College of Engineering

Wellesley Road Shivajinagar Pune 411005 (MS)

Year: 2017-2018 **MIS Number:** | | | | | | | | | | |

Examination: End Semester **Semester:** IV **Class:** SY (Comp and IT)

Course: Theory of Computation **Code:** CT-16011

Date: April 30, 2018 **Maximum Marks:** 60 **Time:** 10:00 to 1:00

N.B.

(i) Attempt any **five** the questions. Question paper contains **six** questions.

(ii) Figures to the right indicate full marks.

(iii) Assume suitable data if necessary.

(iv) Unspecified symbols have usual meanings.

(v) Write your MIS Number on Question Paper

(vi) Writing anything on question paper is not allowed.

Q.1 (*a*) In certain programming languages, comments appear between delimiters such as /# and #/ . Let C be the language of all valid delimited comment strings. A member of C must begin with /# and end with #/ but have no intervening #/ . For simplicity, assume that the alphabet for C is $\sum = \{ a, b, /, \# \}$.

(i) Give a DFA that recognizes C with formal definition.

(ii) Give a regular expression that generates C.

(06)

(b) Prove the following:
"The class of regular languages is closed under the *concatenation* operation."

(06)

Q.2 (*a*) Show that, if M is DFA that recognizes language B, swapping the accept and nonaccept states in M yields a new DFA that recognizes the complement of B. Conclude that the class of regular languages is closed under complement.

(06)

(b) Using Pumping lemma show that the following languages are not regular. **(Any Two)**

(i) $L_1 = \{01^n2^n \mid n \geq 0\}$

(ii) $L_2 = \{a^{2^n} \mid n \geq 0\}$. Here, a^{2^n} means a string of 2^n a's

(iii) $L_3 = \{0^{2n}1^n \mid n \geq 0\}$

(06)

Q.3 (*a*) Consider the grammar $G = (V, \Sigma, R, S)$, where:
$V = \{S, A\}$
$\Sigma = \{a, b\}$
and R is the set of rules:

$$\begin{aligned} \{S &\rightarrow AA, \\ A &\rightarrow AAA, \\ A &\rightarrow a, \\ A &\rightarrow bA, \\ A &\rightarrow Ab\} \end{aligned}$$

(i) Which strings of $L(G)$ can be produced by derivations of four or fewer steps?

(ii) For any $m, n, p > 0$, describe a derivation in G of the string $b^mab^nab^p$.

(06)

(b) Let CFG be:

$$\begin{aligned} S &\rightarrow aSb \mid bY \mid Ya \\ Y &\rightarrow bY \mid aY \mid \epsilon \end{aligned}$$

Give a simple description of $L(G)$ in English. Use that description to give a CFG for $\overline{L(G)}$, the complement of $L(G)$. **(06)**

Q.4 (*a*)Write the formal definition of *Pushdown automata.* Comment on acceptance of the following language. Justify your answer.

$$L(M) = \{0^n 1^{2n} \mid n > 0\}$$

(06)

(b) List the variants of Turing machine. Show how Multitape Turing machine is equivalent to Standard Single tape Turing machine. **(06)**

Q.5 (*a*) Let R, S and T be any three regular expressions. State True or False for the following. Justify your answer, if your answer is false, show a counterexample.

(i) $(\epsilon + R)^* S = R^* S$

(ii) $(R + S)^* S^* = (R^* S)^*$

(iii) $S(RS + R)^* = (SR + R)^* R$

(06)

(b) Finite Automaton (FA) can be used for solving real life problems like controlling traffic signals. List any five applications of finite automata and explain any two in details.

(06)

Q.6 (*a*) Let A be the language containing only the string s, where

$$s = \begin{cases} 0 & \text{if life never will be found on Mars} \\ 1 & \text{if life will be found on Mars someday.} \end{cases}$$

Is A decidable? Why or why not? **(06)**

(b) Give implementation-level descriptions of Turing machines that decide the following languages over the alphabet $\{0, 1\}$. Separate Turing machine for each language. :

(i) $\{w \mid w$ contains an equal number of 0's and 1's$\}$

(ii) $\{w \mid w$ contains twice as many 0's as 1's$\}$

(06)