MVD & 4NF

classes(course, teacher, book)

(c, t, b) ∈ classes

course	teacher	book
DB	t_1	DB1
DB	t_1	DB2
DB	t_2	DB1
DB	t_2	DB2

DB — t_1 DB1

DB — t_2 DB2

Key = $\underbrace{\text{course, teacher, book}}$

in a BCNF.

Redundancy.

Multivalued Dependency (MVD)

$\alpha, \beta \subseteq R$, $\alpha \twoheadrightarrow \beta$ holds on R, if

for all $t_1, t_2 \in r \ni t_1[\alpha] = t_2[\alpha]$

$\exists\ t_3, t_4 \in r$ such that

$$\boxed{t_1[\alpha] = t_2[\alpha] = t_3[\alpha] = t_4[\alpha]}$$

$t_3[\beta] = t_1[\beta]$ $t_1[\beta]$

$t_3[R-\beta] = t_2[R-\beta]$

$t_4[\beta] = t_2[\beta]$ $t_2[\beta]$

$t_4[R-\beta] = t_1[R-\beta]$

	α	β	$R-\alpha-\beta$
t_1	a_1, a_2	a_3, a_4	a_5, a_6
t_2	a_1, a_2	b_3, b_4	b_5, b_6
t_3	a_1, a_2	a_3, a_4	b_5, b_6
t_4	a_1, a_2	b_3, b_4	a_5, a_6

4NF

R - relation

D - Functional & MV dependencies.

$\forall\ \alpha \twoheadrightarrow \beta,\ \alpha, \beta \subseteq R,$

at least one of the following holds.

* $\alpha \twoheadrightarrow \beta$ is trivial ($\beta \subseteq \alpha$ or $\alpha \cup \beta = R$)
* α is a super key for R

$R = (A, B, C, G, H, I)$

$D = \{ A \twoheadrightarrow B$
$B \twoheadrightarrow HI$
$CG \twoheadrightarrow H \}$

Trivial

$\alpha \twoheadrightarrow \beta$

$\beta \subseteq \alpha$ (or) $\alpha \cup \beta = R$

$A \twoheadrightarrow B$: 4NF, A not a key.

Decomposition: $R_1 = (A, B)$

$R_2 = R - \{B\} = \{A, C, G, H, I\}$

$R_1 = (A, B)$, D_1 find from D^+ on R_1.

$A \twoheadrightarrow B$ Trivial, so, in 4NF

Restriction of MVD:

$$\alpha \twoheadrightarrow (\beta \cap R_i)$$

where $\alpha \subseteq R_i$ and $\alpha \twoheadrightarrow \beta$ in D^+.

$R_2 = \{A, C, G, H, I\}$

$D_2 = \{ CG \twoheadrightarrow H, \ldots \}$

Not trivial

not in 4NF.

Decompose R_2.

$R_3 = (C, G, H)$, $D_3 = \{CG \twoheadrightarrow H\}$

Trivial, 4NF

$R_4 = (A, G, G, I)$, $D_4 = \{$

$A \twoheadrightarrow HI$ in D^+

$A \twoheadrightarrow I$ in D_4

so, not in 4NF

Decompose:

$R_5 = (A, I)$, $D_5 = \{A \twoheadrightarrow I\}$ Trivial, 4NF

$R_6 = (A, C, G)$, $D_6 = \{ \quad \}$ 4NF.