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[This question paper contains 7 printed pages]

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Science

Your Roll No.

Sl. No. of Q. Paper

Unique Paper Code

Name of the Course

Name of the Paper

: Theory of Computation

: B.Sc.(Hons.) Computer

Semester

Time : 3 Hours

Maximum Marks: 75

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Instructions for Candidates :

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

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- (b) All questions in Section-A are compulsory.
- (c) Attempt any four questions from Section-B.
- (d) Parts of a question must be answered together.
- (e) Assume alphabet $\Sigma = \{a, b\}$ unless stated otherwise.

P.T.O.

Section - A

1. (a) Do the following regular expressions represent the same language (give reason) :

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 $R_1 = ((a + b)(a + b))^* a$

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 $R_2 = (a + b)((a + b)(a + b))*a$

- (b) Write a regular expression and build a deterministic finite automata for the language containing all strings having a at every odd position. 2+3
- (c) Describe in English the languages represented by the following regular expressions : 2+2
 - (i) b*ab*ab*ab* + b*ab*ab*
 - (ii) $(a + b)^*aa (a + b)^*$
- (d) Describe pumping lemma for regular languages. 2
- (e) Based on the language S = {aa, ba, ab, bb}, describe the language S*. 2

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7. (i) Build FA for each of the following regular languages L, and L,. $L_{1} = b(a+b)^{*}$ $L_2 = a(a+b)*b + b(a+b)*a$ (ii) Build FA for $L_1 \cap L_2$. 4 (iii) Describe in English the language represented by $L_1 \cap L_2$.

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4. (i) Give Context Free Grammar (CFG) for the following language : 5

 $\{a^i b^j c^k \mid i+j=k; i, j, k \ge 0\}$ and $\sum = \{a,b,c\}$

(ii) Build pushdown automation (PDA) to accept the following language : 5 $\{Sb^{n+1}; S \text{ is a string of only a's, n=length}(S), n \ge 1\}$

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- 5. (i) Convert the following CFG to CNF :
 - $E \rightarrow E + E$
 - $E \rightarrow E * E$
 - $E \rightarrow (E)$
 - $E \rightarrow 6 | 7$

The terminals here are + * () 6 7.

- (ii) Prove that the recursive languages are closed under complementation. 5
- 6. (i) Design a Turing Machine that scans to the right until it finds two consecutive a's and then halts. The alphabet of the Turing machine should be {a, b, ⊥, Δ}.
 - (ii) Prove that context-free languages closed under Union and concatenation. 5

(f) What are the languages generated by the following grammars : 3+3
(i) S → XA

- (i) $S \rightarrow AA$ $X \rightarrow aXb \mid A$ $A \rightarrow aA \mid A$ (ii) $S \rightarrow AB$ $A \rightarrow aA \mid A$
 - B→bB | A
- (g) Show that the following CFG is ambiguous :
 - 3

- $\begin{array}{l} S \rightarrow X \, a \, X \\ X \rightarrow a \, X \mid b \, X \mid \Lambda \end{array}$
- (h) Describe the language (in English) accepted by the following PDA : 3



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P.T.O.

- (i) Describe the halting problem.
- (j) Let $M=(K, \sum, \delta, s, \{h\})$, where
 - $\mathbf{K}=\{\mathbf{q}_0,\mathbf{q}_1,\mathbf{h}\}$
 - $\Sigma = \{a, b, \bigsqcup, \triangleright\}$
 - $S = q_0$

and	δ	is	given	by	the	following	table	:
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q,	σ	δ(q, σ)
\mathbf{q}_{0}	а	(q ₁ , b)
q _o	b	(q ₁ , a)
\mathbf{q}_{0}	U	(h, ∐)
q _o	⊳	$(\mathbf{q}_0, \rightarrow)$
q	a	(q_0, \rightarrow)
q ₁	.b	(q_0, \rightarrow)
q _i	U	(q_0, \rightarrow)
q ₁	Þ	(q_1, \rightarrow)

Trace the computation of M starting from the configuration $(q_0, r a abbba)$.

Section -B

- 2. (i) Let L=All strings that end with aa or bb. Construct DFAs for L and L' (i.e., Complement of L).
 - (ii) Is the language {a^mb^m; m≥0} regular? Justify using Pumping Theorem.
- **3.** (i) Build an FA accepting the language comprising of all strings having first two characters same as the last two.

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(ii) Convert the following Transition Graph (TG)
 into regular expression using Bypass
 algorithm.



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