

**Master Schema:**

Electricity\_Billing (user\_id, admin\_id, fb\_id, service\_no, transaction\_id, bill\_no, oc\_id, ec\_id, cons\_appl\_ID, cons\_category\_ID, passw, phn\_no, email\_id, first\_name, last\_name, admin\_control\_area, auto\_renewal, DOB, fb\_time, fb\_desc, fb\_date, postal\_code, account\_no, card\_holder\_name, expiry\_date, state, city, pincode, paid\_amt, pay\_status, pay\_date, pay\_time, bill\_amt, bill\_area, issue\_month, issue\_date, units\_consumed\_cycle, total\_other\_charges, fixed\_charges, GST, Duty, total\_energy\_charges, tarrif\_slab, energy\_charges\_per\_unit, office, laundry, Heating\_Cooling, lights, kitchen, misc, tools, units\_consumed\_heavy, units\_consumed\_medium, units\_consumed\_low)

**1NF:**

1. The relation has primary keys.
2. phn\_no is a multivalued attribute, so it can be flattened out.
3. There are no repeating groups.

**Functional dependencies:**

* user\_id, phone\_no → first\_name, last\_name, passw, email\_id, phone\_no, DOB
* user\_id → auto\_renewal, postal\_code, account\_no, card\_holder\_name, expiry\_date
* admin\_id, user\_id → admin\_control\_area
* fb\_id, user\_id → fb\_time, fb\_date, fb\_desc
* service\_no → state, city, pincode
* pincode → city, state
* transaction\_id → pay\_time, pay\_date, pay\_status, paid\_amt
* bill\_no, user\_id → bill\_amt, bill\_area, issue\_month, issue\_date, paid\_amt, pay\_time, pay\_date, pay\_status, transaction\_id
* bill\_no → units\_consumed\_cycle, oc\_id, ec\_id, cons\_appl\_id, cons\_category\_id, fixed\_charges, total\_other\_charges, GST, Duty, tariff\_slab, total\_energy\_charges, energy\_charges\_per\_unit, office, tools, misc, kitchen, lights, Heating\_Cooling, laundry, units\_consumed\_heavy, units\_consumed\_medium, units\_consumed\_low
* oc\_id → fixed\_charges, total\_other\_charges, GST, Duty
* ec\_id → total\_energy\_charges, energy\_charges\_per\_unit, tariff\_slab
* cons\_appl\_id → office, tools, misc, kitchen, lights, Heating\_Cooling, laundry
* cons\_category\_id, bill\_no → units\_consumed\_heavy, units\_consumed\_medium, units\_consumed\_low

**2NF:**

1. The table is in 1NF.
2. Partial dependencies exist.

Master schema can be decomposed as:

Customer(user\_id, auto\_renewal, postal\_code, account\_no, card\_holder\_name, expiry\_date), with FDs:  
user\_id → auto\_renewal, postal\_code, account\_no, card\_holder\_name, expiry\_date

user\_details (user\_id, phone\_no, DOB, first\_name, last\_name, passw, email\_id), with FDs:  
phone\_no, user\_id --> first\_name, last\_name, passw, email\_id

Admin (admin\_id, user\_id, admin\_control\_area), with FDs:  
admin\_id, user\_id --> admin\_control\_area

Service(service\_no, pincode, state, city) with FDs:

service\_no --> pincode

pincode --> city, state

Bill(bill\_no, units\_consumed\_low, units\_consumed\_medium, units\_consumed\_heavy, tools, misc, kitchen, lights, Heating\_Cooling, laundry, office, energy\_charges\_per\_unit, tarrif\_slab, total\_energy\_charges, Duty, GST, total\_other\_charges, fixed\_charges, cons\_category\_ID, cons\_appl\_ID, ec\_id, oc\_id, units\_consumed\_cycle) with FDs:

bill\_no → units\_consumed\_cycle, oc\_id, ec\_id, cons\_appl\_id, cons\_category\_id, fixed\_charges, total\_other\_charges, GST, Duty, tariff\_slab, total\_energy\_charges, energy\_charges\_per\_unit, office, tools, misc, kitchen, lights, Heating\_Cooling, laundry, units\_consumed\_heavy, units\_consumed\_medium, units\_consumed\_low

oc\_id, bill\_no → fixed\_charges, total\_other\_charges, GST, Duty

ec\_id, bill\_no → total\_energy\_charges, energy\_charges\_per\_unit, tariff\_slab

cons\_appl\_id, bill\_no → office, tools, misc, kitchen, lights, Heating\_Cooling, laundry

cons\_category\_id, bill\_no → units\_consumed\_heavy, units\_consumed\_medium, units\_consumed\_low

Payment(bill\_no, user\_id, transaction\_id, bill\_area, issue\_month, issue\_date, paid\_amt, bill\_amt, pay\_status, pay\_date, pay\_time), with FDs:  
bill\_no, user\_id --> transaction\_id, pay\_amt, pay\_date, pay\_status, paid\_amt, issue\_date, issue\_month, bill\_area, bill\_amt  
transaction\_id --> paid\_amt, pay\_status, pay\_date, pay\_time

Feedback (fb\_id, user\_id, fb\_desc, fb\_date, fb\_time), with FDs:  
fb\_id, user\_id --> fb\_type, rating, fb\_desc, fb\_date, fb\_time

**3NF:**

1. All relations are in 2NF.
2. Transitive dependencies exist in Service, Bill and Payment relations

Service table can be decomposed as:

Address (pincode, city, state), with FDs:  
pincode --> state, city  
  
service\_details (service\_no, pincode), with FDs:  
service\_no --> pincode

Bill table can be decomposed as:

Energy\_charge(ec\_id, energy\_charge\_per\_unit, tariff\_slab, total\_energy\_charges) with FDs:

ec\_id --> energy\_charge\_per\_unit, tariff\_slab, total\_energy\_charges

other\_charge(oc\_id, Duty, GST, fixed\_charges, total\_other\_charges) with FDs:

oc\_id --> Duty, GST, fixed\_charges, total\_other\_charges

Appliances(cons\_appl\_id, office, tools, misc, kitchen, lights, Heating\_Cooling, laundry) with FDs:

cons\_appl\_id --> office, tools, misc, kitchen, lights, Heating\_Cooling, laundry

Consumption(cons\_category\_id, units\_consumed\_heavy, units\_consumed\_medium, units\_consumed\_low) with FDs:

cons\_category\_id --> units\_consumed\_heavy, units\_consumed\_medium, units\_consumed\_low

Billing(bill\_no, cons\_category\_id, cons\_appl\_id, ec\_id, oc\_id, units\_consumed\_cycle) with FDs:

bill\_no --> cons\_category\_id, cons\_appl\_id, ec\_id, oc\_id, units\_consumed\_cycle

Payment table can be decomposed as:

Payment\_details (transaction\_id, pay\_amt, pay\_status, pay\_date, pay\_time), with FDs:  
transaction\_id --> pay\_amt, pay\_status, pay\_date, pay\_time  
  
Bill\_details (bill\_no, user\_id, transaction\_id, bill\_area, issue\_month, issue\_date), with FDs:  
bill\_no, user\_id --> transaction\_id, bill\_area, issue\_month, issue\_date

**BCNF – Boyce-Codd normal form:**

1. All relations are in 3NF.
2. In each relation, it can be observed that the super key determines all other attributes in
3. the relation.
4. Hence, all relations are in BCNF.

**Database schema after normalisation:**

* User\_details (user\_id, phone\_no, DOB, first\_name, last\_name, passw, email\_id)
* customer\_details (user\_id, auto\_renewal, postal\_code, account\_no, card\_holder\_name, expiry\_date)
* Admin (admin\_id, user\_id, admin\_control\_area)
* Address (pincode, city, state)
* service\_details (service\_no, pincode)
* Billing(bill\_no, cons\_category\_id, cons\_appl\_id, ec\_id, oc\_id, units\_consumed\_cycle)
* Energy\_charge(ec\_id, energy\_charge\_per\_unit, tariff\_slab, total\_energy\_charges)
* other\_charge(oc\_id, Duty, GST, fixed\_charges, total\_other\_charges)
* Appliances(cons\_appl\_id, office, tools, misc, kitchen, lights, Heating\_Cooling, laundry)
* Consumption(cons\_category\_id, units\_consumed\_heavy, units\_consumed\_medium, units\_consumed\_low)
* Payment\_details (transaction\_id, pay\_amt, pay\_status, pay\_date, pay\_time)
* Bill\_details (bill\_no, user\_id, transaction\_id, bill\_area, issue\_month, issue\_date),
* Feedback (fb\_id, user\_id, fb\_type, rating, fb\_desc, fb\_date, fb\_time)