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

PAPER ID : 1071 Roll No. | | | | | | | | | | |

**B.Tech.**

FOURTH SEMESTER EXAMINATION, 2005-2006

# THEORY OF AUTOMATA AND FORMAL LANGUAGES

*Time : 3 Hours* *Total Marks : 100*

**Note :** *(i) Attempt **ALL** questions.*
*(ii) All questions carry equal marks.*
*(iii) In case of numerical problems assume data wherever not provided.*
*(iv) Be precise in your answer.*



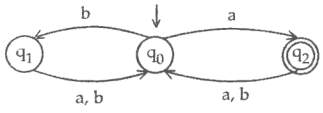
**1.** Attempt ***any four*** parts of the following : **(5x4=20)**

(a) Consider the language S*, where S = {*xx*, *xxx*}. In how many ways can $x^{19}$ be written as the product of words in S ? This means : How many different factorizations are there of $x^{19}$ into *xx* and *xxx* ?

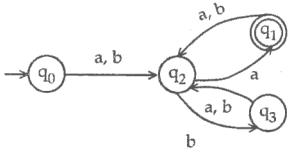
(b) When asked to give a recursive definition for the language, PALINDROME over the alphabet $\Sigma = \{a, b\}$, a student wrote :
Rule 1 : *a* and *b* are in PALINDROME.
Rule 2 : If *x* is in PALINDROME, then so are *axa* and *bxb*.
But, all the words in the language defined above have an odd length and so it is not all of PALINDROME. Correct this problem.

(c) Describe in English the languages accepted by the following FAS :

(i)




(ii)



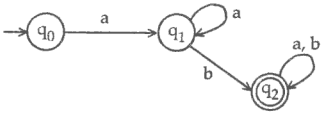

(d) Given a Transition Graph, called $TG_1$, that accepts the language $L_1$ and another transition graph, called $TG_2$, that accepts the language $L_2$, show how to build a new transition graph, called $TG_3$ that accepts exactly the language $L_1 + L_2$.

(e) What is a generalized transition graph ? Explain with a suitable example.

(f) What is chomsky hierarchy ? Explain.

**2.** Attempt *any four* parts of the following : **(5x4=20)**

(a) Consider the following automata (DFA) M.




Obtain a DFA which accepts the complement of the language accepted by M.

(b) Differentiate between Moore machine and Mealy machine by taking suitable examples.

(c) Convert to a DFA the following NFA :

| | | 0 | 1 |
|---|---|---|---|
| → | p | {p, q} | {p} |
| | q | {r} | {r} |
| | r | {s} | $\phi$ |
| | s | {s} | {s} |

(d) Give DFA's accepting the following languages over the alphabet {0, 1}

(i) The set of all strings ending in 00.

(ii) The set of strings with 011 as a substring.

(e) Design a NFA to recognize the following set of strings. 0101, 101, and 011. Assume the alphabet is {0, 1}. Hence obtain the equivalent deterministic finite automata DFA.

(f) Give English description of the language of the following regular expression.

(0*1*)* 000 (0+1)*

3. Attempt *any two* parts of the following : **(10x2=20)**

(a) Prove that the following are not regular languages.

(i) $\{0^n \mid n$ is a perfect square$\}$

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

(b) Find context - free grammars for the following languages (with $n \geq 0$ and $m \geq 0$)

(i) $L = \{a^n b^m : n \leq m+3\}$

(ii) $L = \{a^n b^m : m = 2n\}$

(c) (i) The following grammar generates prefix expressions with operands $x$ and $y$ and binary operators $+$, $-$, and $*$

$E \rightarrow +EE \mid *EE \mid -EE \mid x \mid y$

Find leftmost and rightmost derivations and a derivation tree for the string $+*-xyxy$.

(ii) Convert the following grammar to Greibach Normal forms.

$S \rightarrow AB \quad A \rightarrow BS \quad B \rightarrow SA \quad A \rightarrow a \quad B \rightarrow b$

**4.** Attempt *any two* parts of the following : **(10x2=20)**

(a) Design a PDA to accept each of the following languages. You may accept either by final state or by empty stack, whichever is more convenient.

(i) $\{0^n\ 1^n \mid n \geq 1\}$

(ii) The set of all strings of 0's and 1's with an equal number of 0's and 1's.

(b) (i) Convert the grammar

$S \rightarrow 0S1 \mid A$

$A \rightarrow 1A0 \mid S \mid E$

to a PDA that accepts the same language.

(ii) Simplify the following grammar.

$S \rightarrow AB \mid BC \mid aACb \mid a$

$A \rightarrow AAB \mid BD \mid abD \mid C$

$C \rightarrow CA \mid S \mid a$

$D \rightarrow d$

$E \rightarrow ab$

(c) Show that the language

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

is a context - free language that is not accepted by any DPDA.

 uptuonline.com

5. Attempt *any two* parts of the following : **(10x2=20)**

(a) (i) Explain halting problem of a turing machine.

(ii) Design Turing machines for the following languages.

$\{ww^R \mid w$ is any string of 0's and 1's$\}$

(b) State Post's correspondence problem. Prove that Post's correspondence problem is undecidable.

(c) Prove or disprove the following :

(i) Complement of a recursively enumerable language is recursively enumerable.

(ii) Union of recursively enumerable languages is recursively enumerable.

- o O o -