Q1) R (A, B, C, D, E, F, G)

$A \rightarrow BC$
$BC \rightarrow DE$
$D \rightarrow F$
$CF \rightarrow G$

- Find closure set of A, BC, D, CF.
- Find the candidate & super key.
- Find the canonical cover.

Closures

$A^+ = ABCDEFG$
$(BC)^+ = BCDEFG$
$D^+ = DF$
$(CF)^+ = CFG$

Candidate Key and SuperKey:

Candidate Key = {A} [∵ A^+ is the whole relation]
Superkeys = {A}, {A, B}, {A, C, D} ...
[Every attribute set that contains A]

Canonical cover:

From the given relation with FDs,
canonical cover:

$A \rightarrow B$
$A \rightarrow C$
$BC \rightarrow D$
$BC \rightarrow E$
$D \rightarrow F$
$CF \rightarrow G$

Q2 R (E, F, G, H, I, J, K, L, M, N) with FDs:

EF → G
F → IJ
EH → KL
K → M
L → N

- What are the candidate and super key for R?
- Find out the canonical cover

Candidate and Superkeys:

$(EFH)^+ =$ EFGHIJKLMN (all attributes)

neither EF, EH or FH alone can close all attributes. Therefore, {E, F, H} is a candidate key.

Therefore, any superset containing {E, F, H} is a superkey.

Canonical cover:

EF → G
F → I
F → J
EH → K
EH → L
K → M
L → N

Q3 Consider a relation scheme,

R(A, B, C, D, E, H) on which the following functional dependencies hold :

$$\{ A \to B, \quad BC \to D, \quad E \to C, \quad D \to A \}$$

What are the candidate keys of R?

$(AEH)^+ = \{A, B, C, D, E, H\}$

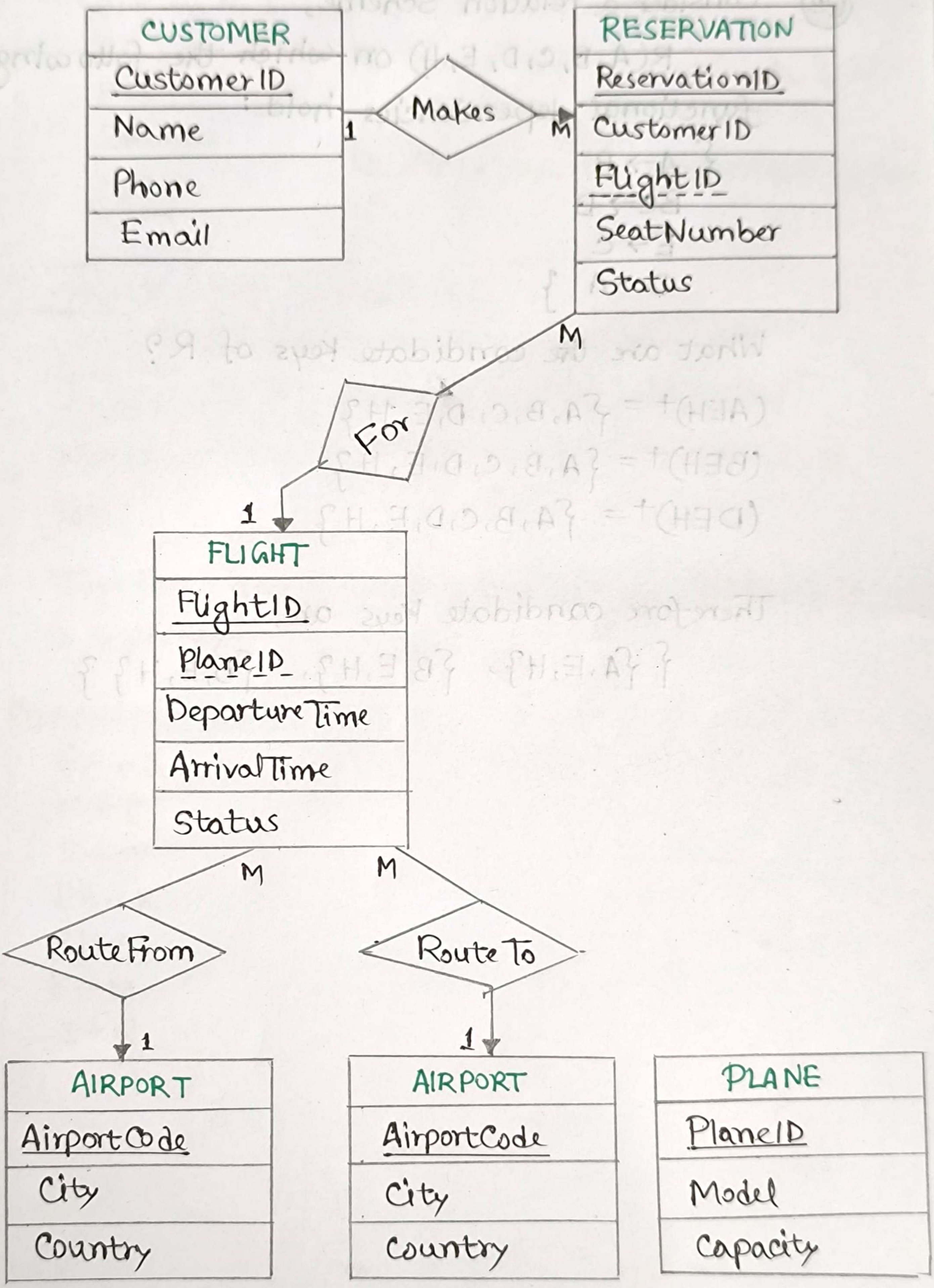
$(BEH)^+ = \{A, B, C, D, E, H\}$

$(DEH)^+ = \{A, B, C, D, E, H\}$

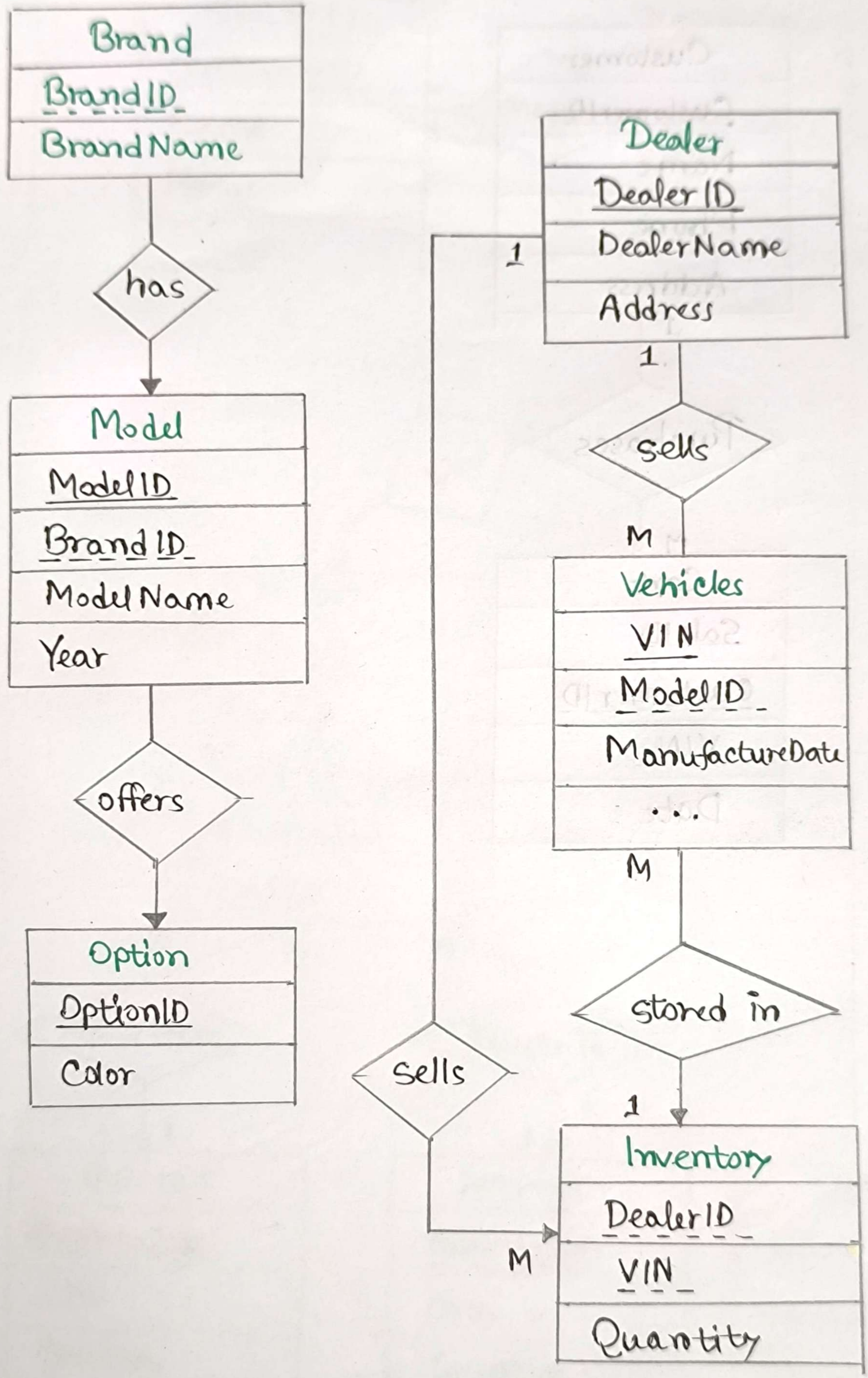
Therefore candidate keys are,

$\{\{A, E, H\}, \{B, E, H\}, \{D, E, H\}\}$

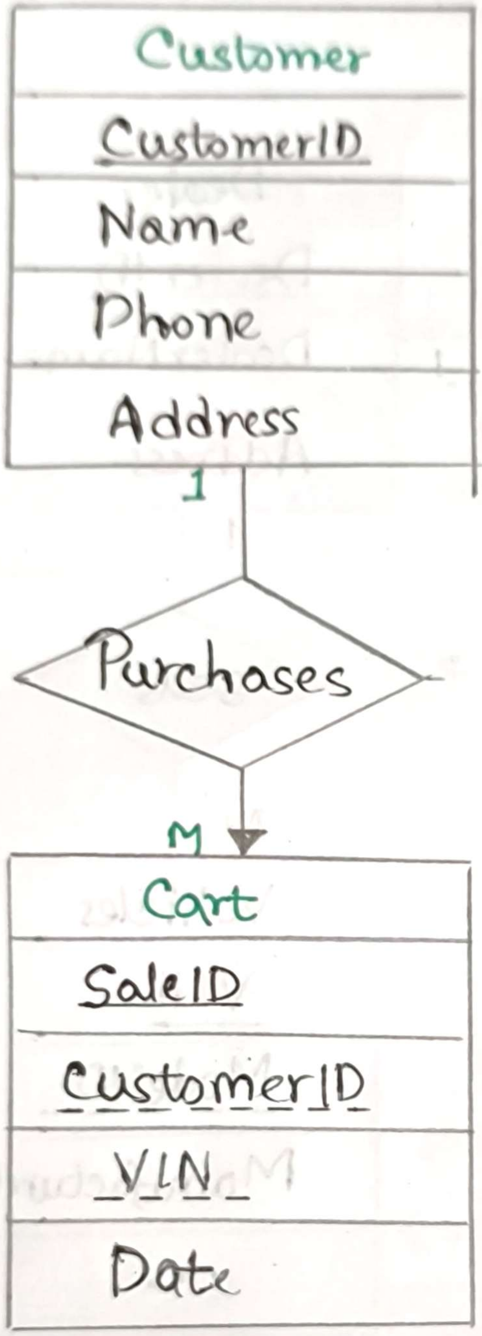
(Q4)


CUSTOMER
CustomerID
Name
Phone
Email
Makes
1
M
RESERVATION
ReservationID
CustomerID
FlightID
SeatNumber
Status
M
For
1
FLIGHT
FlightID
PlaneID
DepartureTime
ArrivalTime
Status
M
M
RouteFrom
RouteTo
1
1
AIRPORT
AirportCode
City
Country
AIRPORT
AirportCode
City
Country
PLANE
PlaneID
Model
Capacity

Q5



Brand
BrandID
BrandName
has
Model
ModelID
BrandID
ModelName
Year
offers
Option
OptionID
Color
Dealer
DealerID
DealerName
Address
1
1
sells
M
Vehicles
VIN
ModelID
ManufactureDate
...
M
stored in
1
sells
M
Inventory
DealerID
VIN
Quantity


Customer
CustomerID
Name
Phone
Address
1
Purchases
M
Cart
SaleID
CustomerID
VIN
Date

(26) Consider the following table:

EmpID	EmpName	DeptID	DeptName	Dept Location
1	Alex	D01	HR	New York
2	Brian	D02	IT	Chicago
3	Clara	D01	HR	New York

(i) Explain and illustrate the process of normalizing the data shown in this table to third normal form (3NF).

From the table, we observe,

There are no multivalued columns.

$\therefore$ The table is in 1NF

The FD structure is:

EmpID → EmpName

Dept ID → Dept Name, Dept Location.

To normalize the table to 3NF, we have to normalize to 2NF first.

The original table can be divided into two subtables following the FD structure:

EmpID	EmpName
1	Alex
2	Brian
3	Clara

employ relation

DeptID	DeptName	DeptLocation
D01	HR	New York
D02	IT	Chicago

department relation

However, the department information is completely lost in the newly created employee relation.
So, we need to reference to the department relation and use employee table where DeptID becomes the foreign key (FK).

EmpID	EmpName	DeptID
1	Alex	D01
2	Brian	D02
3	Clara	D01

DeptID	DeptName	DeptLocation
D01	HR	New York
D02	IT	Chicago

Since there are no transitive FDs, these tables satisfy 3NF conditions.

(ii) Identify the primary and foreign keys in your 3NF relations.

① Employee (EmpID, EmpName, DeptID)

PK → EmpID

FK → DeptID

② Department (DeptID, DeptName, DeptLocation)

PK → DeptID

FK → X

Q7 Consider the following set of key values :
4, 6, 8, 17, 19, ..., 45, 51

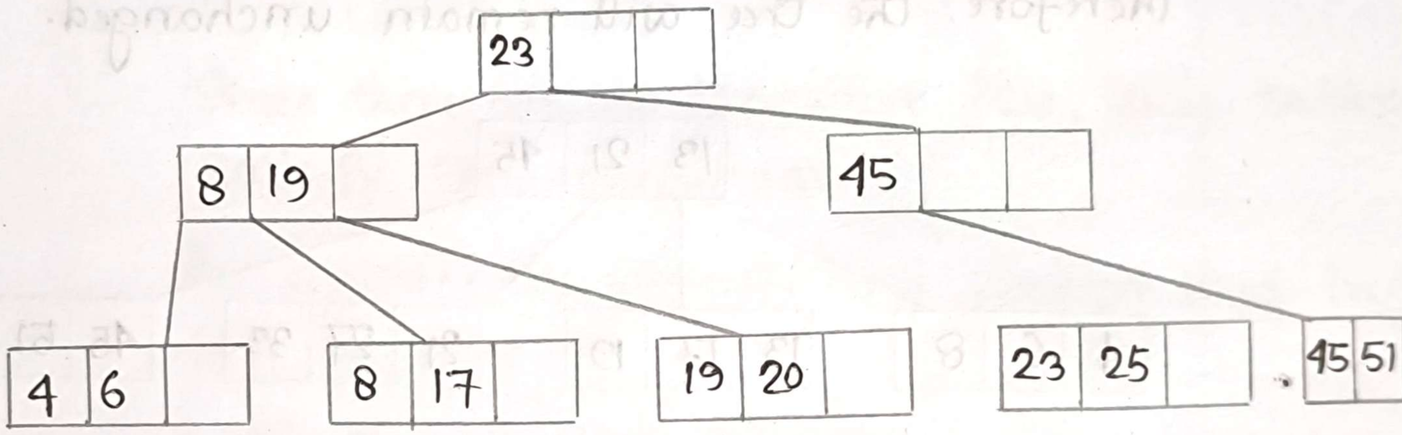
(i) Construct a B+ Tree for order of $n=4$

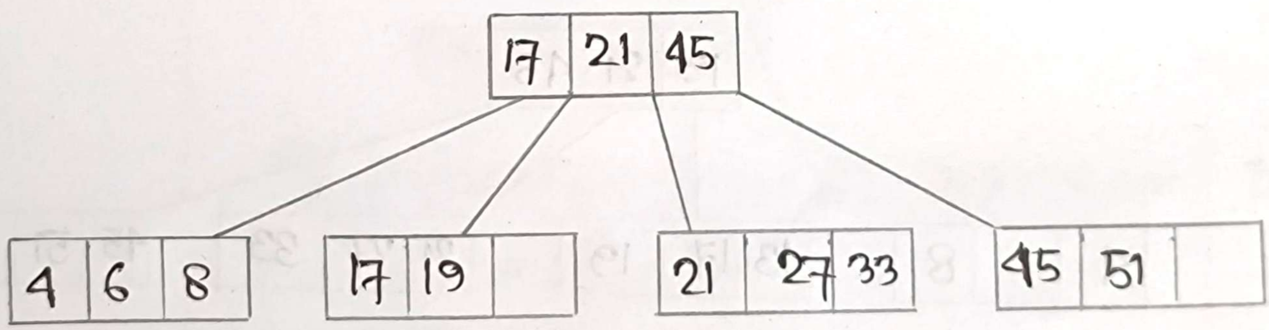
Key values : 4, 6, 8, 17, 19, 20, 23, 25, 45, 51

Since $n=4$

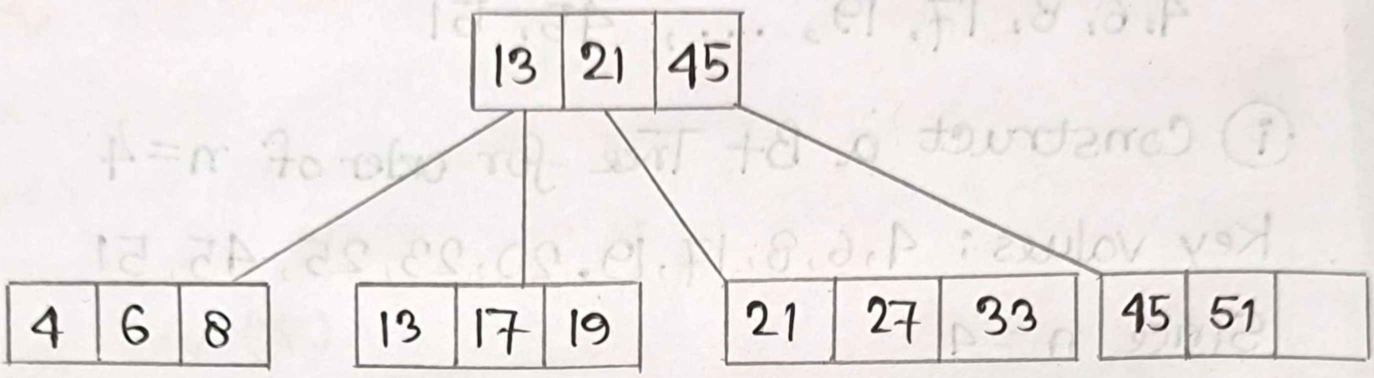
leaf $= n-1 = 3$

min $= \left\lceil \frac{n-1}{2} \right\rceil = 2$



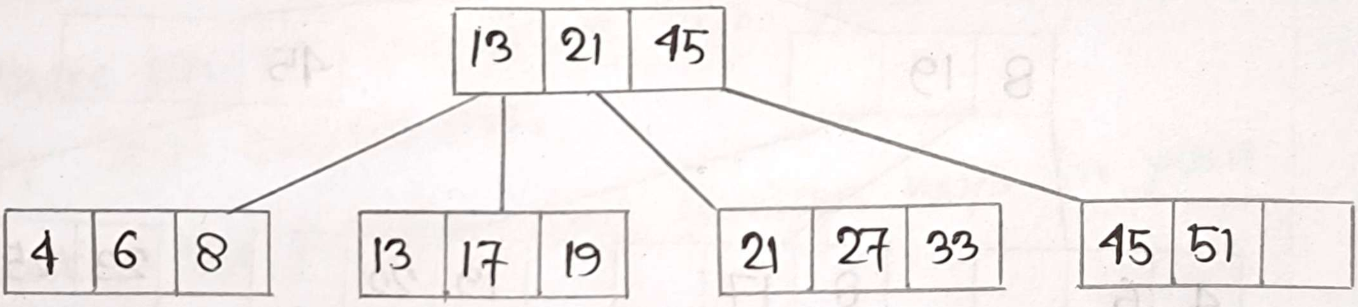


(ii) Insert 13

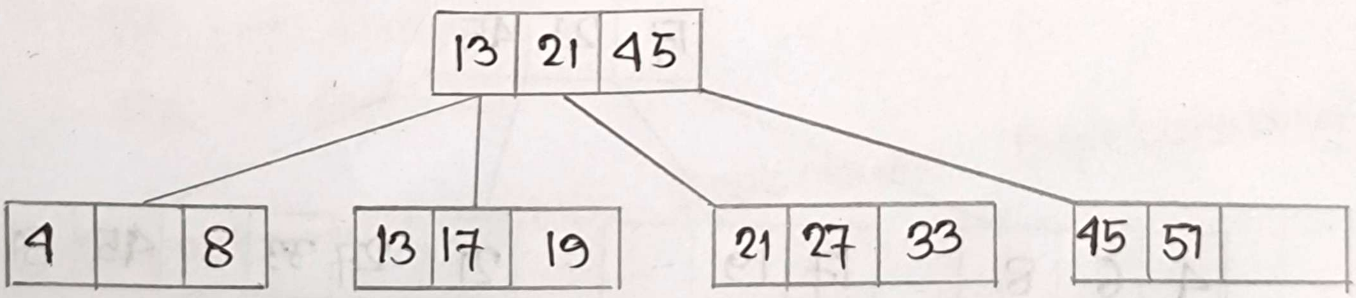


(iii) Insert 17

* 17 already exists in the tree.
Therefore, the tree will remain unchanged.



(iv) Delete 6



Q8) Briefly explain the ACID properties of transaction.

ACID stands for Atomicity, Consistency, Isloation, and Durability. These four properties ensure that database transactions are processed reliably.

1) Atomicity

- A transaction is treated as a single, indivisible unit.
- Either all operations happen or none happen.
- If any part of the transaction fails, the entire transaction is rolled back.

2) Consistency

- A transaction must move the database from one valid state to another valid state.
- All integrity constraints (primary keys, foreign keys, rules) must remain satisfied.

③ Isolation

— Multiple concurrent transactions must not intefere with each other.

— Each transaction should behave as if it is running alone.

— Different isolation levels ensure different levels of visibility among transactions.

④ Durability

— Once a transaction is committed, its changes are permanent, even if a crash occurs.

— A database management system uses log, backups and recovery mechanisms to ensure this.