

Ans 1

①  $A(\underline{m}, n, r, k)$  — (3) marks

②  $A-C(\underline{m}, u, v, g)$  — (3) marks

③  $D(\underline{w}, x)$

④  $B(\underline{x})$   
 $B(\underline{x}, s)$  } — (3) marks

⑤  $B-D(\underline{x}, \cancel{W}, l)$  — (3) marks

if part ④ is wrong ⑤ is evaluated  
to 0

Every redundant Relation Results in a  
penalty.

Q 4  $\Rightarrow$

$$(a) \quad \pi_{name} \left( \text{Teaches} \bowtie \sigma_{Dname = 'CSE'} \text{Department} \right)$$

or

$$\pi_{name} \left( \sigma_{Dname = 'CSE'} \left( \text{Teaches} \bowtie \text{Department} \right) \right)$$

no partial marks

$$(b) \quad R_1 \leftarrow \text{Teaches} \bowtie \sigma_{Dname = 'CSE'}^{\text{Department}}$$

$$R_2 \leftarrow \pi_{TID, ISSN} (R_1 \bowtie \text{Publication})$$

$$\pi_{ISSN} \left( \text{Journal} \bowtie \left( R_2 \div \pi_{TID} (R_1) \right) \right)$$

or  
just  $\rightarrow R_2 \div \pi_{TID} (R_1)$

$$\pi_{\text{name}}^{(c)} \left( \sigma_{\text{Jname} = \text{'IJMDU'}} \left( \text{Journal} \bowtie (\text{Teacher} \bowtie \text{Publication}) \right) \right)$$

No partial Marking

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Ans 2

- ①  $A B C \rightarrow D$  ✓
  - ②  $A B C \rightarrow E$  ✓
  - ③  $A \rightarrow B$  ✓
  - ④  $A \rightarrow D$  ✗
  - ⑤  $D \rightarrow C$  ✓
  - ⑥  $B \rightarrow C$  ✗
  - ⑦  $B \rightarrow D$  ✗
- 
- ⑦  $(A B C)^+ = A B C D E$

$$(A B C)^+_{-①} = A B C E D$$

$$(A B C)^+_{-②} = A B C D$$

$$A^+ = A B D C E$$

$$(A^+)_{-③} = A D C$$

$$(A^+)_{-④} = A B C D E$$

$$(B^+)_{-⑦} = B$$

$$D^+ = D C$$

$$(B^+)_{-⑥} = B D C$$

$$ABC \rightarrow E$$

$$A \rightarrow B$$

$$D \rightarrow C$$

$$B \rightarrow D$$

$$A^+ = (ABD)^+$$

Final Ans

$$A \rightarrow E$$

$$A \rightarrow B$$

$$D \rightarrow C$$

$$B \rightarrow D$$

Sol. 3

$R(A, B, C, D, E)$

①

$$BD \rightarrow E$$

$$E \rightarrow C$$

$$B \rightarrow A$$

$$C \rightarrow D$$

a)  $B^+ \rightarrow BA$

$$A^+ \rightarrow A$$

$$C^+ \rightarrow CD$$

$$D^+ \rightarrow D$$

$$E^+ \rightarrow ECD$$

$$AB^+ \rightarrow AB$$

$$AC^+ \rightarrow ACD$$

$$AD^+ \rightarrow AD$$

$$AE^+ \rightarrow AECD$$

$$BC^+ \rightarrow BCDAE$$

$$BD^+ \rightarrow BDECA$$

$$BE^+ \rightarrow BECDA$$

$$CD^+ \rightarrow CD$$

$$CE^+ \rightarrow CED$$

$$DE^+ \rightarrow DEC$$

→ 2 Marks  
for  
Explanation

Candidate Key →  $BC, BD, BE$  — 2 Marks

b) Since there are no multivalued attributes — Explanation  
2 Marks

Normal form of R is 1NF — 2 marks  
as it has partial dependency  
∴ not in 2NF

c)

$BD \rightarrow E$  in 2NF  
 $E \rightarrow C$  in 2NF  
 $B \rightarrow A$  Not in 2NF (Partial dependency)  
 $C \rightarrow D$  in 2NF

(2)

B C D E  
 $BD \rightarrow E$   
 $E \rightarrow C$   
 $C \rightarrow D$

AB  
 $B \rightarrow A$  in 2NF

6 Marks

For 3NF  
 No Transitive dependency  
 or  $X \rightarrow Y \rightarrow \text{Prime}$   
           ↓  
       Super key

Key  
 ∴ in 2NF  $BD \rightarrow E$   
 2NF  $E \rightarrow C \rightarrow \text{prime attribute}$   
 2NF  $C \rightarrow D \rightarrow \text{prime attribute}$

$B \rightarrow A$  2NF  
 )  
 Key

∴  $BCDE$  &  $AB$   
 $BD \rightarrow E$   
 $E \rightarrow C$   
 $C \rightarrow D$   
 $B \rightarrow A$

in 3NF

— 6 Marks



d) For BCNF  $\rightarrow$  All determinants should be super key (3)

super key  
BCNF  $\overline{BD} \rightarrow E$   
 $E \rightarrow C$   
not super key  $C \rightarrow D$   
not super key  
 $B \rightarrow A$   
 $\downarrow$   
super key

$\therefore$  BDE EC BA  
 $BD \rightarrow E$   $E \rightarrow C$   $B \rightarrow A$   
 $\downarrow$   $\downarrow$   $\downarrow$   
super key super key super key

All in BCNF — 2 marks.

Combining BDE & EC E is common key.  
Combining BDEC & BA B is common key.  
 $\therefore$  decomposition is lossless  $\rightarrow$  3 marks

For dependency preserving

BDE EC BA  
 $\times B^+ \rightarrow BA$   $E \rightarrow C$   $B \rightarrow A$   
 $\times D^+ \rightarrow D$   $F_2$   $F_3$   
 $\times E^+ \rightarrow ECD$   
 $B D^+ \rightarrow BDEC$   
 $B E^+ \rightarrow BECD$   
 $D E^+ \rightarrow DEC$   $\left[ \begin{array}{l} E \rightarrow D \\ BD \rightarrow E \\ BE \rightarrow D \end{array} \right] F_1$

$F_1^+ \cup F_2^+ \cup F_3^+ = E \rightarrow D, BD \rightarrow E, BE \rightarrow D, E \rightarrow C, B \rightarrow A$

Since  $C \rightarrow D$  is not here

$\therefore$  not dependency preserving.

— 5 marks



either solutions to d)

4

BCE

CD

BA

$C \rightarrow D$   
↓  
super key.

$B \rightarrow A$   
↓  
super key

All in BCNF — 2 marks

Combining BCE & CD  $BCED \rightarrow C$  is common key

Combining BCED & BA  $\rightarrow B$  is common key

∴ decomposition is lossless  $\rightarrow 3$  marks

For Dependency Preserving

BCE

$B^+ \rightarrow BA$

$C^+ \rightarrow CD$

$E^+ \rightarrow ECD$

$BC^+ \rightarrow BCAD$

$BE^+ \rightarrow BEACD$

$CE^+ \rightarrow CED$

$E \rightarrow C$

$BC \rightarrow E$

$BE \rightarrow C$

}  $F_1$

CD

$C^+ \rightarrow DC$

$D^+ \rightarrow D$

✓  $C \rightarrow D$

$F_2$

BA

$B^+ \rightarrow BA$

$A^+ \rightarrow A$

✓  $B \rightarrow A$

$F_3$

$F_1^+ \cup F_2^+ \cup F_3^+ = E \rightarrow C, BC \rightarrow E, BE \rightarrow C, C \rightarrow D, B \rightarrow A$

∴  $BD \rightarrow E$  is lost  
∴ Not Dependency Preserving  
— 5 marks.