R.

[MCQ: 2013: 2M]

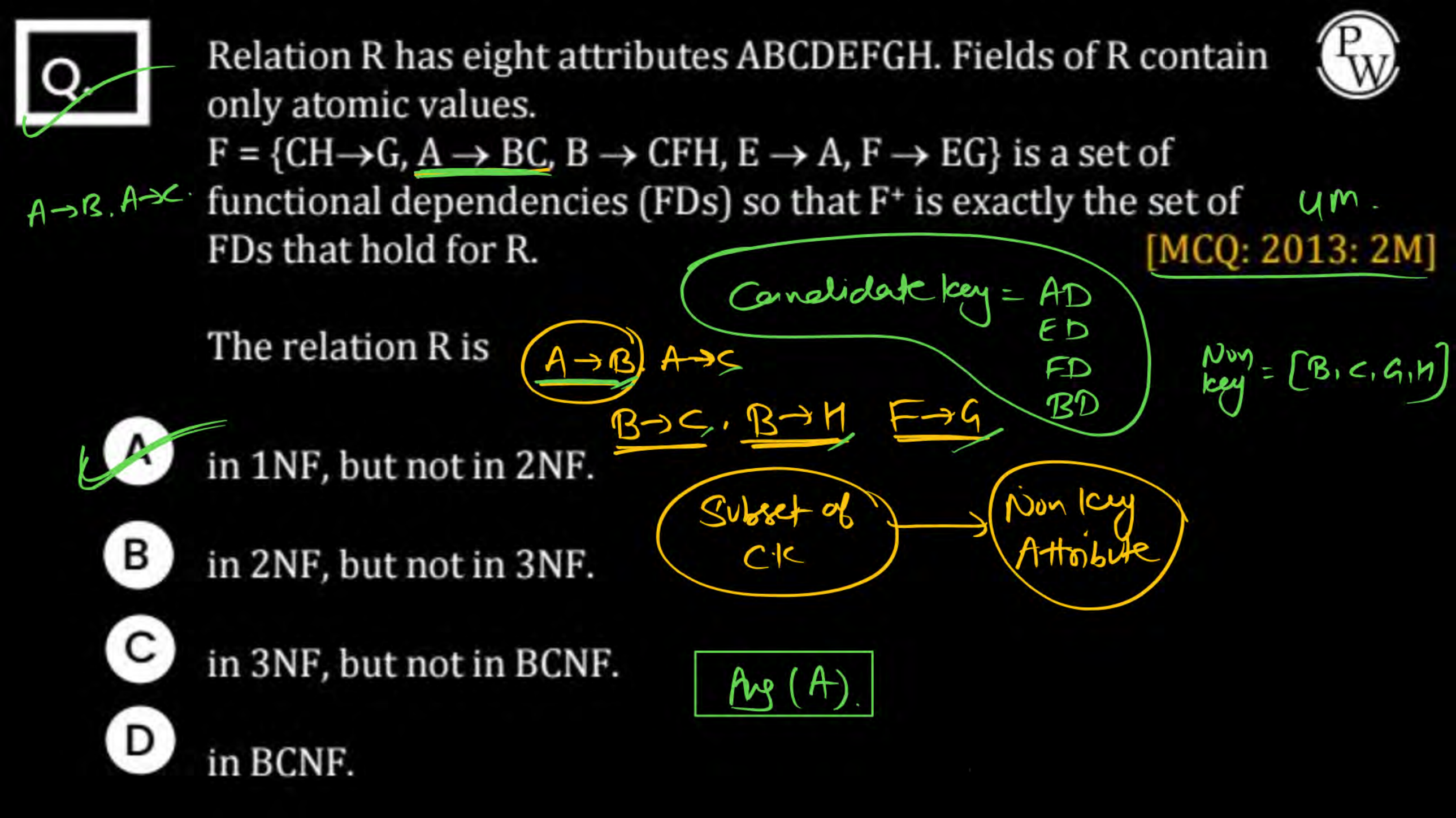
The relation R is

(A) in 1NF, but not in 2NF.

(B) in 2NF, but not in 3NF.

(C) in 3NF, but not in BCNF.

(D) in BCNF.



Q.

Given an instance of the STUDENTS relation as shown below:

StudentID	StudentName	StudentEmail	StudentAge	CPI
2345	Shankar	shankar@math	X	9.4
1287	Swati	swati@ee	19	9.5
7853	Shankar	shankar@cse	19	9.4
9876	Swati	swati@mech	18	9.3
8765	Ganesh	ganesh@civil	19	8.7

For(StudentName, StudentAge) to be a key for this instance, the value X should NOT be equal to 19.

[NAT: 2014: 1M]

Q.

Given the following two statements:

S1: Every table with two single-valued attributes is in 1NF, 2NF, 3NF and BCNF.

(Binary Relation) → BCNF

False

S2: $AB \rightarrow C, D \rightarrow E, E \rightarrow C$ is a minimal cover for the set of functional dependencies $AB \rightarrow C$, $D \rightarrow E$, $AB \rightarrow E$, $E \rightarrow C$.

Which one of the following is CORRECT?

[MCQ: 2014: 2M]

(A) S1 is TRUE and S2 is FALSE.

Ans (A)

(B) Both S1 and S2 are TRUE.

(C) S1 is FALSE and S2 is TRUE.

(D) Both S1 and S2 are FALSE.

Q.

Consider the following four relational schemas. For each schema, all non-trivial functional dependencies are listed. The underlined attributes are the respective primary keys.

Schema I: Registration (rollno, courses)

Field 'courses' is a set-valued attribute containing the set of courses a student has registered for.

Non-trivial functional dependency:

rollno → courses

Schema II: Registration (rollno, courseid, email)

Non-trivial functional dependencies:

rollno, courseid → email

email → rollno

Schema III: Registration (rollno, courseid, marks, grade)

Non-trivial functional dependencies:

rollno, courseid → marks, grade

marks → grade

Schema IV: Registration (rollno, courseid, marks, credit)

Non-trivial functional dependencies:

rollno, courseid → credit

courseid → credit

Which one of the relational schemas above is in 3NF but not in BCNF?

[MCQ: 2018: 2M]

(A) Schema I

(B) Schema II

(C) Schema III

(D) Schema IV

Q.

A database of research articles in a journal uses the following schema.

(VOLUME, NUMBER, STARTPAGE, ENDPAGE, TITLE, YEAR, PRICE)

The primary key is (VOLUME, NUMBER, STARTPAGE, ENDPAGE) and the following functional dependencies exist in the schema.

(VOLUME, NUMBER, STARTPAGE, ENDPAGE) $\rightarrow$ TITLE

(VOLUME, NUMBER) $\rightarrow$ YEAR

(VOLUME, NUMBER, STARTPAGE, ENDPAGE) $\rightarrow$ PRICE.

The database is redesigned to use the following schemas.

(VOLUME, NUMBER, STARTPAGE, ENDPAGE, TITLE, PRICE)

(VOLUME, NUMBER, YEAR)

Which of the weakest normal form that the new database satisfies, but the old one does not?

[MCQ: 2016: 1M]

(A) 1NF

(B) 3NF

(C) 2NF

(D) BCNF

Q. Consider a relational table R that is in 3NF, but not in BCNF. Which one of the following statements is TRUE?

[MCQ: 2020-2M]

(A) R has a nontrivial functional dependency X→A, where X is not a superkey and A is a non-prime attribute and X is a proper subset of some key.

(B) R has a nontrivial functional dependency X→A, where X is not a superkey and A is a non-prime attribute and X is not a proper subset of any key.

(C) A cell in R holds a set instead of an atomic value.

(D) R has a nontrivial functional dependency X→A, where X is not a superkey and A is a prime attribute.

Ans (D).

$X \to A$

$X \to y$

3NF

BCNF

× X : Super key

OR

[A] y : Prime key Attribute

3NF ✓

X : Super key.

×

Q.

Consider a relation R (A, B, C, D, E) with the following three functional dependencies.

$AB \rightarrow C$; $BC \rightarrow D$; $C \rightarrow E$;

The number of superkeys in the relation R is _____.

[NAT:2022-1M]

Candidate key = AB

Number of Super key = $2^{5-2} = 2^3 = 8$ Super key.

OR

AB CDE

$2^3 = 8$ Super key

(AB, ABC, ABD, ABE, ABCD, ABDE, ABCE, ABCDE)

Any Doubt ?

THANK YOU!