

Your Roll No.

Sl. No. of Ques. Paper	: 6192	F-5
Unique Paper Code	: 2341502	
Name of Paper	: Theory of Computation	
Name of Course	: B.Tech. Computer Science	
Semester	: V	
Duration :	: 3 hours	
Maximum Marks	: 75	

(Write your Roll No. on the top immediately on receipt of this question paper.)

*Question No. 1 is of 35 marks and **all** its parts are compulsory Attempt any **four** questions from Q. No. 2 to Q. No. 7 .*

PART A

NOTE: *For all the questions, consider the alphabet {a, b} unless otherwise specified.*

1. (a) For a language defined over the alphabet , is $(a^*b^*)^*=(a+b)^*$? Generate the first 6 words of each of the language in the lexicographic order. 3

(b) Construct a Finite Automata (FA) for a language having strings that do not end in a double letter, *i.e.*, aa or bb. 3

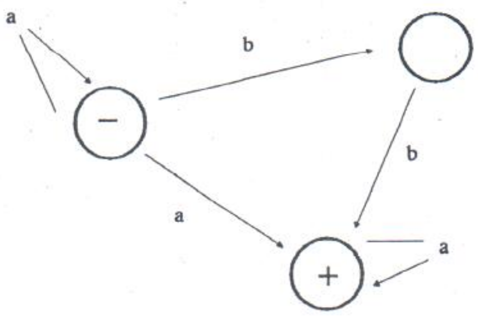
(c) Build an FA machine that accepts all strings that have an even length that is not divisible by 6. 3

(d) Consider the grammar for the language a^nb^n:

$$S \to aS|ab$$

Chomky-ize the grammar. 3

(e) Convert the following Non-deterministic FA (NFA) to Deterministic FA (DFA): 3



(f) Find a Context Free Grammar (CFG) for a language of the form $a^xb^ya^z$ where x, y, z = 1, 2, 3 ... and x + z = y = {abba, aabbba, abbbaaa, ...} 4

P. T. O.

(g) Construct a Push Down Automata (PDA) that accepts strings with unbalanced open and close round braces, where all the opening braces precede the closing braces, *i.e.*, strings of the form $(^n)^m$, where n, m = 1, 2, 3 ... (*i.e.*, n, m ∈ N) and n≠m. Some example strings are {()), ((), ((()), (((), ... }. The alphabet for the language is {(,)}. 4

(h) Design a Turing Machine (TM) to accept the language with words of the form $a^n b^n a^n$ where n = 1, 2, 3 ... (*i.e.*, n, m ∈ N). 4

(i) Construct a TM that transforms the configuration $Uw\underline{U}$ (where w is an input string with no blanks) into the configuration $UUw\underline{U}$. U is representing the blank symbol and _ shows the current position of the head of the TM. 4

(j) Use Pumping Lemma to show that the language PALINDROME is non-regular. 4

PART B

2. (a) What language is PALINDROME ∩ $\{a^n b^{n+m} a^m \mid n, m = 1, 2, 3 \ldots$ (*i.e.*, n, m ∈ N)}. Is it context free? If context free, draw the PDA, else use Pumping Lemma to show that it is non-CF. 5

(b) Give a CFG for language with words of type $a^x b^y a^z b^w$, x, y, z, w = 1, 2, 3 ... $y > x$, $z > w$ and $x + z = y + w$. 5

3. (a) Consider the CFG in Chomsky Normal Form (CNF):

$S \rightarrow PQ$

$Q \rightarrow QS/b$

$P \rightarrow a$ 5

Generate the derivation trees for the words (i) abab, (ii) ababab.

Consider Q as the self embedded non terminal, trace the division of each word w into uvxyz and uvvxyyz, where $|u| + |z| \geq 0$, $|v| + |y| > 0$ and $|x| > 0$.

(b) Consider the following languages:

$L_1 = \{a^n b^m \text{ where } n \geq m\}$

$L_2 = \{a^n b^m \text{ where } m \geq n\}$

What is the language formed by their intersection? Show that this language is context free by constructing a PDA. 5

4. (a) Use pumping lemma to show that language $\{a^n b^{2n} \mid n = 1, 2, 3 \ldots\}$ is non-regular. 4

(b) For the languages $L_1 = (a+b)^*a$ and $L_2 = (a+b)^*aa(a+b)^*$ construct the respective FAs and derive the finite automata that define $L_1 \cap L_2$. 1+2+3

5. (a) Consider the homomorphism h from the alphabet {0, 1, 2} to {a, b} defined by:

$$h(0) = ab,\ h(1) = b,\ h(2) = aa.$$

(i) If L is the language $(ab + baa)^*bab$, what is $h^{-1}(L)$?

(ii) If L is the language consisting of the single string ababb, what is $h^{-1}(L)$? 4

(b) Given the language represented by $(1+0)^*1$, show that the reverse of the language is also regular using a DFA. 3

(c) Construct a DFA accepting all strings w over {0, 1} such that the number of 1's in w is 3 mod 4. 3

6. (a) Give the regular expression for the following language:

(i) All the strings in which b's occur in clumps of an odd number at a time such as abaabbbab, ab, ababbba, ...

(ii) All words that contain exactly two b's or exactly three b's. 3+2

(b) If L is a recursive language, then prove that its complement is also recursive. 5

7. (a) What does the following notation represent:

U("M""w") = "M(w)", where $M = (K, \Sigma, \delta, s, H)$ and U is the Universal TM. 5

(b) Design a Turing Machine for finding the two's complement of a given number which is provided as input to it in binary form over the alphabet {0, 1}. 5

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