M. C. A.

(END SEM.) EXAMINATION, 2006-07

THEORY OF FORMAL LANGUAGES & AUTOMATA

Time : 3 Hours] [Total Marks : 100

Note : Attempt all questions. Every question carries 20 marks. Make suitable assumption wherever needed.

1 Attempt any four parts of the following : 5x4=20

(a) Convert the following NFA to an equivalent DFA

![Diagram 1](image1)

Fig. 1

(b) Obtain a minimum state DFA equivalent to the following

![Diagram 2](image2)

Fig. 2

V-1460] 1 [Contd...
(c) For the regular expression given below, obtain an NFA without E-moves.
\((0 + 1)^* (00 + 11)\)

(d) Design a moore machine that accepts all strings of 0’s and 1’s treated as binary integer number return a remainder 1 when divided by 3.

(e) Give the statement of pumping lemma and using it prove that the following language is not regular.

\[ L = \left\{ 0^{i^2} | \text{i is integer, } i \geq 1 \right\} \]

(f) Prove that regular sets are closed under union and complementation.

2 Attempt any four parts of the following : 5x4=20

(a) Consider the CFG with the following production rules:

- \( S \rightarrow aB \mid bA \)
- \( A \rightarrow bAA \mid aS \mid a \)
- \( B \rightarrow aBB \mid bS \mid b \)

Give a right most derivation and draw derivation tree for the string abbaab.

(b) Prove that the following grammar of arithmetic expressions is ambiguous

- \( E \rightarrow E + E \mid E * E \mid (E) \mid id \)

(c) Find a CFG with no useless symbols equivalent to the following grammar:

- \( S \rightarrow AB \mid CA \)
- \( A \rightarrow a \)
- \( B \rightarrow BC \mid AB \)
- \( C \rightarrow AB \mid b \)

(d) Convert the grammar of question no. 2 (a) into chomsky normal form (CNF).
(e) Construct a Greibach Normal Form (GNF) grammar equivalent to the following:

CFG

S → AA | 0
A → SS | 1

(f) Remove all E and unit production rules from the following CFG:

S → AaA | CA | BaB
A → aaBa | CDA | aa | DC
B → bB | bAB | bb | aS
C → Ca | bc | D
D → bD | A

3 Attempt any two parts of the following: 10×2=20

(a) What are deterministic and non-deterministic PDA? Design a PDA for the following language

L = { WW^R | WE (0+1)^* and W^R is reverse of W } 

(b) Consider the following transition functions of a PDA that accepts strings through empty stack mechanism:

δ (q_0, 1, z_0) = \{(q_0, X z_0)\}
δ (q_0, ε, z_0) = \{(q_0, ε)\}
δ (q_0, 1, X) = \{(q_0, XX)\}
δ (q_1, 1, X) = \{(q_1, ε)\}
δ (q_0, 0, X) = \{(q_1, X)\}
δ (q_1, 0, z_0) = \{q_0, z_0\}

Find out a CFG for the above PDA.
(c) For the following CNF, using CYK algorithm check the membership of the string aaaaa.

\[
\begin{align*}
S & \rightarrow AB \mid BC \\
A & \rightarrow BA \mid a \\
B & \rightarrow CC \mid b \\
C & \rightarrow AB \mid a
\end{align*}
\]

4 Attempt any two parts of the following: 10x2=20

(a) Design a Turing machine that accepts the language of question no. 3 (a).

(b) Prove the following:
   
   (i) The union of two recursive languages is recursive and so is for two recursively enumerable languages.
   
   (ii) Complement of a recursive language is also recursive.

(c) (i) Define universal Turing machine and universal language.
   
   (ii) What is post correspondence problem? Explain with an example.

5 Attempt any two parts of the following:

(a) Give a complete overview of Type-0, type-1, type-2 and type-3 grammar with Chomsky hierarchy.

(b) If \( L \) is a Context Free Language (CFL) and \( R \) is a Regular Set, then prove that \( LDR \) is a CFL.

(c) Construct right-linear grammars for the following languages
   
   (i) \((0+1)^* 1 (0+1)^*\)
   
   (ii) \((0+1)^* 00\)