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No. of Printed Pages—6 CS-404

B. TECH.

FOURTH SEMESTER EXAMINATION, 2003–2004

THEORY OF AUTOMATA & FORMAL LANGUAGES

Time : 3 Hours *Total Marks : 100*

Note : (1) Attempt **ALL** questions.
(2) All questions carry equal marks.
(3) Assume suitable data if required.

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

(*a*) State True or False with reason : **(1+1+1+2)**

(i) The intersection of two regular languages is regular.

(ii) The intersection of two context free languages is context free language.

(iii) The intersection of a context free language and a regular language is regular language.

(iv) The complement of a deterministic context free language is deterministic context free language.

(*b*) Let $\sum = \{a, b\}$. For each of the following languages over $\sum$, find a regular expression representing it : **(1·5+1·5+2·0)**

(i) All string that exactly contain one *'a'*.

(ii) All string beginning with *'ab'*.

(iii) All string that contain either the sub-string *'aaa'* or *'bbb'*.

89

(c) Draw DFA for following over the set $\sum = \{0, 1\}$:—

(i) $L = \{ w \mid |w| \bmod 3 = 0 \}$

(ii) $L = \{ w \mid |w| \bmod 3 > 1 \}$

Note $|w|$ represents the length of the string w.

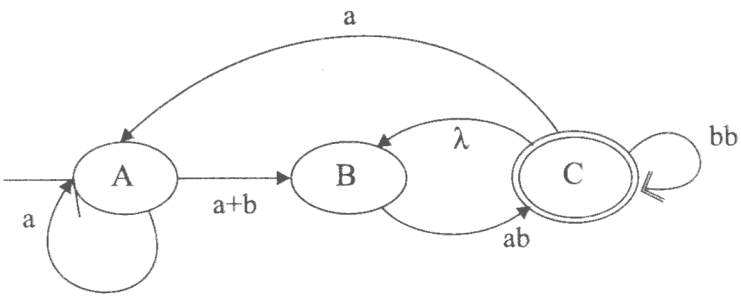
(d) Find the regular grammar for the language $L = \{ a^n b^m \mid n + m \text{ is even} \}$.

(e) Show that the following languages are regular :—

(i) $L = \{ a^n \mid n > 4 \}$

(ii) $L = \{ vwv \mid v, w \in \{a, b\}^*, |v| = 2 \}$

(f) Consider the following generalized transition diagram :—



(i) Find an equivalent generalized transition graph with two states.

(ii) What is the language accepted by this language ?

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

(*a*) Consider the context free grammar :

$$G = \{ S \rightarrow Asb \mid AS \mid \varepsilon,\ A \rightarrow aA \mid \varepsilon \}.$$

State True / False for the following :—

(i) The string *ababb* is generated by the grammar *G*.

(ii) Every string of the form :

$$a^n b^m,\ m >= n >= 0,$$ is generated by *G*.

(iii) The grammar is ambiguous.

(iv) The language generated by *G* is regular.

(*b*) Show the derivation tree for string *'aabbbb'* with grammar :

$S \rightarrow AB \ / \ \lambda$

$A \rightarrow a\ B$

$B \rightarrow S\ b$

Give the verbal description of the grammar.

(*c*) Find the context free grammar for the following languages (with n > = 0, m > = 0, k > = 0) :—

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

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

(*d*) Explain why the grammar below that generates strings with an equal number of 0's and 1's is ambiguous :—

$S \rightarrow 0A \mid 1B$

$A \rightarrow 0AA \mid 1\ S \mid 1$

$B \rightarrow 1BB \mid 0\ S \mid 0$

(e) Reduce the following grammar into Chomosky normal form :—

$$G = \{\{S\}, \{a, b, c\}, \{S \to a \mid b \mid cSS\}, S\}$$

(f) Do the following :—

(i) State the Pumping Lemma for the context free languages. (Do not prove.)

(ii) Explain the ambiguity in context free languages. Is ambiguity possible in regular languages ?

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

(a) Explain the difference between Deterministic and non-Deterministic push down automata, giving their definition. Give one example of each.

(b) Construct PDA for the following :—

$$L = \{a^n cb^{2n} \mid n >= 1\}$$

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

(c) Using pumping lemma for context free languages, prove that the following language is not context free :—

$$L = \{a^p \mid p \text{ is a prime number.}\}$$

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

(a) State True / False with reason :

(i) Every language described by a regular expression can be recognised by a deterministic finite automation.

(ii) Every recursively enumerable language can be generated by a context free language.