This question paper contains 4 printed pages.

Your Roll No. ....

Sl. No. of Ques. Paper : **1332** **F–7**

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 four questions from Q. Nos 2 to 7.

PART A

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

1. (a) Is $(S^*)^+ = (S^+)^*$ for all sets S ? Explain with an example. (2)

(b) Consider the language PALINDROME and a string y over the given alphabet. Prove that if the string y^3 is in PALINDROME, then so is the string y. (3)

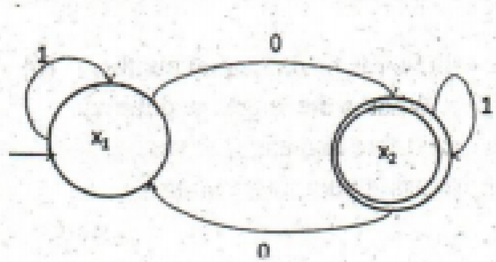
(c) Give a regular expression for the language of all words that do not end in a double letter. (3)

(d) Show that (ab)*a and a(ba)* define the same language. Give the set of strings representing the two languages. Give the first five strings generated in the lexicographic manner. (2)

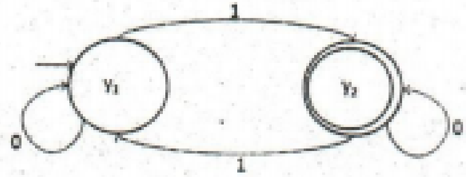
(e) Using pumping lemma for regular languages, show that the language $L=\{a^n ba^n \mid n \geq 0\}$ is not regular. (3)

(f) Given two Finite Automata(FA): FA_1 and FA_2 find the machine for the intersection of the languages represented by these FA's. (4)

FA_1



P.T.O.



(g) Create a Push Down Automata(PDA) for the language L = { a^nS , where S starts with b and length (S) = n }. (4)

(h) Find a Context Free Grammar(CFG) for the language defined by the regular expression a*b*. (2)

(i) Show that the following CFG is ambiguous by finding a word with two distinct syntax trees: (3)

S→AA

A→AAA| a | bA | Ab

(j) Convert the following CFG into CNF: (3)

S→aXX

X→aS | bS | a

(k) Explain the working of the following Turing Machine(TM) (2)

$>R \xrightarrow{a\neq U} R \xrightarrow{b\neq U} R_U a R_U b$

U represents the blank symbol.

(l) Describe the Universal Turing Machine. (4)

PART B

2(a) Let language L_1= EQUAL, the language with words having equal number of a's and b's and L_2= {$a^nb^ma^n$| m,n=1,2,...}. What is the language defined by the intersection of L1 and L2? Is it a context free language? If yes, construct a PDA for the language, else prove using pumping lemma for CFLs. (6)

2(b) Construct a CFG for the language L = { $a^m b^n$ | m>n , m, n>=1}. (4)

3(a) Prove that regular languages are closed under complementation, i.e., if a language L is regular then L'(complement of L) is also regular. (3)

3 (b) For the following pair of regular languages find an FA that defines the difference, L_1-L_2: (4)

$L_1 = (a+b)^*c$

$L_2 = b(a+b)^*c$

$\Sigma = \{a,b,c\}$

3 (c) Build an FA that accepts the language of all strings of a's and b's such that the next to last letter is an a. (3)

4(a) Consider the homomorphism **h** from the alphabet {0,1,2} to {a,b}.defined by: (4)

h(0)=ab, h(1)=b, h(2)=aa

i) What is h(0210)?

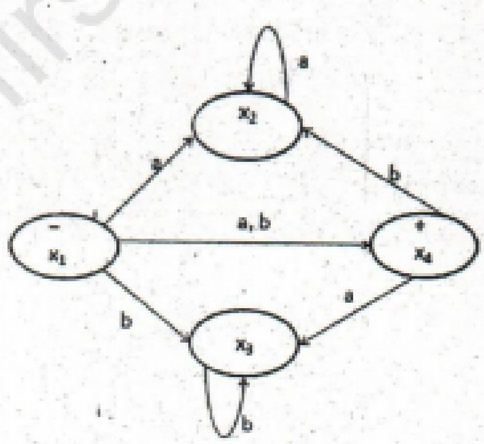
ii) What is h(2201)?

iii) If L is the language 1^*02^*, what is h(L)?

4(b) Give a PDA for the language with words of type $a^x b^y a^z b^w$ x,y,z,w = 1, 2,3 ... (6)

y>x and z>w and x+z=y+w.

5(a) Convert the following NFA to DFA. (5)



5 (b) Write regular expression and construct a DFA for the following language of all words that have an even number of substrings **ab** in them. (5)

P.T.O.

6(a) Consider the following CFG in Chomsky Normal Form (CNF) (6)

$S \rightarrow PQ$

$Q \rightarrow QS \mid b$

$P \rightarrow a$

Generate the derivation trees for the word i)abab ii)ababab

Consider S as the self embedded non terminal, trace the division of each word *w* into uvxyz and uvvxyyz,

where $|u|+|z|>=0$, $|v|+|y|>0$ and $|x|>0$.

6(b) Which of the following could be configurations of a Turing Machine? Justify your answer. (4)

i. (q, ▶aUaU, U, Ua)
ii. (q, abc,b, abc)
iii. (p, ▶abc, a, e)
iv. (h, ▶, e, e)

(▶ represents the left end symbol)

7 (a) Give a Turing Machine which computes the function f(w) =ww. (5)

7 (b) The language H = { "M""w" ; Turing machine M halts on input w} describes the halting problem. Prove that H is not recursive, i.e., the Halting problem is undecidable. (5)