**TUTORIAL- 6 & 7**

**Context Free Grammar and Derivations**

**I. Context Free Grammar**

1. L={anbman|n>0, m>0} Solution: S→ aSa|aBa, B→bB|b
2. L={anbmcmd2n|n≥0, m≥0} Solution: S→ aSdd|A, A→bAc|bc
3. odd length palindromes Solution: S→a|b|є|aSa|bSb
4. L={anbm|0≤n≤m≤2n} Solution: S→aSb|aSbb|є
5. L={a+b\*} Solution: G1: S→AB, A→aA|a, B→bB|є G2: S→aS|aB, B→b|є
6. Strings over {a,b} that contain exactly 2b’s

Solution: G1: S→ AbAbA, A→aA|є G2: S→aS|bA, A→aA|bC, C→aC|bC|є

1. with atleast 2b’s Solution: G1: S→AbAbA, A→aA|bA|є

G2: S→aS|bA, A→aA|bC, C→aC|bC|є

1. generate even length string over {a,b} Solution: S→aO|bO|є, O→aS|bS
2. even length b’s Solution: S→aS|bB|є, B→aB|bS|bC, C→aC|є
3. a)even no. of a’s and b’s: S→aB|bA|є, b)even no. of a’s and odd b’s: A→aC|bS|є

c)odd no. of a’s and even b’s: B→aS|bC|є, d)odd no. of a’s and b’s: C→aA|bB|є

1. all strings over {a,b,c} that do not contain ‘abc’

Solution: S→bS|CS|aB|є, B→aB|CS|bC|є, C→aB|bS|є

1. na(w)=nb(w) Solution: G1: S→є|aSb|bSa|SS G2: S→aB|bA|є, A→aS, B→bS|aBB, A→bAA

G3: S→aSbS|bSaS|є

1. without ba as substring Solution:G1: S→aS|bA|є, A→bA|є G2: S→aS|Sb|a|b
2. L(0\*1(0+1)\*) Solution: S→A|B , B→0A|є, B→1B|0B|є
3. L((011+1)\*(01)\*) Solution: G1: S→AB, A→011A|1A|є, B→01|B|є

G2: S→BC, B→AB|є, A→011|1, C→DC|є, D→01

1. L= {anbn|n>0 or n≥1} Solution: S→aSb|ab
2. L= {anbncm | n, m≥1} Solution: S→AB, A→aAb|ab, B→cB|c
3. L={anbncmdm| n,m≥1} Solution: S→AB, A→aAb|ab, B→cBd|cd
4. L={anbm| n,m≥1, n>m} Solution: S→aSb|aAb, A→aA|A
5. L={wcwr| wє{a,b}\*} Solution: S→aSa|bSb|c
6. L={an| n≥1} Solution: S→aA|a
7. L={anbm| n,m≥1} Solution: G1: S→aS|aA, A→bA|b G2: S→AB, A→aA|a, b→bB|b
8. L={a2n| n≥1} Solution: G1: S→aA, A→aS, A→a G2: S→aaS|aa
9. L= {(ab)n|n≥1} Solution: S→aA, A→bS|b
10. L= {0i1j0k| j>i+k} Solution: S→ABC, A→0A1|є, B→1B|1, C→1C0|є
11. L={aibjck|i≠j or j≠k} Solution: S→AC, A→aAb|A1|B1, A1→ aA1|a, B1→bB1|b, C→CC|є
12. L={aibj| i≤2j} Solution: S→aaSb|aSb|B|Sb, B→bB|є
13. L={w|na(w)=nb(w)+1} Solution: S→AaA, A→aAb|bAa|AA|є
14. L=Set of even length string in {a,b} with 2 middle symbols same

Solution: S→aSb|aSa|bSb|bSa|aa|bb

**II.Find the left most and right most derivations for the following grammar**:

1. S→0B|1A, A→0|0S|1AA, B→1|1S|0BB
2. S→aB|bA, A→a|aS|bAA, B→b|bS|aBB
3. S→aAS|a, A→SbA|SS|ba
4. S→S+S, S→S\*S|a|b
5. S→SbS|a
6. S→SaSaS|b
7. S→aSb|SS|є
8. S→aSbS|bSaS|є