**Problems for Practice- CNF (Jahanzeb Solutions)**

* + 1. S 🡺 aSb
    2. S 🡺 ab

**Solution:**

**Step-1:** **Remove Null Productions**

**No Null Production**

**Step-2:** **Remove Unit Productions**

**No Unit Production**

**Step-3:** **Remove Useless Production by introducing**

**New productions and writhe with CFG (X🡪a, Y🡪b)**

1. S🡪XSY
2. S🡪XY
3. X🡪 a
4. Y🡪b

**Step-3:** **Apply decomposition in case of concatenations of more than two non-terminals.**

1. S🡪MY
2. S🡪XY
3. M🡪XS
4. X🡪a
5. X🡪a
6. Y🡪b
7. S🡪 X/Y
8. X🡪 Mab
9. Y🡪Za
10. M🡪 aM
11. M🡪 ^
12. Z🡪 bZ
13. Z🡪^

**STEP:1 (REMOVE NULL PRODUCNTION)**

1. S🡪X/Y
2. X🡪Mab/ab
3. Y🡪Za
4. M🡪aM/a
5. Z🡪bZ/b

**STEP:2 (ELIMINATE UNIT PRODUCTIONS)**

1. S🡪Mab/Za
2. X🡪Mab/ab
3. Y🡪Za
4. M🡪aM/a
5. Z🡪bZ/b

**STEP: 3 (ELIMINATE USELESS PRODUCTIONS BY INTROCING ( H**🡪b, P🡪a **)**

1. S🡪MPH/ZP
2. X🡪MPH/PH
3. Y🡪ZP
4. M🡪PM/a
5. Z🡪HZ/a
6. H🡪 b
7. P🡪 a

**STEP: 4 (ELIMINATE MORE THAN TWO CANCATINATED NON-TERMINAL BY INTRODUCTING T**🡪MP )

1. **S**🡪TH/ZP
2. **X**🡪TH/PH
3. **Y**🡪ZP
4. **M**🡪PM/a
5. **Z**🡪HZ/a
6. **T**🡪MP
7. **H**🡪b
8. **P**🡪a
9. S🡪 bX/Y/Z
10. X🡪 aX
11. X🡪 bX
12. Y🡪 bY
13. Y🡪 ^
14. Z🡪 aZ
15. Z🡪^

**STEP 1: (REMOVE NULL PRODUCNTIONS)**

1. **S**🡪bX/Y/Z
2. **X**🡪aX
3. **X**🡪bX
4. **Y**🡪bY/b
5. **Z**🡪aZ/a

**STEP: 2: (REMOVE UNIT PRODUCNTIONS)**

1. **S**🡪bX/bY/b/aZ/a
2. **X**🡪aX/bX
3. **Y**🡪bY/b
4. **Z**🡪aZ/a

**STEP: 3: (ELIMINATE USELESS PRODUCTIONS BY INTRODUCING ( R**🡪a, Q🡪b**)**

1. **S**🡪QX/QY/b/RZ/a
2. **X**🡪RX/QX
3. **Y**🡪QY/b
4. **Z**🡪RZ/b
5. **R**🡪a
6. **Q**🡪b

**STEP: 4 (ELIMINATE MORE THAN TWO CANCATINATED NON-TERMINAL**

**NO MORE THAN TWO NON-TERMINALS IN CONCATENATIONS**

* + 1. S 🡺 aSbb
    2. S 🡺 abb

**Solution**

**STEP 1: (REMOVE NULL PRODUCNTIONS)**

**No Null Productions**

**STEP 2: (REMOVE UNIT PRODUCNTIONS)**

**No Unit Productions**

**STEP 3: (ELIMINATE USELESS PRODUCTIONS BY INTRODUCING ( R**🡪a, X🡪b**)**

1. **S**🡪RSXX
2. **S**🡪RXX
3. **R🡪 a**
4. **X🡪 b**

**(Z**🡪RS, U🡪XX)

1. **S**🡪ZU
2. **S**🡪RU
3. **Z**🡪RS
4. U🡪XX
5. R🡪a
6. X🡪b
   * 1. S 🡺 aaSbb
     2. S 🡺 aabb

(R🡪a, X🡪b)

1. S🡪RRSXX
2. S🡪RX

(Q🡪RR, C🡪XX)

1. S🡪QSC
2. S🡪RX

(H🡪SC)

1. S🡪QH
2. S🡪RX
3. H🡪SC
4. Q🡪RR
5. C🡪XX
6. R🡪a
7. X🡪b
   * 1. S 🡺 aaaSbbb
     2. S 🡺 aaabbb

(F🡪a, H🡪b)

1. S🡪FFFSHHH
2. S🡪FFFHHH

(L🡪FF, K🡪HH)

1. S🡪FLSHK
2. S🡪FLHK

(D🡪FL, G🡪HK)

1. S🡪DSG
2. S🡪DG

(V🡪DS)

1. S🡪VG
2. S🡪DG
3. V🡪DS
4. D🡪FL
5. G🡪HK
6. L🡪FF
7. K🡪KK
8. F🡪a
9. H🡪b
   * 1. S 🡺 aSb
     2. S 🡺 abb

(Y🡪a, Z🡪b)

1. S🡪YSZ
2. S🡪YZZ

(M🡪YZ)

1. S🡪SM
2. S🡪MZ
3. M🡪YZ
4. Y🡪a
5. Z🡪b
   * 1. S 🡺 aSc
     2. S 🡺 bSc
     3. S 🡺 bc

(Y🡪a, Z🡪b, N🡪c)

1. S🡪YSN
2. S🡪ZSN
3. S🡪ZN

( R🡪SN)

1. S🡪YR
2. S🡪SR
3. S🡪ZN
4. R🡪SN
5. Y🡪a
6. Z🡪b
7. N🡪c
   * 1. S 🡺 XY
     2. X 🡺 aXb
     3. X 🡺 ab
     4. Y 🡺 bYc
     5. Y 🡺 bc

STEP 1: NO NULL PRODUCTION

STEP 2: ELIMINATE UNIT PRODUCTION

1. S🡪XY/aXbbYc/aXbbc/abbYc/abbc
2. X🡪aXb
3. X🡪ab
4. Y🡪bYc
5. Y🡪bc

STEP 3: ELIMINATE USELESS PRODUCTION

(Q🡪a, P🡪b, Z🡪c)

1. S🡪XY/QXPPYZ/QXPPZ/QPPYZ/QPPZ
2. X🡪QXP
3. X🡪QP
4. Y🡪PYZ
5. Y🡪PZ

(X🡪QP, Y🡪PZ)

1. S🡪XY/XXYY/XXY/XYY/XY
2. X🡪XX
3. X🡪QP
4. Y🡪YY
5. Y🡪PZ

(M🡪XX, N🡪YY)

1. S🡪XY/MN/MY/XN/XY
2. X🡪XX
3. X🡪QP
4. Y🡪YY
5. Y🡪PZ
   * 1. S 🡺 aSb/Y
     2. Y 🡺 aYc
     3. Y 🡺 ab

(M🡪a, N🡪b, O🡪c)

1. S🡪MSN/MYO
2. Y🡪MYO
3. Y🡪MN

(Y🡪MN, T🡪MY)

1. S🡪SY/TO
2. Y🡪TO
3. Y🡪MN
4. T🡪MY
5. M🡪a
6. N🡪b
7. O🡪c
   * 1. S 🡺 aSbb
     2. S 🡺 abbb

(M🡪a, N🡪b)

1. S🡪MSNN
2. S🡪MNNN

(O🡪MS, P🡪NN, Z🡪MN)

1. S🡪OP
2. S🡪ZP
3. O🡪MS
4. P🡪NN
5. Z🡪MN
6. M🡪a
7. N🡪b