Grade 13 A/L ICT · Lesson 8

8.7 Normalisation: 0NF to 3NF

Syllabus 8.7. A badly designed table repeats data and suffers **insert, update and delete anomalies**. **Normalisation** splits it using **functional dependencies** (full, partial and transitive) through **zero, first, second and third normal form**.

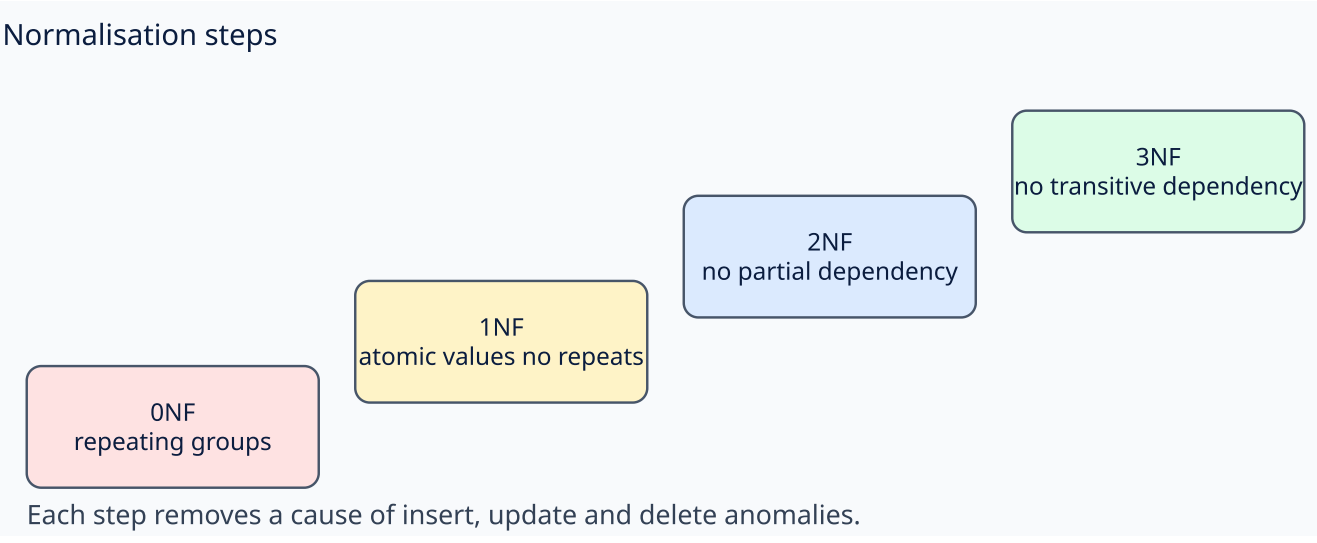
1. Redundancy and anomalies

OrderNo	Date	CustID	CustName	ItemCode	ItemName	Qty	Price
1001	2026-03-01	C01	Perera	P1	Pen	3	50
1001	2026-03-01	C01	Perera	P2	Book	2	200
1002	2026-03-02	C02	Silva	P1	Pen	5	50
1003	2026-03-02	C01	Perera	P2	Book	1	200
1003	2026-03-02	C01	Perera	P3	Ruler	4	80

- **Insert anomaly** – a new item cannot be stored until someone orders it.
- **Update anomaly** – Perera appears in 4 rows; changing the name in one row only makes data inconsistent.
- **Delete anomaly** – deleting order 1002 also loses customer Silva.

2. Functional dependencies

A → B means each value of A fixes one value of B. With key (OrderNo, ItemCode): **full** – (OrderNo, ItemCode) → Qty; **partial** – OrderNo → Date, CustID and ItemCode → ItemName, Price; **transitive** – OrderNo → CustID → CustName.



Steps of normalisation

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3. Normal forms

0NF
Unnormalised: repeating groups (several items in one order row).

1NF
Atomic values, no repeating groups; a key is chosen.

2NF
1NF and no partial dependency on part of a composite key.

3NF
2NF and no transitive dependency between non-key attributes.

🧱 **Worked example: Normalise the order data to 3NF and check that nothing is lost.** 0NF has 3 orders with repeating items → **1NF: 5 rows** (key OrderNo + ItemCode). Remove partial dependencies → **2NF**: Order(OrderNo, Date, CustID, CustName), Item(ItemCode, ItemName, Price), OrderLine(OrderNo, ItemCode, Qty). Remove the transitive CustID → CustName → **3NF: 4 tables** (Customer split off). Joining them in sqlite3 gives back exactly the 1NF rows (lossless). Cells: 40 → 37. Order totals: 1001 = Rs. 550, 1002 = Rs. 250, 1003 = Rs. 520.

3NF schema

```
Customer(CustID, CustName)
Order(OrderNo, Date, CustID)        -- FK CustID
Item(ItemCode, ItemName, Price)
OrderLine(OrderNo, ItemCode, Qty)   -- PK (OrderNo, ItemCode)
```

💡 2NF only matters when the key is composite; a single-column key in 1NF is already in 2NF.

🚀 **Beyond the syllabus (2026 update)** *Not required for the exam – read for interest.* Big data warehouses in 2026 sometimes denormalise on purpose for faster reports, but day-to-day systems stay in 3NF.

Key Words

Normalisation – Process of organising tables to reduce redundancy and anomalies.

Insert anomaly – Cannot add data without unrelated other data.

Update anomaly – Changing repeated data in some rows only leaves inconsistency.

Delete anomaly – Deleting a row also loses other needed facts.

Functional dependency – A value of one attribute set determines another attribute.

Full dependency – Attribute depends on the whole composite key.

Partial dependency – Attribute depends on only part of a composite key.

Transitive dependency – Non-key attribute depends on another non-key attribute.

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Zero normal form – Unnormalised data with repeating groups.

First normal form – Atomic values and no repeating groups.

Second normal form – 1NF with no partial dependencies.

Third normal form – 2NF with no transitive dependencies.

Sample Q&A

1. What is an update anomaly?

> **Answer:** Repeated data changed in only some rows becomes inconsistent.

2. Give a partial dependency in the order table.

> **Answer:** ItemCode → ItemName, Price (part of the key).

3. Give the transitive dependency.

> **Answer:** OrderNo → CustID → CustName.

4. How many rows in 1NF?

> **Answer:** 5.

5. How many tables in 3NF?

> **Answer:** 4: Customer, Order, Item, OrderLine.

6. Condition for 3NF?

> **Answer:** In 2NF and no transitive dependency.

MCQ

1. Data with repeating groups is in

A. 2NF
B. BCNF only
C. 3NF
D. 0NF
E. 1NF

2. Removing repeating groups gives

A. 1NF
B. 3NF
C. 2NF
D. 0NF
E. no form

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3. ItemCode → ItemName with key (OrderNo, ItemCode) is a

A. transitive dependency
B. partial dependency
C. multi-valued key
D. foreign key
E. full dependency

4. OrderNo → CustID → CustName is a

A. candidate key
B. full dependency
C. transitive dependency
D. partial dependency
E. domain

5. (OrderNo, ItemCode) → Qty is a

A. full dependency
B. partial dependency
C. insert anomaly
D. redundancy
E. transitive dependency

6. The order data in 1NF has

A. 10 rows
B. 6 rows
C. 8 rows
D. 5 rows
E. 3 rows

7. Losing customer Silva when order 1002 is deleted is a

A. insert anomaly
B. join
C. partial dependency
D. update anomaly
E. delete anomaly

8. The 3NF design of the order data has

A. 1 table
B. 6 tables
C. 4 tables
D. 3 tables
E. 5 tables

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9. Which term means: “Process of organising tables to reduce redundancy and anomalies”?

A. Second normal form
B. Normalisation
C. Update anomaly
D. Full dependency
E. Transitive dependency

10. Which term means: “Cannot add data without unrelated other data”?

A. Third normal form
B. Zero normal form
C. Insert anomaly
D. Partial dependency
E. Delete anomaly

11. Which term means: “Changing repeated data in some rows only leaves inconsistency”?

A. Normalisation
B. Transitive dependency
C. Functional dependency
D. Update anomaly
E. First normal form

12. Which term means: “Deleting a row also loses other needed facts”?

A. Zero normal form
B. Second normal form
C. Insert anomaly
D. Full dependency
E. Delete anomaly

13. Which term means: “A value of one attribute set determines another attribute”?

A. Partial dependency
B. Functional dependency
C. Update anomaly
D. Third normal form
E. First normal form

14. Which term means: “Attribute depends on the whole composite key”?

A. Transitive dependency
B. Second normal form
C. Normalisation
D. Delete anomaly
E. Full dependency

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15. Which term means: “Attribute depends on only part of a composite key”?

A. Insert anomaly
B. Partial dependency
C. Zero normal form
D. Functional dependency
E. Third normal form

16. Which term means: “Non-key attribute depends on another non-key attribute”?

A. Transitive dependency
B. Full dependency
C. Normalisation
D. First normal form
E. Update anomaly

17. Which term means: “Unnormalised data with repeating groups”?

A. Partial dependency
B. Second normal form
C. Insert anomaly
D. Zero normal form
E. Delete anomaly

18. Which term means: “Atomic values and no repeating groups”?

A. First normal form
B. Transitive dependency
C. Third normal form
D. Update anomaly
E. Functional dependency

19. Which term means: “1NF with no partial dependencies”?

A. Full dependency
B. Delete anomaly
C. Second normal form
D. Zero normal form
E. Normalisation

20. Which term means: “2NF with no transitive dependencies”?

A. Functional dependency
B. Insert anomaly
C. First normal form
D. Partial dependency
E. Third normal form

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Structured Questions

1. Explain insert, update and delete anomalies with the order table. *(3 marks)*

> Insert new item; update Perera rows; delete order 1002 loses Silva.

2. Define full, partial and transitive dependency with examples. *(3 marks)*

> Full (OrderNo, ItemCode) → Qty; partial ItemCode → Price; transitive CustID → CustName.

3. Convert the 0NF order data to 1NF and state the key. *(3 marks)*

> Repeat order data per item; 5 rows; key (OrderNo, ItemCode).

4. Normalise the 1NF table to 2NF. *(3 marks)*

> Order(OrderNo, Date, CustID, CustName); Item(ItemCode, ItemName, Price); OrderLine(OrderNo, ItemCode, Qty).

5. Normalise to 3NF and explain which anomaly is removed. *(3 marks)*

> Customer(CustID, CustName) split; Order keeps CustID FK; removes update anomaly on CustName.

Summary

- Redundancy causes insert, update and delete anomalies.
- 1NF: atomic values, no repeating groups.
- 2NF: remove partial dependencies.
- 3NF: remove transitive dependencies.
- A good decomposition is lossless – joins rebuild the data.

MCQ answer key – 8.7

1. **D** – Unnormalised.
2. **A** – 1NF.
3. **B** – Part of key.
4. **C** – Via non-key.
5. **A** – Whole key.
6. **D** – Each item line.
7. **E** – Delete.
8. **C** – Customer, Order, Item, OrderLine.
9. **B** – Normalisation – Process of organising tables to reduce redundancy and anomalies.
10. **C** – Insert anomaly – Cannot add data without unrelated other data.
11. **D** – Update anomaly – Changing repeated data in some rows only leaves inconsistency.
12. **E** – Delete anomaly – Deleting a row also loses other needed facts.

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13. **B** – Functional dependency – A value of one attribute set determines another attribute.
14. **E** – Full dependency – Attribute depends on the whole composite key.
15. **B** – Partial dependency – Attribute depends on only part of a composite key.
16. **A** – Transitive dependency – Non-key attribute depends on another non-key attribute.
17. **D** – Zero normal form – Unnormalised data with repeating groups.
18. **A** – First normal form – Atomic values and no repeating groups.
19. **C** – Second normal form – 1NF with no partial dependencies.
20. **E** – Third normal form – 2NF with no transitive dependencies.

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