# 23BCS10193 – Shivanshu Ranjan

## Session-8 :- Data Normalization

# Q9

**Relation:** R(A, B, C, D, E, F, G, H, I)
**Functional Dependencies:**

$$AB \to C, \quad BD \to EF, \quad AD \to GH, \quad A \to I$$

**Solution:**
**Candidate Key Determination:**

$$(ABD)^+ = \{A, B, C, D, E, F, G, H, I\}$$

**Candidate Key:** $\{ABD\}$
**Highest Normal Form:** 2NF (Partial dependency exists: $AB \to C$)

# Q10

**Relation:** R(A, B, C, D, E)
**Functional Dependencies:**

$$AB \to CD, \quad D \to A, \quad BC \to DE$$

**Solution:**
**Attribute Closure:**

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

**Candidate Key:** $\{BC\}$
**Highest Normal Form:** 2NF (Transitive dependency: $D \to A$)

# Q11

**Relation:** P(F1, F2, F3, F4, F5)
**Functional Dependencies:**

$$F1 \to F3, \quad F2 \to F4, \quad (F1, F2) \to F5$$

**Solution:**
**Candidate Key:**

$$(F1, F2)^+ = \{F1, F2, F3, F4, F5\}$$

**Candidate Key:** $\{F1, F2\}$
**Prime Attributes:** F1, F2
**Non-Prime Attributes:** F3, F4, F5
**Highest Normal Form:** 2NF (Partial dependencies: $F1 \to F3$, $F2 \to F4$)

# Q12

**Relation:** R(R_N, Name, Dob, Age, C_N, Cname, Instructor, Grade, Eligibility)

**Functional Dependencies:**

$$Dob \to Age, \quad Age \to Eligibility$$
$$Name \to R\_N, \quad R\_N \to Name$$
$$C\_N \to Cname, \quad C\_N \to Instructor$$
$$(R\_N, C\_N) \to Grade$$

**Solution:**
**Candidate Key:** $\{R\_N, C\_N\}$
**Highest Normal Form:** 2NF (Partial and transitive dependencies present)

# Additional Question 1

**Relation:** R(A, B, C, D, E)
**Functional Dependencies:**

$$A \to B, \quad B \to C, \quad AC \to D, \quad D \to E$$

**Solution:**

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

**Candidate Key:** $\{A\}$
**Highest Normal Form:** 3NF (Transitive dependency exists but determinant is key)

# Additional Question 2

**Relation:** R(A, B, C, D, E)
**Functional Dependencies:**

$$A \to BC, \quad B \to D, \quad CD \to A, \quad E \to A$$

**Solution:**
**Candidate Keys:** $\{E\}, \{CD\}$
**Highest Normal Form:** BCNF (All determinants are candidate keys)

# Additional Question 3

**Relation:** R(P, Q, R, S)
**Functional Dependencies:**

$$PQ \to R, \quad R \to S, \quad S \to Q$$

**Solution:**

$$(PQ)^+ = \{P, Q, R, S\}$$

**Candidate Key:** $\{P, Q\}$
**Highest Normal Form:** 2NF

# Additional Question 4

**Relation:** R(P, Q, R, S, T)
**Functional Dependencies:**

$$PQ \to R, \quad R \to S, \quad S \to T, \quad T \to P$$

**Solution:**
**Candidate Keys:** $\{P, Q\}, \{Q, T\}$
**Highest Normal Form:** 3NF