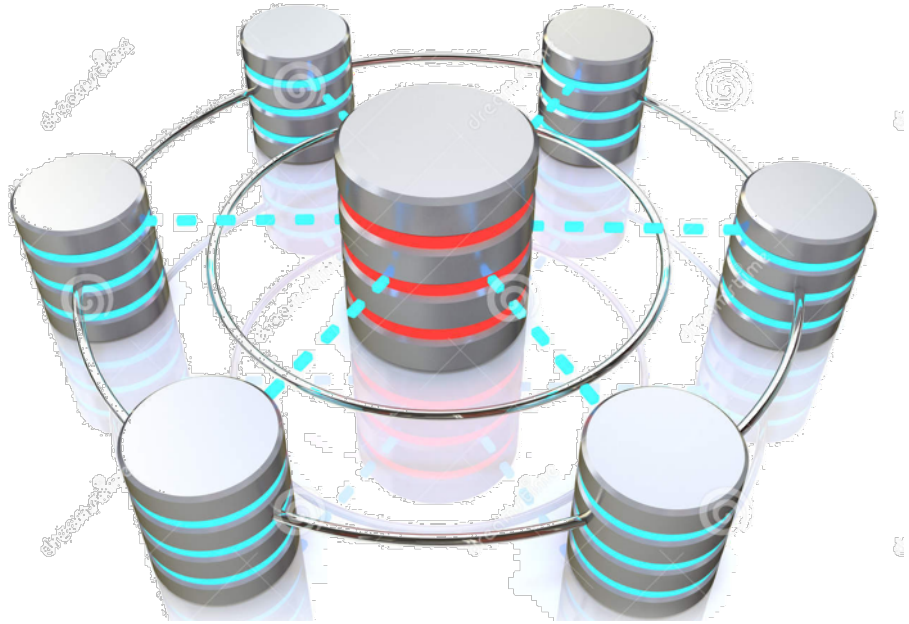
greatlearning
Learning for Life

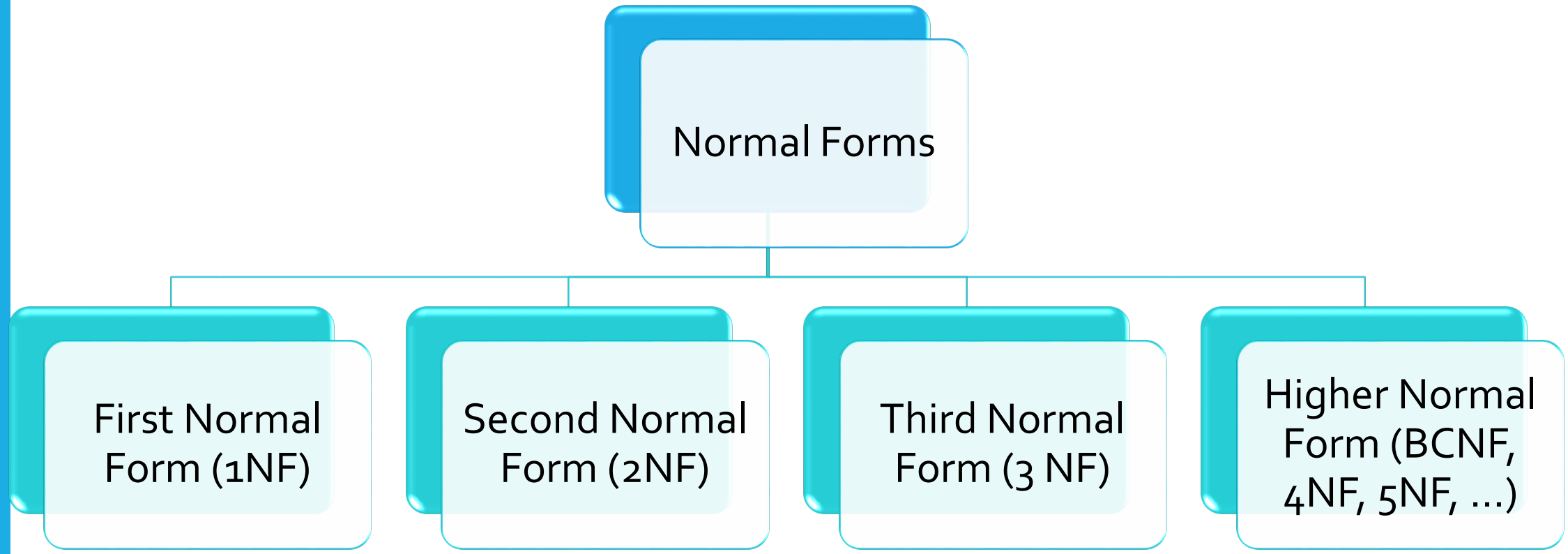
# NORMALIZATION

# NORMALIZATION AND NORMAL FORMS

- Normalization
- Decompose larger, complex table into simpler and smaller ones
- Moves from lower normal forms to higher normal forms
- Usually done after E-R modeling
  - Should not include computed fields

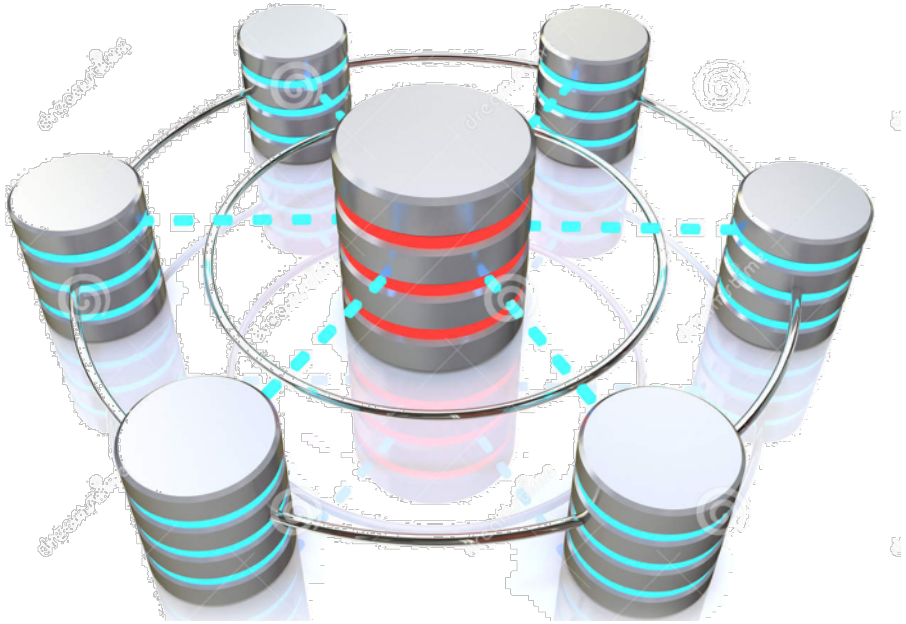


# NORMALIZATION AND NORMAL FORMS



# NEED FOR NORMALIZATION

- In order to produce good database design, ask questions:
- Does the design ensure all database operations will be efficiently performed?
- Is there any expensive DBMS operations which are avoidable?
- Is the information unnecessarily replicated?



# NEED FOR NORMALIZATION

How many rows should to be updated if there is a change in student details for Rob? – Update Anomalies

| Student_Details | Course_details | | Pre-requisite | Result_details |
|---|---|---|---|---|
| 0101 Tim 11/4/1985 | M1 Physics-Math-Chemistry | 7 | Basic Math | 02/11/2015 82 A |
| 0102 Rob 10/04/1986 | M4 Physics-Bio-Chemistry | 8 | Basic Physics | 21/11/2015 89 A |
| 0103 Mary 11/07/1985 | B3 Botany-Zoology | 10 | Basic Biology | 12/11/2015 62 B |
| 0104 Rob 10/04/1986 | H6 History-Geo-Eco | 9 | Basic History | 21/11/2015 89 A |
| 0105 Tom 03/08/1988 | C3 Bio-Chemistry | 11 | Basic Biology | 12/11/2015 50 C |

How many times the student_details should be stored for each of the courses enrolled? – Data Duplication

Is it possible to insert a course which is not enrolled by any student? – Insertion Anomalies

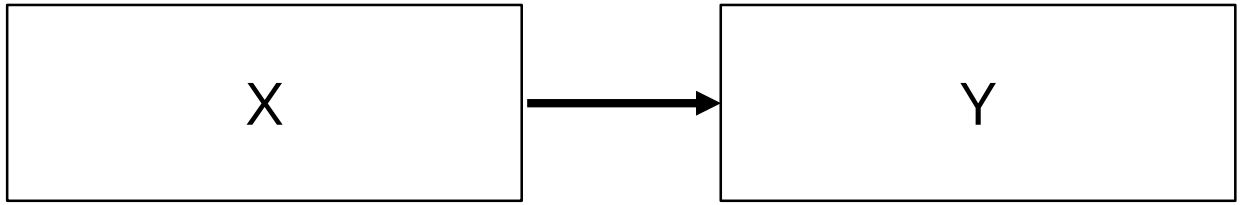
Can we delete the course_details for a student Tom? – Delete Anomalies

## FUNCTIONAL DEPENDENCY

- Consider the relation
  - Result (student#, course#, CourseName, InstructorName Marks, Grade)
    - Student# and course# together defines exactly one value of marks. Student#, course# → Marks
    - Student# and course# determines Marks or Marks is functionally dependent on student# and course#
- Other functional dependencies in the relation:
  - Course# - CourseName
  - Course# - InstructorName
  - Marks - Grade

## FUNCTIONAL DEPENDENCY

- In a given relation R, X and Y are attributes. Attribute Y is functionally dependent on attribute X if each value of X determines exactly one value of Y.



# FD TYPES

Full Functional Dependency

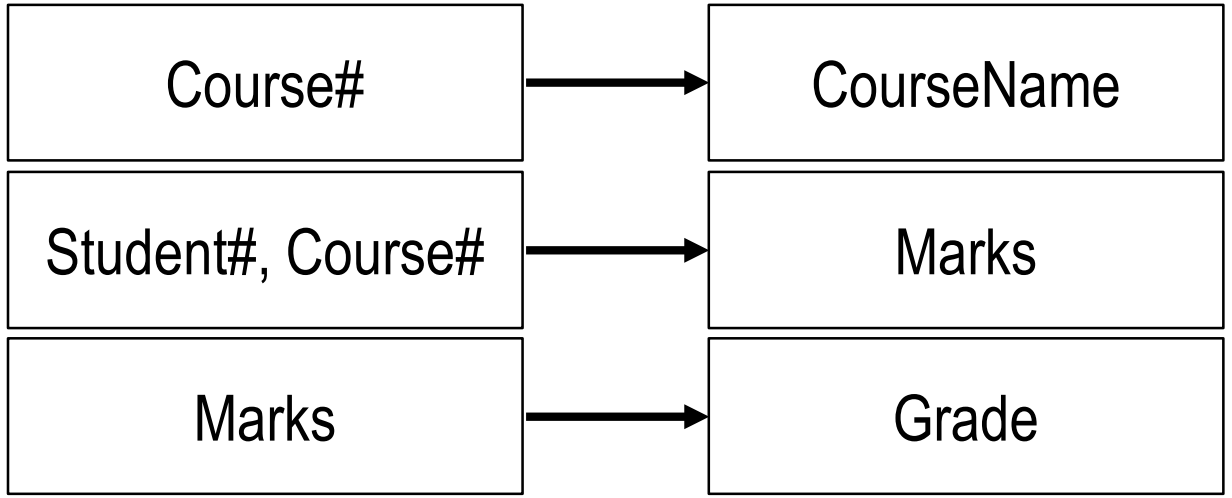
Partial Functional Dependency

Transitive Dependency

## FD TYPES

### Full Functional Dependency

- Attribute Y is functionally dependent on attribute X, if and only if it is not functionally dependent on the subset of X
- Result(student#, course#, CourseName, InstructorName, Marks, Grade)

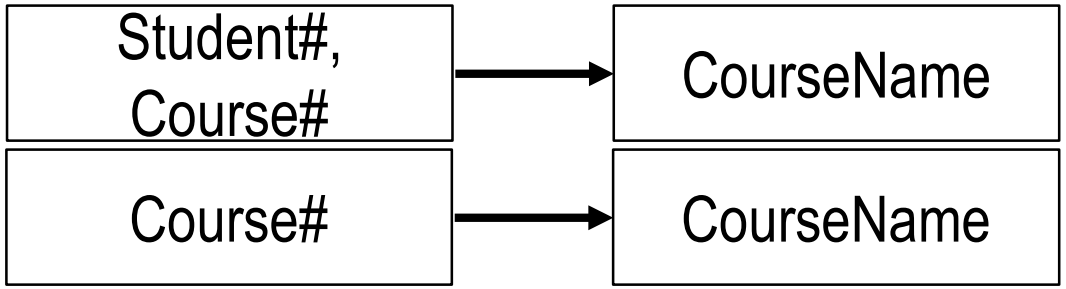



Marks is dependent on {Student#, Course#} together and not on the subset of {Student#, Course#}

# FD TYPES

## Partial Functional Dependency

- Attribute Y is partially dependent on attribute X, if and only if it is dependent on the subset of attribute X.
- REPORT (Student#, Course#, StudName, CourseName, Marks, Grade)

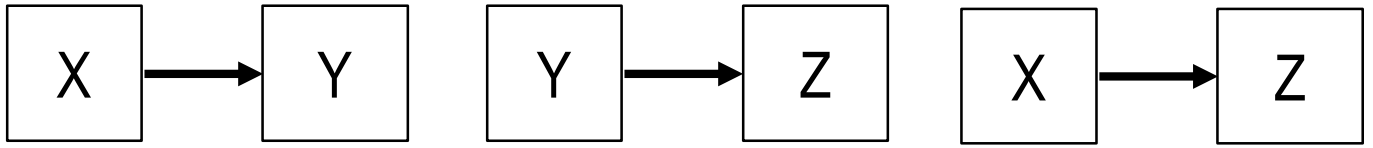



**COURSENAME IS DEPENDENT ON {STUDENT#, COURSE#} AND ON THE SUBSET {COURSE#}**

# FD TYPES

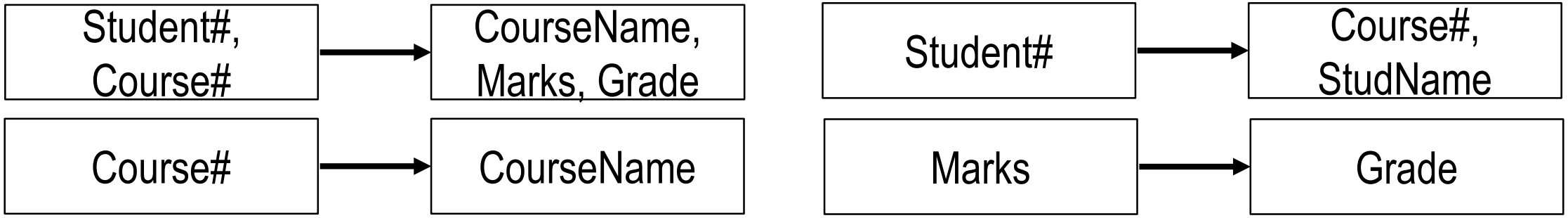
## Transitive Dependency

X, Y, Z are three attributes



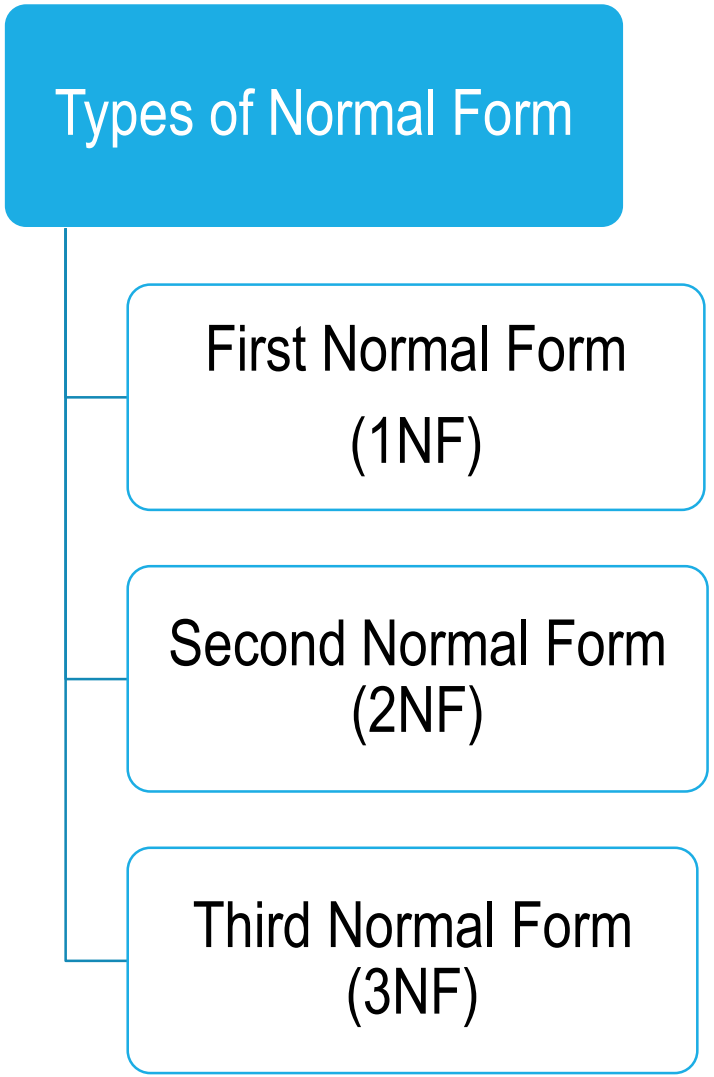

# KEY ATTRIBUTE - ALTERNATE DEFINITION

- In a Given relation R, if an attribute X determines all other attributes, then X is said to be a Key attribute
- REPORT (Student#, Course#, StudName, CourseName, Marks, Grade)

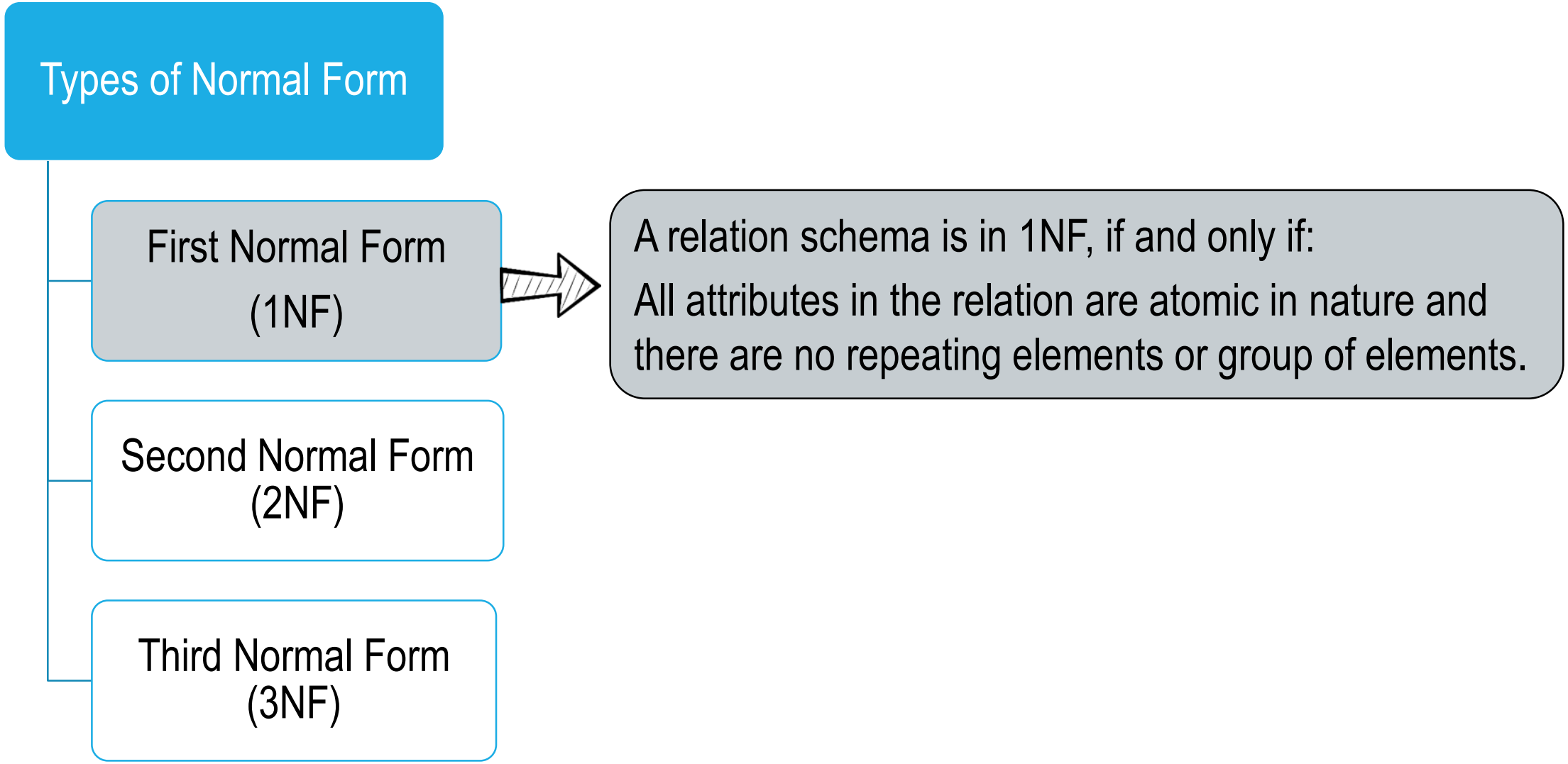



**{STUDENT#, COURSE#} TOGETHER DETERMINES ALL THE ATTRIBUTES IN THE RELATION AND HENCE IS THE KEY ATTRIBUTE OF THE RELATION**

# NORMALIZATION



# FIRST NORMAL FORM



# FIRST NORMAL FORM (1NF)

Student Marks Table

| Student_Details | Course_details | | Pre-requisite | Result_details | | |
|---|---|---|---|---|---|---|
| 0101 Tim 11/4/1985 | M1 Physics-Math-Chemistry | 7 | Basic Math | 02/11/2015 | 82 | A |
| 0102 Rob 10/04/1986 | M4 Physics-Bio-Chemistry | 8 | Basic Physics | 21/11/2015 | 89 | A |
| 0103 Mary 11/07/1985 | B3 Botany-Zoology | 10 | Basic Biology | 12/11/2015 | 62 | B |
| 0104 Rob 10/04/1986 | H6 History-Geo-Eco | 9 | Basic History | 21/11/2015 | 89 | A |
| 0105 Tom 03/08/1988 | C3 Bio-Chemistry | 11 | Basic Biology | 12/11/2015 | 50 | C |

# FIRST NORMAL FORM (1NF)

## Student Marks Table in 1NF

| Student# | Student_Name | Date Of Birth | Course# | CourseName | Pre-Requisite | Duration in days | Date Of Exam | Marks | Grade |
|---|---|---|---|---|---|---|---|---|---|
| 0101 | Tim | 11/4/1985 | M1 | Physics-Math - Chemistry | Basic Math | 7 | 02/11/2015 | 82 | A |
| 0102 | Rob | 10/04/1986 | M4 | Physics-Bio - Chemistry | Basic Physics | 8 | 21/11/2015 | 89 | A |
| 0103 | Mary | 11/07/1985 | B3 | Botany - Zoology | Basic Biology | 10 | 12/11/2015 | 62 | B |
| … | … | … | … | … | … | … | … | … | … |

# SECOND NORMAL FORM (2NF)

Types of Normal Form

- First Normal Form (1NF)
- Second Normal Form (2NF)
- Third Normal Form (3NF)

A relation is said to be in 2NF, if and only if:

- It is in 1NF.
- No partial dependency exists between non-key attributes and key attributes.

# SECOND NORMAL FORM (2NF)

## Student Marks Table in1NF

| Student# | Student_ Name | DOB | Course# | CourseName | Pre Requisite | Duration in days | Date of Exam | Marks | Grade |
|---|---|---|---|---|---|---|---|---|---|
| 0101 | Tim | 11/4/1985 | M1 | Physics-Math - Chemistry | Basic Math | 7 | 02/11/2015 | 82 | A |
| 0102 | Rob | 10/04/1986 | M4 | Physics-Bio-Chemistry | Basic Physics | 8 | 21/11/2015 | 89 | A |
| 0103 | Mary | 11/07/1985 | B3 | Botany-Zoology | Basic Biology | 10 | 12/11/2015 | 62 | B |

## SECOND NORMAL FORM (2NF)

- Key and Non Key Attributes of Student_marks table
- {Student#, Course#} : Candidate key
- Key Attributes: Student#, Course#
- Non Key Attributes: StudentName, DOB,CourseName, Pre-Requisite, DurationDays, Dateof exam, Marks, Grade
- Functional dependencies:

**STUDENT# ,COURSE# → MARKS**

**STUDENT#, COURSE# → GRADE**

**MARKS → GRADE**

**STUDENT# → STUDENTNAME, DOB**

**COURSE# → COURSENAME, PRE-REQUISITE, DURATIONDAYS, DATEOF EXAM**

Partial Dependency with the Key attribute → Split/Decompose the tables to remove partial dependencies

# SECOND NORMAL FORM (2NF)

Student Table

| Student# | Student_Name | Date Of Birth |
|---|---|---|
| 0101 | Tim | 11/4/1985 |
| 0102 | Rob | 10/04/1986 |
| 0103 | Mary | 11/07/1985 |

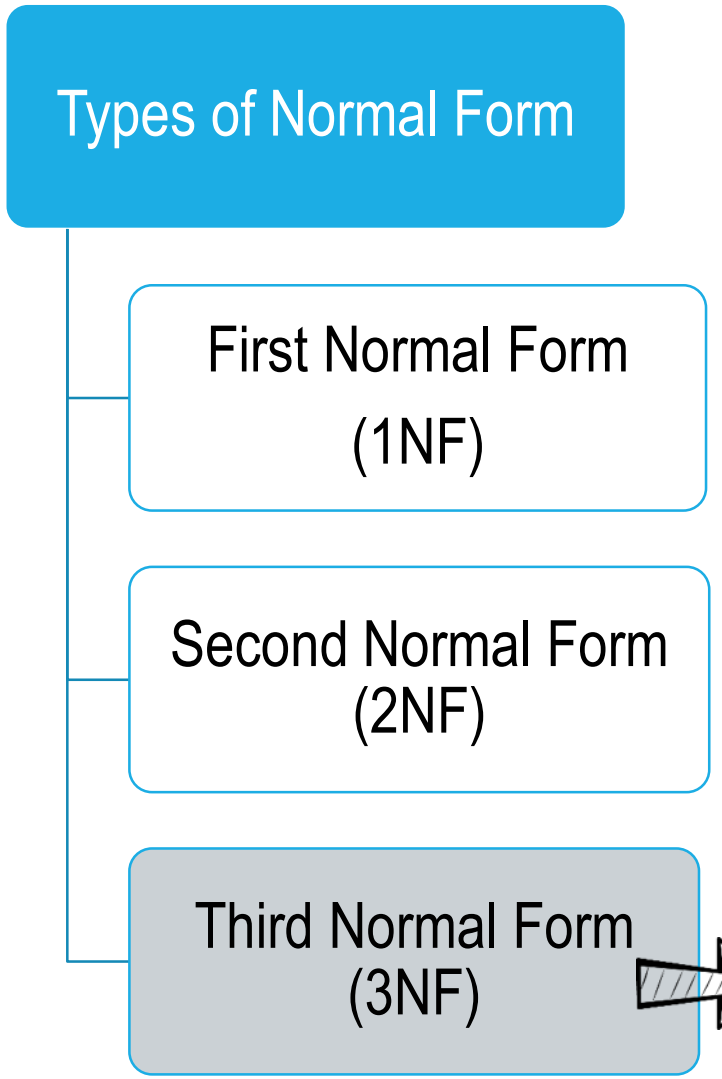
Result Table

| Student# | Course# | Marks | Grade |
|---|---|---|---|
| 0101 | M1 | 82 | A |
| 0102 | M4 | 89 | A |
| 0103 | B3 | 62 | B |

Course Table

| Course# | CourseName | Prerequisite | Durationindays | Date Of Exam |
|---|---|---|---|---|
| M1 | Physics-Math-Chemistry | Basic Math | 7 | 02/11/2015 |
| M4 | Physics-Bio-Chemistry | Basic Physics | 8 | 21/11/2015 |
| B3 | Botany-Zoology | Basic Biology | 10 | 12/11/2015 |

# THIRD NORMAL FORM (3NF)




A relation R is said to be in 3NF if and only if:

- It is in 2NF.
- No transitive dependency exists between non-key attributes and key attributes through another non-key attribute.

# THIRD NORMAL FORM (3NF)

Result_table

| Student# | Course# | Marks | Grade |
|---|---|---|---|
| 0101 | M1 | 82 | A |
| 0102 | M4 | 89 | A |
| 0103 | B3 | 62 | B |

**STUDENT# ,COURSE# ⟶ MARKS**

**STUDENT#, COURSE# ⟶ GRADE**

**MARKS ⟶ GRADE**

**STUDENT#,COURSE#⟶ MARKS⟶ GRADE:TD** → Remove

# THIRD NORMAL FORM (3NF)

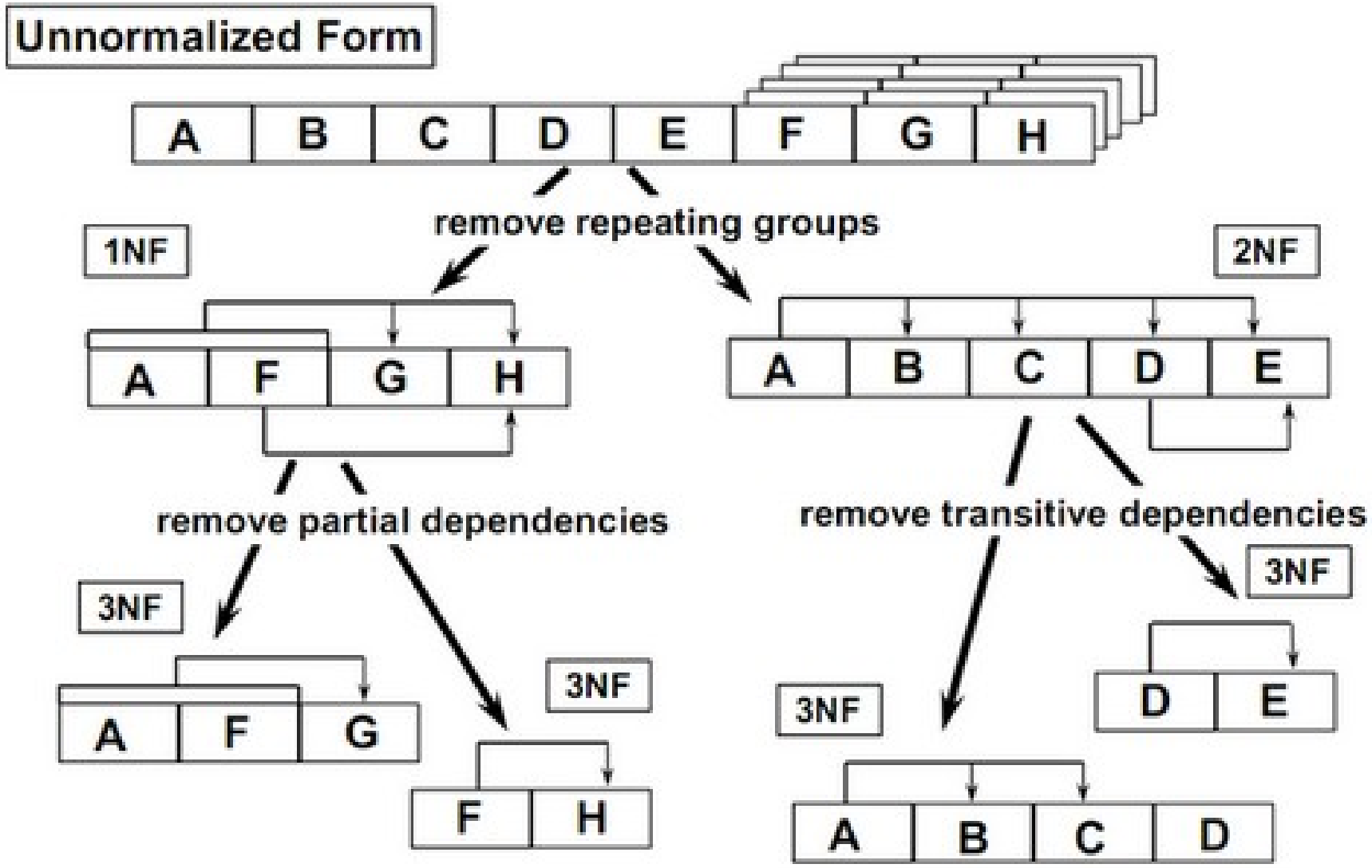
Result Table

| Student# | Course# | Marks |
|---|---|---|
| 0101 | M1 | 82 |
| 0102 | M4 | 89 |
| 0103 | B3 | 62 |

Marks Grade Table

| Marks | Grade |
|---|---|
| 82 | A |
| 89 | A |
| 62 | B |

# NORMALIZATION IN A NUTSHELL



# PROS AND CONS OF NORMALIZATION

- Based on mathematical foundation
- Removes the redundancy to a large extent
- After 3NF, data redundancy is minimized to the extent of foreign keys
- Removes the anomalies present in INSERTs, UPDATEs and DELETEs

- Data retrieval or SELECT operation performance will be severely affected
- Normalization might not always represent real world scenarios

# THANK YOU