1. $X(\underline{c}, \underline{a}, b)$

$Y(\underline{c}, d)$

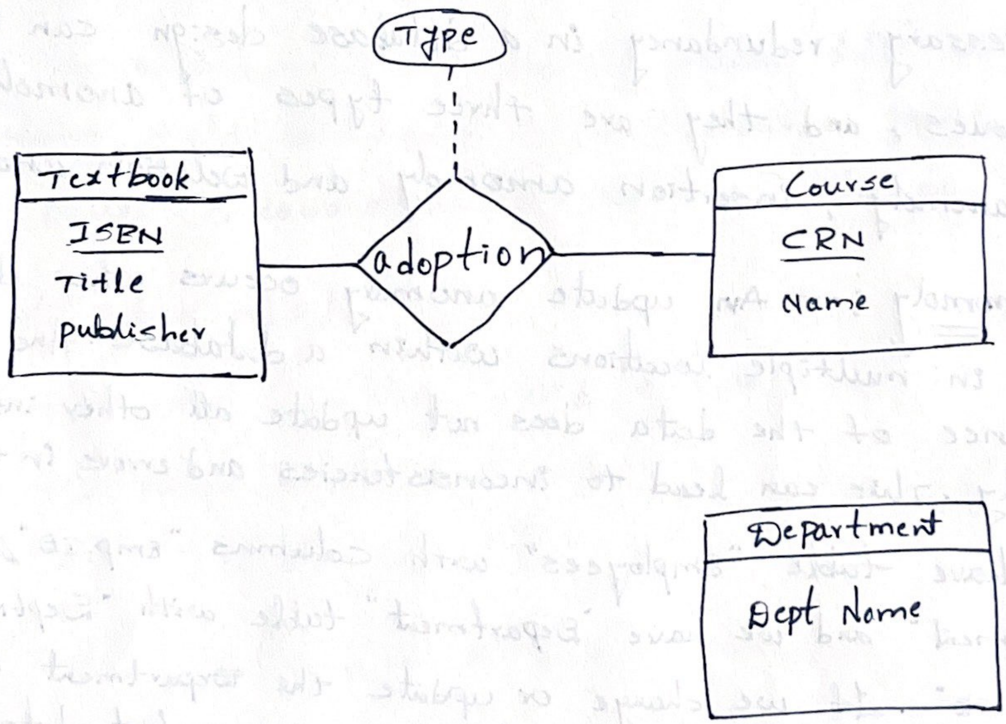
$Z(\underline{c}, \underline{a}, e, \underline{h})$

$T(\underline{h}, f, g)$

$R_1(\underline{c}, \underline{a})$

$R_2(\underline{c}, a, \underline{h})$

2.



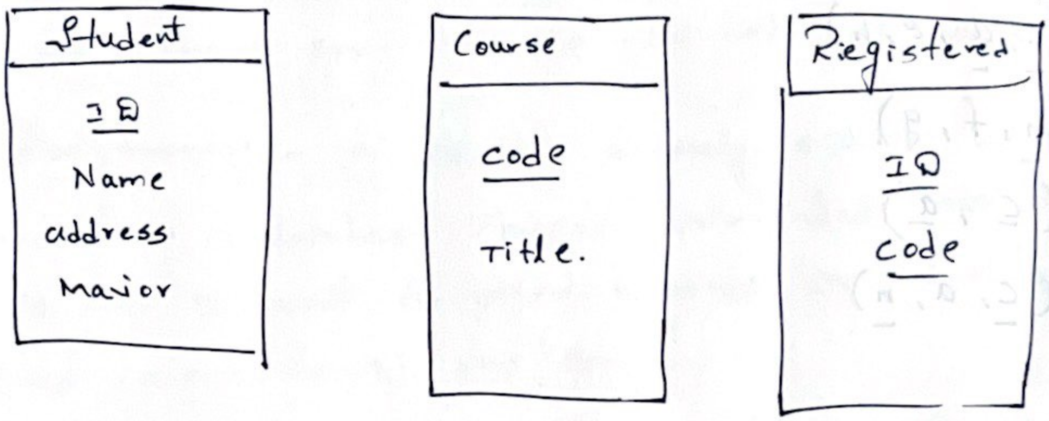

textbook ($\underline{\text{ISBN}}$, title, publisher)

Course ($\underline{\text{CRN}}$, name)

adoption ($\underline{\text{ISBN}}$, $\underline{\text{CRN}}$, Type)

Department ($\underline{\text{Dept Name}}$)

3. $\Pi_{student.ID}\left[\left[\sigma_{(Title\,=\,Database\ systems)}\ Course \bowtie Registered\right] \cup \left[\sigma_{Major\,=\,'cs'}\ student\right]\right]$




4. Unnecessary redundancy in a database design can lead to Several issues, and they are three types of anomolies - update anomoly, insertion anomoly and deletion anomoly.

1. update anomoly :— An update anomaly occurs when data is duplicated in multiple locations within a database. And updating One instance of the data does not update all other instances. consistently. This can lead to inconsistencies and errors in the data.

Ex:- We have table "Employees" with columns "Emp.ID" & "EmpName" and "Department" and we have "Department" table with "DeptName" and "Course ID". If we change or update the Department name in only one of the tables, we will have the inConsistent data.

2. Insert anomoly :- An Insertion anomoly occurs when a database design requires the insertion of redudant data in-order to add a new record to the database. This can lead to ineffcienes and data inconsistencies.

Ex:- We have a database of customers that include their name, address. and order history. If we have a seperation table for order items that includes the customer names and address for Ever order item we must insert reedudant data for customer name and address Every time a new order is added to the databan

c. Deletion Anomoly:- A deletion anomoly occurs when deleting a record from a database causes unintended loss of data that is still relevant to other records in the database. This can lead inconsistencies and Errors.

Ex:- Suppose we have a database of students that include their name, maior and course grades. If we have a redudant field for maior in the course grade table, This can cause inconsistencies in the data. and lead to Errors.

5. $R(a, b, c, d, e)$

$F = \{a \rightarrow bc,\ cd \rightarrow e,\ b \rightarrow d,\ e \rightarrow a\}$

All the Given F are in 1NF.

$\{a\}^+ = \{a, b, c, d, e\}$

$\{c, d\}^+ = \{c, d, e, a, b\}$

$\{b\}^+ = \{b, d\}$

$\{e\}^+ = \{e, a, b, c, d\}$

$\{a\}^+, \{c, d\}^+, \{e\}^+$ are the keys

So, a, c, d, e are prime attributes b is non-prime attribute.

$\{a\}^+$ is not a proper subset of the any key.

$a \rightarrow bc$ is in 2NF as $\{a\}^+$ is the key.

$cd \rightarrow e$ is in 2NF as e is prime attribute.

$b \rightarrow d$ is in 2NF as d is prime attribute.

$e \rightarrow a$ is in 2NF as a is prime attribute.

As all the functional dependencies are in 2NF. So given relation R is in 2NF.

6.(a) $R(a, b, c, d)$

$f = \{bd \rightarrow c, c \rightarrow a, a \rightarrow d\}$

$\{b, d\}^+ = \{b, d, c, a\}$

$\{c\}^+ = \{c, a, d\}$

$\{a\}^+ = \{a, d\}$

$\{b, d\}^+$ is the super key and its in BCNF

So, $c \rightarrow a$ and $a \rightarrow d$ violates the BCNF only $bd \rightarrow c$ is in BCNF.

(b) Take one of the dependencies which is not satisfying the BCNF.

so take $a \rightarrow d$.

$\{a\}^+ = \{a, d\}$

$R_1 = (a, d)$

$R_2 = R - \{\{a\}^+ - \{a\}\} = \{a, b, c\}$

$R_2(a, b, c)$

$R_1$ is in BCNF as it holds only two attributes

$R_2$ is in BCNF as it doesn't hold any functions dependency to decompose relation into further.

Now final Schema is

$R_1 (a, d)$ $R_2 (a, b, c)$.

7. $R(b, o, i, s, q, d)$

$F = \{s \rightarrow d,\ i \rightarrow b,\ is \rightarrow q,\ b \rightarrow o,\ i \rightarrow o\}$

for a functional dependency to be in 3NF

i.e., for Eg : $A \rightarrow B$ Either

(i) A is a Super key for R or

(ii) B is Contained in a key for R.

$\{s\}^+ = \{s, d\}$

$\{i\}^+ = \{i, b, o\}$

$\{i, s\}^+ = \{i, s, q, b, o, d\}$

$\{b\}^+ = \{b, o\}$

$\{i\} = \{i, b, o\}$

So $is \rightarrow q$ becomes the Super key so it satisfies 3NF.

other given functional dependencies does'nt Contain Super key also Right side attributes are non-prime attributes

b) $\{i, s\}$ is the key for given R.

(ii) Canonical Cover fc

$$\left.\begin{array}{l} s \to d \\ i \to b \\ is \to q \\ b \to o \\ i \to o \end{array}\right\} \quad \begin{array}{l} s \to d \\ i \to b,\ i \to o \text{ therefore } i \to bo \\ b \to o \\ is \to q \end{array}$$

Now, final cover is

$s \to d$
$i \to bo$
$b \to o$
$is \to q$

Now, we need to perform leftside decomposition for the final cover.
Lets take $is \to q$, if we remove Either 'i' or 's' the remaining functional dependencies does not hold, so there are no Extraneous attributes.

Now, we need to perform Right side decomposition for the final cover.

$$\left.\begin{array}{l} s \to d \\ i \to bo \\ b \to o \\ is \to q \end{array}\right\} \text{ we can remove } b \to o \text{ as } i \to bo \text{ satisfies it.}$$

So, the final dependencies which holds the relation are

$s \to d$
$i \to bo$
$is \to q.$

final shema is $R_1\ (s, d)$
$R_2\ (i, b, o)$
$R_3\ (i, s, q)$ //