(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 110407 Roll No. | | | | | | | | | | |

B.Tech.

(SEM. IV) THEORY EXAMINATION 2013-14

THEORY OF AUTOMATA & FORMAL LANGUAGES

Time : 3 Hours *Total Marks : 100*

Note :– Attempt all the questions in fair Handwriting in Sequence. Assume where required and Mention it.

1. Attempt any **four** parts of the following : **(5×4=20)**

   (a) Write Regular expressions for each of the following languages over the alphabet (0,1) :–

      (i) The set of all strings in which every pair of adjacent zero's appears before any pair of adjacent one's.

      (ii) The set of all strings not containing 101 as substring.

   (b) Draw DFA of following language over {0,1} :–

      (i) All strings with even no. of 0's and even no. of 1's.

      (ii) All strings of length at most 5.

   (c) Convert following NFA to equivalent DFA :

→p	{q,s)	{q}
*q	{r}	{q,r}
r	{s}	{p}
*s	ϕ	{p}

   (d) Show that every Context free language is context-sensitive.

(e) Draw DFA for following over set $\Sigma = \{0,1\}$

(i) $L = \{ \omega : |\omega| \bmod 3 = 0 \}$

(ii) $L = \{ \omega : |\omega| \bmod 3 > 1 \}$

$|\omega|$ represents length of string ω.

(f) Find the regular grammar for the language

$L = \{ a^n b^m \mid n + m \text{ is even} \}$.

2. Attempt any **four** parts of the following : **(5×4=20)**

(a) Convert the given grammar in Chomsky Normal form (CNF)

$S \rightarrow ABa \quad A \rightarrow aab \quad B \rightarrow Ac$.

(b) Following Grammar generates language of Regular Expression :

$0^*1\ (0+1)^* \quad S \rightarrow A1B \quad A \rightarrow 0A/\in \quad B \rightarrow 0B|1B|\in$

Give leftmost and rightmost derivation of strings 00101.

(c) Show the below grammar is ambiguous :–

$G = (V,T,EP)$, $V = (E,I)$, $T = \{a,b,c,+,*,(.....)\}$

$P \Rightarrow \quad E \rightarrow I \quad E \rightarrow E+E \quad E \rightarrow E*E \quad E \rightarrow (E) \quad I \rightarrow a|b|c$.

(d) Find Context free grammar for following languages with $(n >= 0, m >= 0, k >= 0)$.

(i) $L = \{ a^n b^n c^k \mid k >= 3 \}$

(ii) $L = \{ a^m b^n c^k \mid n = m \text{ or } m <= k \}$.

(e) Given context free Grammar, how do you determine that grammar as :

(i) Empty or Non Empty

(ii) Finite or Non-Finite

(iii) Whether a string x belongs to language of grammar.

(f) Design a NFA to recognize following set of strings 0101, 101 and 011. Alphabet set is {0,1}. Find the equivalent Regular Expression.

3. Attempt any **two** parts of the following : **(10×2=20)**

(a) Construct PDA for following :–

$L = \{a^n c\, b^{2n} \mid n >= 1\}$

over alphabet $\Sigma = \{a,b,c\}$. Specify the acceptance state.

(b) Prove that following are not Regular Languages :

(i) $\{o^n \mid n \text{ is perfect square}\}$.

(ii) The set of strings of form $0^i 1^j$ such that the greatest common divisor of i and j is 1.

(c) (i) For given CFG, find equivalent CFG with no useless variables :

$S \rightarrow AB|AC \quad A \rightarrow aAb|bAa|a \quad B \rightarrow bbA|aaB|AB$
$C \rightarrow abCa|aDb \quad D \rightarrow bD|aC$

(ii) Explain Chomsky Normal form and Greibach Normal form. Convert following CFG to Equivalent Greibach Normal form :

$S \rightarrow AA \quad A \rightarrow SS \quad S \rightarrow a \quad A \rightarrow b$

4. Attempt any **two** parts of the following : **(10×2=20)**

(a) Consider given PDA :

PDA $M = (\{q_0\}, \{0,1\}, \{a,b,z_0\}, \delta, q_0, z_0, \phi)$
δ is defined as :

$\delta(q_0, a, z_0) = \{(q_0, az_0)\}$

$\delta(q_0, 1, z_0) = \{(q_0, bz_0)\}$

$\delta(q_0, 0, a) = \{(q_0, aa)\}$

$\delta(q_0, 1, b) = \{(q_0, bb)\}$

$\delta(q_0, 0, b) = \{(q_0, \in)\}$

$\delta(q_0, 1, a) = \{(q_0, \in)\}$

$\delta(q_0, \in, z_0) = \{\{q_0, \in)\}$

Convert given PDA M to corresponding CFG.

(b) Prove the Lemma that language recognized by final state PDA machine is also recognized by empty-stack PDA machine and vice-versa. i.e. L(M) = N(M)

Where L(M) → Language by Final State PDA machine.

N(M) → Language by Empty Stack PDA machine.

(c) Prove that the languages L_1 and L_2 are closed under Intersection and complementation if they are regular, but not closed under the above said two properties if they are context free languages.

5. Attempt any **two** parts of the following : **(10×2=20)**

(a) Design a Turing Machine that can compute proper subtraction i.e. m$n, where m and n are positive integers, m$n is defined as m-n if m>n
and 0 if m≤n.

(b) State **True/False** with reason :–

(i) Every language described by Regular Expression can be recognized by DFA.

(ii) Every R.E.L. can be generated by CFL.

(iii) The Halting problem of TM is decidable.

(iv) Complement of R.E.L. is also R.E.L.

(v) Every CFL can be recognized by TM.

(c) Design a Transducer (Mealy or Moore) Machine to compute multiplication of two n-bit binary numbers.