[This question paper contains 4 printed pages.]

Your Roll No.....

K

Sr. No. of Question Paper : 3374

Unique Paper Code : 32341502

Name of the Paper : Theory of Computation

Name of the Course : **B.Sc. (Hons.) Computer Science (CBCS-LOCF)**

Semester : V

Duration : 3 Hours

Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Question No. **1 (Section A)** is compulsory.
3. Attempt any **4** Questions from Nos. **2** to **7 (Section B)**.
4. Parts of a question must be answered together.
5. Consider S = {a, b} for all the questions unless specified otherwise.

Section A

1. (a) Describe the language for the following regular expression: `((a+b)b)*`. 2

   (b) Construct a regular expression for language L of all words having `b` at the second and third position. 2

   (c) Consider the following Context Free Grammar (CFG): 2

   `S → AbB`

   `A → aA | Λ`

   `B → aB | bB | Λ`

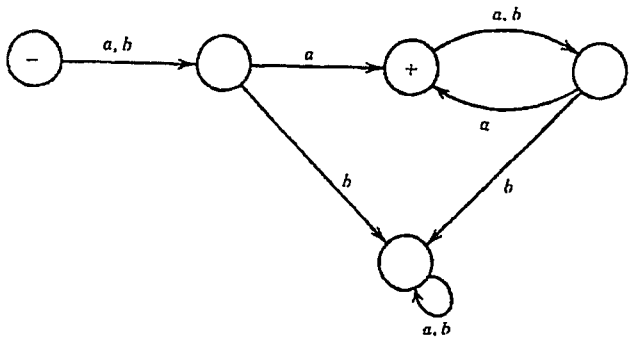
   Create a parse tree for the word `aaba`

   (d) Give a context-free grammar (CFG) for `b*a*`. 3

   (e) Build a deterministic finite automaton that accepts all strings of `a`'s and `b`'s such that the next-to-last letter is an `a`. 3

P.T.O.

(f) Describe the language accepted by the following finite automaton: 3



(h) Using the pumping lemma, show that the following language is a non-regular language: 4

$\{a^n ba^{2n}$ where $n \geq 1\} = \{abaa, aabaaaa, aaabaaaaaa, \ldots\}$

(i) Build an FA that defines $L_1 \cap L_2$ where: 4

L_1 is the language of all odd-length words

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

(j) Prove that a language is recursive if and only if the language itself and its complement are both recursively enumerable. 4

(k) Show that the intersection of $L_1 = \{a^n b^m : n \geq m\}$ and $L_2 = \{a^n b^m : m \geq n\}$ is context-free. 4

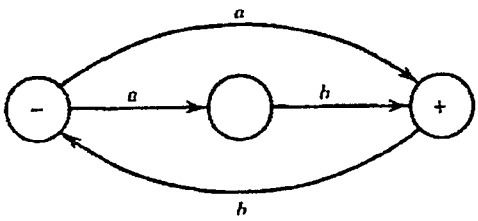
(l) Show that the following grammar is ambiguous: 4

$S \rightarrow XbaaX \mid aX$

$X \rightarrow Xa \mid Xb \mid \Lambda$

Section B

2 (a) Convert the following non-deterministic finite automaton to a deterministic finite automaton: 5



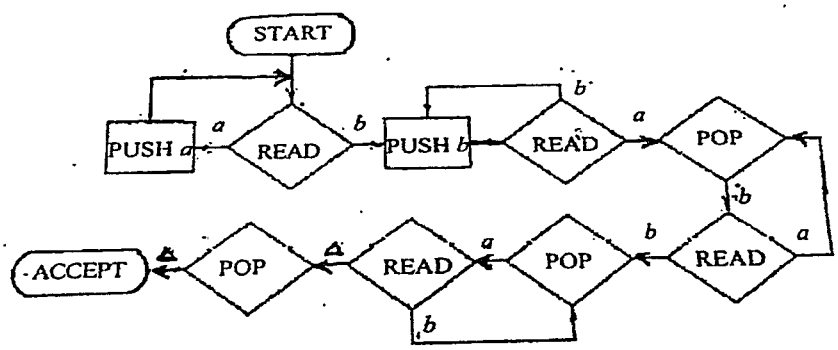
(b) i. Explain the halting problem. 5

ii. Describe the Universal Turing Machine.

3 (a) Construct a PDA for the language L = $\{a^n b^n \mid n>=0\}$. 5

(b) Is the language $\{a^n b^n c^m \mid n,m = 1,2,3...\}$ context free? If yes, give a CFG for the same, else prove using the pumping lemma. 5

4. (a) Which language does the following PDA accept? Trace the string **aababb** on the PDA. 6



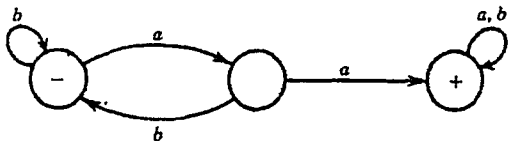
(b) Convert the following CFG to Chomsky Normal Form: 4

```
E -> E + E
E -> E * E
E -> D
D -> 7
```

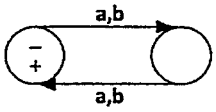
The terminals are +, *, 7

5 (a) Find FA1 ∩ FA2 corresponding to the following finite automata. 6

FA1



FA2



(b) Construct a CFG for the language L = a(bb)*. Also, construct a CFG for L*. 4

6 (a) Assume Σ = {0, 1, ▷, ⊔}, then create a Turing machine M_2 that takes a binary number as input on the tape, and leaves the two's complement of the input binary number as output on the tape when halts. 6

(b) Are Context Free Languages closed under complementation? Justify. 4

7 (a) Build deterministic finite automata for the following languages over the alphabet {a,b}: 6

(i) language of words having a double letter in them

(ii) language of words having an odd number of a's

(b) Convert the following TG into a regular expression: 4