Proof that relations are in Boyce-Codd Normal Form

1. **'Players' relation :**

   - Attributes :

   Players {PlayerID, Name, Nationality, DoB, Role, StrikeRate, BowlingStyle, BattingStyle}

   - Functional dependencies :

     PlayerID → Name
     PlayerID → Nationality
     PlayerID → DoB
     PlayerID → Role
     PlayerID → StrikeRate
     PlayerID → BowlingStyle
     PlayerID → BattingStyle

   Let X = PlayerID
   X^+ = {PlayerID, Name, Nationality, DoB, Role, StrikeRate, BowlingStyle, BattingStyle}
   Thus, **Primary key = PlayerID**

   The left side of all the FDs in minimal set of FDs for the relation 'Players' is PlayerID, which is the primary key of this relation, so **"Players" is in BCNF.**

2. **'IPL' relation :**

   - Attributes :
     IPL {Year, TitleSponsor, ManOfTheSeries, ChampionTeam}

   - Functional dependencies :

     Year → TitleSponsor
     Year→ ManOfTheSeries
     Year→ ChampionTeam

   Let X = Year

X^+ = {Year, TitleSponsor, ManOfTheSeries, ChampionTeam}
Thus, **Primary key = Year**

The left side of all the FDs in minimal set of FDs for the relation 'IPL' is Year, which is the primary key of this relation, so **"IPL" is in BCNF.**

3. **'Stadium' relation :**

- Attributes :
  Stadium {StadiumName, City, Country, Capacity, RentAmount}

- Functional dependencies :
  {StadiumName, City} → Country
  {StadiumName, City}→ Capacity
  {StadiumName, City}→ RentAmount

Let X = {StadiumName, City}
X^+ = {StadiumName, City, Country, Capacity, RentAmount }
Thus, **Primary key = {StadiumName, City}**

The left side of all the FDs in minimal set of FDs for the relation 'Stadium' is {StadiumName, City}, which is the primary key of this relation, so **"Stadium" is in BCNF.**

4. **'HeadCoachDetails' relation :**

- Attributes :
  HeadCoachDetails {CoachID, CoachName, YearsOfExperience, DoB, Country}

- Functional dependencies :
  CoachID → CoachName
  CoachID → YearsOfExperience
  CoachID → DoB
  CoachID → Country

Let X = CoachID
X^+ = {CoachID, CoachName, YearsOfExperience, DoB, Country}
Thus, **Primary key = CoachID**

The left side of all the FDs in minimal set of FDs for the relation 'HeadCoachDetails' is CoachID, which is the primary key of this relation, so **"HeadCoachDetails" is in BCNF.**

5. **'Umpire' relation :**

- Attributes :
  Umpire {UmpireID, Name, YearsOfExperience, Country}

- Functional dependencies :
  UmpireID → Name
  UmpireID → YearsOfExperience
  UmpireID → Country

Let X = UmpireID
X^+ = {UmpireID, Name, YearsOfExperience, Country}
Thus, **Primary key = UmpireID**

The left side of all the FDs in minimal set of FDs for the relation 'Umpire' is UmpireID, which is the primary key of this relation, so **"Umpire" is in BCNF.**

6. **'UmpiredBy' relation :**

- Attributes :
  UmpiredBy {MatchID, UmpireID}

Here Primary key = {MatchID, UmpireID}
According to theorem, all attribute primary key relation is always in BCNF.
Hence **"UmpiredBy" is in BCNF.**

7. **'TeamOwner' relation :**

- Attributes :
  TeamOwner {CompanyName, BusinessDomain, Country}

- Functional dependencies :
  CompanyName → BusinessDomain
  CompanyName → Country

Let X = CompanyName
X^+ = {CompanyName, BusinessDomain, Country}
Thus, **Primary key = CompanyName**

The left side of all the FDs in minimal set of FDs for the relation 'TeamOwner' is CompanyName, which is the primary key of this relation, so **"TeamOwner" is in BCNF.**

8. **'TitleSponsor' relation :**

- Attributes :
  TitleSponsor {CompanyName, BusinessDomain, Country}

- Functional dependencies :
  CompanyName → BusinessDomain
  CompanyName → Country

Let X = CompanyName
X^+ = {CompanyName, BusinessDomain, Country}
Thus, **Primary key = CompanyName**

The left side of all the FDs in minimal set of FDs for the relation 'TitleSponsor' is CompanyName, which is the primary key of this relation, so **"TitleSponsor" is in BCNF.**

9. ‘YearWisePlayerDetails’ relation :

- Attributes :
  YearWisePlayerDetails {TeamID, PlayerID, Year, TotalWickets, TotalRuns, MaximumWickets, MaximumWicketRuns, MaximumRuns, PlayerPrice Out-Notout}

- Functional dependencies :
  {PlayerID, Year} → TotalWickets
  {PlayerID, Year} → TotalRuns
  {PlayerID, Year} → MaximumWickets
  {PlayerID, Year} → MaximumWicketRuns
  {PlayerID, Year} → MaximumRuns
  {PlayerID, Year} → Out-Notout
  {PlayerID, Year} → PlayerPrice
  {PlayerID, Year} → TeamID

Let X = {PlayerID, Year}
X^+ = {TeamID, PlayerID, Year, TotalWickets, TotalRuns, MaximumWickets, MaximumWicketRuns, MaximumRuns, Out-Notout, PlayerPrice}
Thus, **Primary key = {PlayerID, Year}**

The left side of all the FDs in minimal set of FDs for the relation ‘YearWisePlayerDetails’ is {PlayerID, Year}, which is the primary key of this relation, so **“YearWisePlayerDetails” is in BCNF.**

10. ‘TeamDetails’ relation :

- Attributes :
  Teams {Year, TeamID, CaptainID, CoachID, SponsorCompany, SponsorAmount}

- Functional dependencies :
  {TeamID, Year} → CaptainID
  {TeamID, Year} → CoachID
  {TeamID, Year} → SponsorComapany

{TeamID, Year} → SponsorAmount

Let X = {TeamID, Year}
X^+ = {Year, TeamID, CaptainID, CoachID, SponsorCompany, SponsorAmount}

Thus, **Primary key = {TeamID, Year}**

The left side of all the FDs in minimal set of FDs for the relation 'Teams' is {TeamID, Year}, which is the primary key of this relation, so **"Teams" is in BCNF.**

Earlier, this table also had attributes, TeamName and OwnerCompany, but as the relation was not in BCNF, we have decomposed the table into two tables, 'Teams' and 'TeamDetails' both of which are in BCNF.

11. 'Teams' relation :

- Attributes :

TeamDetails {TeamID, TeamName, OwnerCompany}

- Functional dependencies :

TeamID→ TeamName
TeamID → OwnerCompany

Let X = TeamID
X^+ = {TeamID, TeamName, OwnerCompany}

Thus, **Primary key = TeamID**

The left side of all the FDs in minimal set of FDs for the relation 'TeamDetails' is TeamID, which is the primary key of this relation, so **"TeamDetails" is in BCNF.**

12.‘Match’ relation :

- Attributes :

Match {MatchID, MatchType, Date, StadiumName, City, ManOfTheMatch}

- Functional dependencies :

MatchID → MatchType
MatchID → Date
MatchID → StadiumName
MatchID → City
MatchID → ManOfTheMatch

Let X = MatchID
X^+ = {MatchID, MatchType, Date, StadiumName, City, ManOfTheMatch}
Thus, **Primary key = MatchID**
The left side of all the FDs in minimal set of FDs for the relation ‘Match’ is MatchID which is the primary key of this relation, so **“Match” is in BCNF.**

13.‘Played’ relation :

- Attributes :

Played {MatchID, TeamID, TeamRuns, 4s, 6s, Wickets, Winner}

- Functional dependencies :

{MatchID,TeamID} → TeamRuns
{MatchID,TeamID} → 4s
{MatchID,TeamID} → 6s
{MatchID,TeamID} → Wickets
{MatchID,TeamID} → Winner

Let X = {MatchID,TeamID}
X^+ = {MatchID, TeamID, TeamRuns, 4s, 6s, Wickets, Winner}
Thus, **Primary key = {MatchID, TeamID}**

The left side of all the FDs in minimal set of FDs for the relation ‘Played’ is {MatchID,TeamID} which is the primary key of this relation, so **“Played” is in BCNF.**