Unique Paper Code	:	32341502
Name of the Course	:	B.Sc. (H) Computer Science
Name of the Paper	:	Theory of Computation
Semester	:	V
Year of admission	:	2019 and onwards

Duration: Three Hours — Maximum Marks: 75

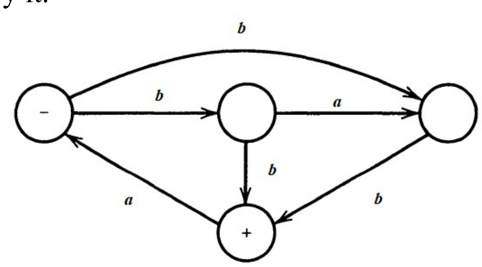
Instructions for Candidates:

i. Attempt any **FOUR** questions.
ii. Each question carries equal marks.
iii. *Consider* $\mathbf{\Sigma = \{a\ b\}}$ *for all the questions unless specified otherwise.*

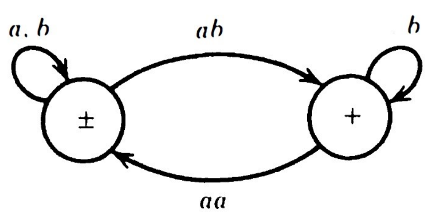
1. Consider the language L, of all the words of length four or more having first two letters same as last two letters.
   For the above language, perform the following:

   - Write all the words of L with the length five or less
   - Write the number of words having length six
   - Construct the regular expression
   - Build Finite Automaton (FA)

2. Prove that it is true for all the regular languages that complement of a regular language is also regular.
   Construct the deterministic finite automaton (DFA) that recognizes the same language as the non-deterministic finite automaton (NFA) given below and also describe the language recognized by it.



   Convert the following transition graph into its equivalent regular expression:



3. Consider the following languages:

   L_1 = Language of all the words having '***b***' at second position

   L_2 = Language of all the words having no two consecutive ***a***'s

   Construct Finite Automaton FA_1 for L_1, FA_2 for L_2. Also construct regular expression and finite automata for the following:

   - $L_1 + L_2$
   - $L_1 \cap L_2$
   - $(L_1)^*$

4. For the language L_3 : $a^{n+m}b^mc^n$; where $\Sigma = \{a\ b\ c\}$ and $m, n >= 1$, using pumping lemma, prove that the language is not regular. For the above language, do the following:

   - Write a context free grammar (CFG) for L_3, and construct parse tree for the word ***aaabbc*** using this CFG
   - Build a pushdown automaton (PDA) for L_3

5. Consider the following context free grammars (CFGs):

   G_1: S → bS | aX
   X → bS | aY
   Y → aY | bY | a | b

   G_2: S → XaX | bX
   X → XaX | XbX | **Λ**

   G_3: S → A | AA
   A → B | BB
   B → abB | b | bb

   G_4: S → BABABA
   A → a | **Λ**
   B → b | **Λ**

   For the above CFGs, perform the following:

   - Write a regular expression for the language represented by G_1
   - Convert G_2 into its equivalent CFG without null(**Λ**)-production
   - Convert G_3 into its equivalent CFG without unit-production
   - Convert G_4 into its equivalent Chomsky Normal Form (CNF)

6. Consider the language L_4: $a^nb^nc^n$ where $\Sigma = \{a\ b\ c\}$ and $n >= 1$, and perform the following:

   - Build a turing machine M_1, that accepts L_4
   - Build another turing machine M_2, that accepts complement of L_4
   - Is L_4 a recursive language or recursively enumerable language? Justify your answer
   - Is L_4 a context-free language? Justify your answer.