University of Rajshahi

Department of Computer Science and Engineering

B.Sc. (Engg.) Examination-2020, Part-2, Even Semester

Course: CSE2211 (Theory of Computation)

Full Marks-52.5 Time: 3 hours

[N.B. Answer any **SIX** questions taking **THREE** from each of the sections]

Section-A

1. a) Define alphabet and string. Explain the operation of string. 2.75
   b) Construct DFAs for the following regular languages: 6
      i) {w ∈ {0, 1}*| w ending with '01'}
      ii) { w ∈ {0, 1}*| w is a binary number whose decimal equivalent is divisible by 3}
      iii) $\{a^m b^n c^l : m, n, l \geq 0\}$.

2. a) Define Finite Automata (FA). Show the features of FA with block diagram. 3
   b) Discuss the various operations of DFA. 1.75
   c) Construct a deterministic machine that accepts the string (say w) of language over {0,1} in which the no. of 0's of w is even and w is started with 01. 4

3. d) Convert an NFA to DFA for the language containing "all strings in {0, 1}* in which the 2rd symbol from the right hand side is 1". 4
   e) Given a regular expression a(b|c)*|a. Convert it to an ε-NFA using Thomson construction. Then convert the ε-NFA directly to DFA. 4.75

4. a) Define Mealy machine by 6-tuple. Give an example with state table and state diagram. 3
   b) Construct a Mealy machine that accepts the language consisting of strings over {a,b} and string should be ending with either 'aa' or 'bb'. Print '1' if the input string is ending with either 'aa' or 'bb', otherwise print '0'. 3
   c) Convert the above Mealy machine to Moore machine. 2.75

Section-B

5. a) What is Computation? Briefly discuss the evolution of Theory of Computation. 3.75
   b) Write down applications of theory of computation. 2.5
   c) Why FA cannot recognize other than regular languages? Explain with example. 2.5

6. a) Construct a CFG to generate even and odd set of palindromes over alphabet {a,b}. 4
   b) Does a pushdown automaton (PDA) have memory? Justify. 1.75
   c) Write and explain the algorithm for minimization of a DFA. 3

7. a) What is an instantaneous description of a PDA? How will you represent it? 2.75
   b) Find PDA that accept the given CFG: 3
      i) S → XaaX ii) X → aX|bX|ϵ
   c) Construct PDAs for the languages: 3
      i) $\{a^n b^m a^{n+m} | \ m, n \geq 1\}$ ii) $\{a^n b^{2n} c^m | \ m, n \geq 1\}$.

8. a) Define Turing machine (TM). Differentiate between TM and PDA. 2
   b) Construct a Turing machine accepting the following language: i){w ∈ {a, b}*| w is consist of even number of a's and odd number of b's}, ii) $\{a^n b^n c^m | \ m, n \geq 1\}$. 6.75

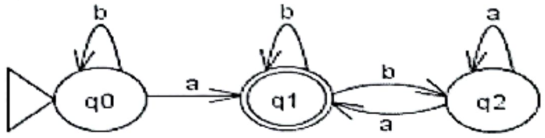
University of Rajshahi
Department of Computer Science and Engineering
B.Sc. Engg. Part - II, Semester – Even, Examination 2019
Course: CSE2211 (Theory of Computation)
Full Marks-52.5 Time: 3 hours

[N.B. Answer any **SIX** questions taking **THREE** from each of the Section]

Section-A

1. a) Define alphabet, string and language. Discuss the basic operations of languages. 3
   b) Define and classify Finite Automata (FA). 2.75
   c) What are the ways by which a finite automata can be represented? Explain with example. 3

2. a) Construct minimal DFAs accepting the following languages: 5.75
      i) {w ∈ {a, b}*| w is consists of even number of a's and odd number of b's}
      ii) {w ∈ {0, 1, 2}*| w is a ternary number whose decimal equivalent is divisible by 2}
      ii) { $a^n b^m c^l$ | l, m, n ≥0}
   b) Define regular expression. Derive a regular expression from the following FA: 3



3. a) Figure 3.1 shows a transition diagram for an NFA. For each string below, say whether the NFA accepts it. 4
      (i) aba (ii) abab and (iii) aaabbb.
   b) Find a regular expression corresponding to the language accepted by the NFA pictured in Figure 3.1. You should be able to do it without applying Kleen's theorem: First find a regular expression describing the most general way of reaching state 4 the first time, and then find a regular expression describing the most general way, starting in state 4, of moving to state 4 the next time. 4.75

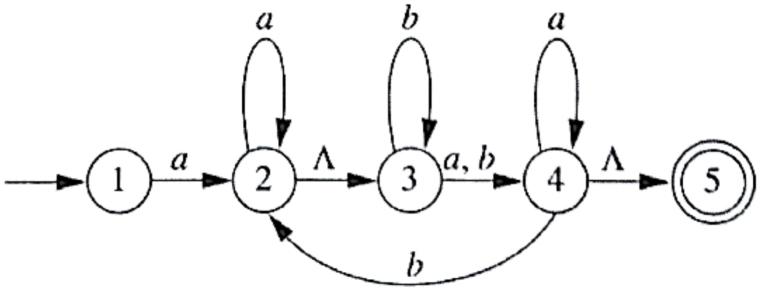


Figure 3.1: NFA

4. a) Define Mealy machine. Distinguish between Moore machine and Mealy machine. 3
   b) Construct a Mealy machine that takes binary numbers as input and produces 2's complement number as output. Assume the string is read LSB to MSB and end carry is discarded. 2.5
   c) Construct a Moore machine that takes strings over alphabet {a, b} as input and counts number of 'ab' as a substring. Then convert it to a Mealy machine. 3.25

Section-B

5. a) What do you mean by Computation? Classify the problems based on computation. 3
   b) Discuss the Chomsky hierarchy of grammars with respect to formal languages. 3
   c) Why FA cannot recognize other than regular languages? Explain with example. 2.75

6. a) What do you mean by derivation? What is the function of it? 1.75
   b) Construct context-free grammars that generate the following languages : 4
      i). {w ϵ {a, b}*|w is any string starting and ending with same symbols}
      ii) {w ϵ {a, b}*|w is odd length string}
      iii) $\{0^l 1^l 2^n 3^n \mid l, n>0\}$.
   c) Construct a machine that accepts the language generated from the following grammar. What is the language for this grammar? 3
      A→ Aa|Ab|Ba, B→Cb, C→ε

7. a) Construct pushdown automata for the following context-free languages: 5
      i) $\{a^n b^l c^m \mid l, m, n \geq 1\}$ ii) $\{a^n b^{2n} c^m \mid m, n \geq 1\}$ ii)$\{0^{n+m} 1^m 2^n \mid m, n \geq 1\}$
   b) Define Chomsky normal form. Convert the following CFG to Chomsky normal form(CNF): 3.75
      S → aX | Yb, X→S|ε, Y→bY |b.

8. a) The TM shown in Figure 8.1, computes a function from $\{a,b\}^*$ to $\{a,b\}^*$. For any string $x \in \{a, b\}^*$, describe the string $f(x)$. 5

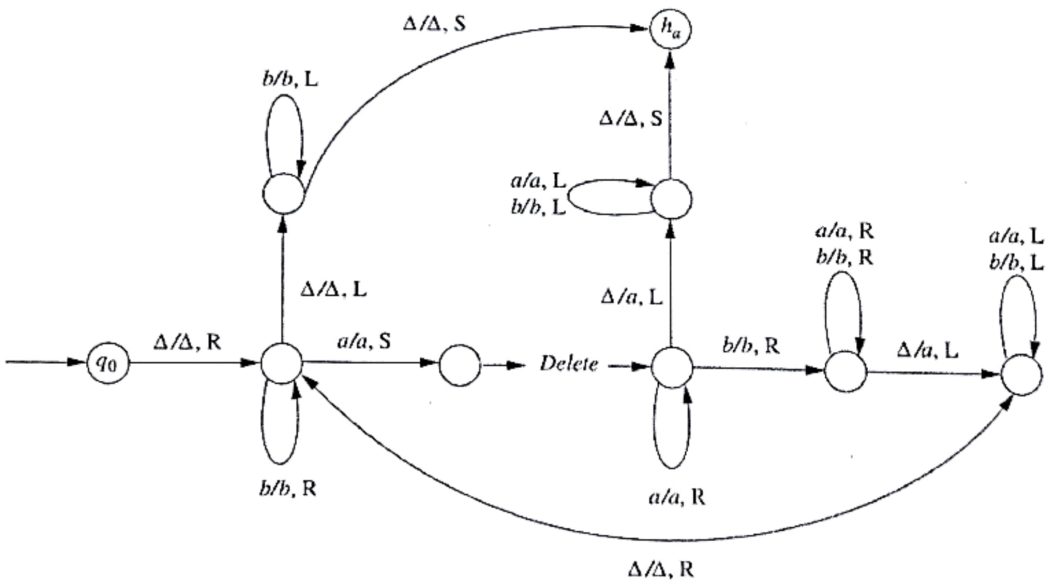


Figure 8.1: TM

b) Draw a transition diagram for a TM with input alphabet {0, 1} that interprets the input string as the binary representation of a nonnegative integer and adds 1 to it. 3.75