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Assignment 3 ToA 6C

(A)

$$S \rightarrow TUV$$

$$T \rightarrow aTb \mid \epsilon$$

$$U \rightarrow cU \mid \epsilon$$

$$V \rightarrow aVc \mid W$$

$$W \rightarrow bW \mid \epsilon$$

i) No starting state on R.H.S so no need for new starting state

ii) Null production :-

$$T \rightarrow \epsilon, U \rightarrow \epsilon, W \rightarrow \epsilon$$

\therefore Remove $T \rightarrow \epsilon$

$$S \rightarrow TUV \mid U$$

$$T \rightarrow aTb \mid ab$$

$$U \rightarrow cU \mid \epsilon$$

$$V \rightarrow aVc \mid W$$

$$W \rightarrow bW \mid \epsilon$$

\therefore Remove $U \rightarrow \epsilon$

$$S \rightarrow TUV \mid U \mid T \mid \epsilon$$

$$T \rightarrow aTb \mid ab$$

$$U \rightarrow cU \mid c$$

$$V \rightarrow aVc \mid W$$

$$W \rightarrow bW \mid \epsilon$$

∴ Remove $W \rightarrow \epsilon$

$S \rightarrow T U I V I U I T I \epsilon$

$T \rightarrow a T b I a b$

$U \rightarrow c U I c$

$V \rightarrow a V c I \epsilon$

$W \rightarrow b W I b$

∴ Remove $V \rightarrow \epsilon$

$S \rightarrow T U I V I U I T I \epsilon$

$T \rightarrow a T b I a b$

$U \rightarrow c U I c$

$V \rightarrow a V c I \epsilon a c$

$W \rightarrow b W I b$

iii) unit production:-

$S \rightarrow V, S \rightarrow U, S \rightarrow T$

$S \rightarrow T U I a V c I a c I c U I c I a T b I a b I \epsilon$

$U \rightarrow c U I c$

$V \rightarrow a V c I a c$

$W \rightarrow b W I b$

iv) useless production:-

$\{a, b, U, V, W, S\}$

As W cannot be reached so it is unreachable

so $S \rightarrow T U I a V c I a c I c U I c I a T b I a b I \epsilon$

$U \rightarrow c U I c$

$V \rightarrow a V c I a c$

let

v) $A \rightarrow a, B \rightarrow b, C \rightarrow c, X \rightarrow AV, Y \rightarrow AT$

$S \rightarrow TU \mid XC \mid A^C \mid CU \mid C \mid YB \mid AB \mid \epsilon$

$U \rightarrow CU \mid c$

$V \rightarrow XC \mid AC$

$A \rightarrow a$

$B \rightarrow b$

$C \rightarrow c$

$X \rightarrow AV, Y \rightarrow AT$

(B)

$S \rightarrow ASA \mid aB$

$A \rightarrow BIS$

$B \rightarrow b \mid \epsilon$

$X \rightarrow A$

i) $S' \rightarrow S$ (new start state)

$S \rightarrow ASA \mid aB$

$A \rightarrow BIS$

$B \rightarrow b \mid \epsilon$

$X \rightarrow A$

ii) ϵ Null Production

$B \rightarrow \epsilon$

$S' \rightarrow S$

$S \rightarrow ASA \mid aB \mid a$

$A \rightarrow BIS \mid \epsilon$

$B \rightarrow b$

$X \rightarrow A$

∴ remove $A \rightarrow \epsilon$

$$S' \rightarrow S$$

$$S \rightarrow ASA|aB|a|SA|AS|S$$

$$A \rightarrow B|S$$

$$B \rightarrow b$$

$$X \rightarrow \epsilon$$

∴ remove $X \rightarrow \epsilon$

iii) Unit Production:-

$$S' \rightarrow S, S \rightarrow S, A \rightarrow B, A \rightarrow S$$

$$S' \rightarrow ASA|aB|a|SA|AS$$

$$S \rightarrow ASA|aB|a|SA|AS$$

$$A \rightarrow b|ASA|aB|a|SA|AS$$

$$B \rightarrow b$$

iv) useless states :-

$$\{b, a, s', s, A, B\}$$

no useless production

v) let $Y \rightarrow a, Z \rightarrow AS$

$$S' \rightarrow ZA|YB|a|SA|~~AS~~|Z$$

$$S \rightarrow ZA|YB|a|SA|~~AS~~|Z$$

$$A \rightarrow b|~~Z~~A|YB|a|SA|~~A~~|Z$$

$$B \rightarrow b$$

$$Y \rightarrow a$$

$$Z \rightarrow AS$$

(c)

$$S \rightarrow a|aA|aB$$

$$A \rightarrow aBB|\epsilon$$

$$B \rightarrow Aa|b$$

i) Null production:-

$$S \rightarrow a|aA|aB \quad \because \text{remove } A \rightarrow \epsilon$$

$$A \rightarrow aBB$$

$$B \rightarrow Aa|b|a$$

ii) Unit production:-

No unit production

iv)

$$\{a, b, S, B, A\}$$

No useless productions

$$v) S \rightarrow a|xA|Y$$

$$A \rightarrow YB$$

$$B \rightarrow AX|b|a$$

$$X \rightarrow a$$

$$Y \rightarrow XB$$