BE 3/4 CSE Sem I, Sec I, II, III   Sub: ALC

UNITS III, IV & V

1. What are the normal forms of CFG's? What are the eliminations or simplifications to be made to a grammar before converting it into a CNF?

a) 1. Remove unit productions from the following CFG.

$$S \rightarrow AA, \quad A \rightarrow B/BB, \quad B \rightarrow abB / b / bb$$

2. Eliminate ϵ-productions from the following CFG.

$$S \rightarrow ABa \mid bC, \quad A \rightarrow BC \mid b,$$
$$B \rightarrow b \mid \epsilon; \quad C \rightarrow c \mid \epsilon$$

3. Remove useless symbols from the following CFG.

$$S \rightarrow aAa, \quad A \rightarrow Sb \mid bCC \mid DaA, \quad C \rightarrow abb \mid DD,$$
$$E \rightarrow aC, \quad D \rightarrow aDA$$

b) Convert the following grammars to CNF.

1. $S \rightarrow aB \mid ab, \quad A \rightarrow aAB \mid a, \quad B \rightarrow ABb \mid b$

2. $S \rightarrow bA \mid aB, \quad A \rightarrow bAA \mid aS \mid a, \quad B \rightarrow aBB \mid bS \mid b$

3. $S \rightarrow aSb \mid ab$

4. $E \rightarrow E+T \mid T, \quad T \rightarrow T*F \mid F, \quad F \rightarrow (E) \mid a$

5. $S \rightarrow iCtS \mid iCtSeS \mid a, \quad C \rightarrow b$

6. $S \rightarrow AA, \quad A \rightarrow B \mid BB, \quad B \rightarrow abB \mid b \mid bb$

7. $S \rightarrow aAa \mid aBC, \quad A \rightarrow aS \mid bD \mid \epsilon, \quad B \rightarrow aBa \mid C \mid b$
$C \rightarrow abb \mid DD, \quad D \rightarrow aDa$

8. $S \rightarrow ABa \mid bC, \quad A \rightarrow BC \mid b, \quad B \rightarrow b \mid \epsilon, \quad C \rightarrow c \mid \epsilon$

M.Anupama

c) Convert the following grammars into GNF.

1. $S \rightarrow AA \mid 0$, $A \rightarrow SS \mid 1$

2. $A \rightarrow BC$, $B \rightarrow CA \mid b$, $C \rightarrow AB \mid a$

II a) What are the closure and decision properties of CFL's ?

b) State and prove pumping lemma for CFL's. What are its applications ?

c) Using pumping lemma prove that the following languages are not CFL's.

1. $L = \{ ww \mid w \in \{0,1\}^* \}$

2. $L = \{ 0^n 1^n 0^n 1^n \mid n \geq 0 \}$

III. Consider the CFG : $S \rightarrow A_1 A_2 \mid A_2 A_3$, $A_1 \rightarrow A_2 A_1 \mid 0$,

$A_2 \rightarrow A_3 A_3 \mid 1$, $A_3 \rightarrow A_1 A_2 \mid 0$

Test if " 10010 " is a member of the CFG or not using CYK algorithm.

IV. a) Give short notes on DCFLs.

b) Define LR(0) and LR(k) grammars.

V. Construct the nonempty sets of items for the following grammars. Which are LR(0) ?

1. $A \rightarrow (A) \mid a$

2. $S \rightarrow AaAb \mid BbBa$, $A \rightarrow \epsilon$, $B \rightarrow \epsilon$

3. $E \rightarrow E * B \mid E + B \mid B$, $B \rightarrow 0 \mid 1$

M.Anupama

4. $E \rightarrow E+T \mid T$, $T \rightarrow T*F \mid F$, $F \rightarrow (E.) \mid id$ ③/④

5. $S' \rightarrow S$, $S \rightarrow aSa \mid bSb \mid e$

VI. a) State and explain programming techniques for Turing Machines.

b) State and explain the extensions to the basic Turing Machines.

VII. a) Define a TM? What are the languages accepted by a TM? Give applications for TMs.

b) Define 'δ' and 'ID' of a TM.

VIII. a) Define CHURCH's hypothesis.

b) Write short notes on (i) Restricted TMs (ii) UTMs.

IX. a) Differentiate between FA, PDA and TMs.

b) Explain TM as a Transducer and Enumerator.

c) Give Reasons for TM not accepting input.

X. Design Turing Machines for the following:

1. To recognize all bit strings ending in 101.

2. To accept $a^n b^n a^n \mid n \geqslant 1$

3. For multiplication of two numbers $m \times N$ (separated by '1')

4. To accept a palindrome consisting of a's and b's of any length.

5. $L = \{ ww \mid w \in \{0,1\}^* \}$ & $L = \{ w \# w \mid w \in \{0,1\}^* \}$

6. To recognize the set of all bit strings that contain an even no. of 1's.

M.Anupama

7. $L = \{a^n b^n \mid n \geq 1\}$

8. To add 2 non negative integers.

9. For equal no. of a's & b's.

10. For subtraction of 2 non negative integers.

XI. Write short notes on:

a) CHOMSKY Hierarchy b) Recursively Enumerable Languages and their properties c) Undecidability with an example

d) LBA e) Intractable problems (P, NP, NP-Hard, NP-Complete)

XII a) What is the Halting problem of a TM?

b) Give 2 examples of (i) Unrestricted grammars (ii) CSGs

XIII. Write about : a) Rice theorm b) CSLs c) SAT and RSAT problems d) Diagonalization language.

XIV a) Compare Rt. linear grammar and Left linear grammar.

b) Give RLG and LLG for i a i) $(0+1)^* 00 (0+1)^*$

ii) $0(10)^*$ iii) $10 + (0+11)0^*1$ iv) $ba^*(b+ba)$

v) $0^* (1(0+1))^*$

XV a) Differentiate between PCP and MPCP.

b) Do the given PCP's have a solution?

1. $X = (011, 11, 1101)$ 2. $X = (1, 10111, 10)$ 3. $X = (10, 011, 101)$

$Y = (101, 011, 110)$ $Y = (111, 10, 0)$ $Y = (101, 11, 011)$

M.Anupama