University of Rajshahi

Department of Computer Science and Engineering

B.Sc. (Engg.) Examination-2022, 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 groups]

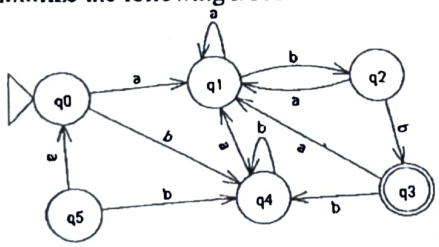
Part-A

1. a) What are the basics of theory of computation (TOC)? What is automata in TOC? 2
   b) Write down classification of problems. What is tractable and intractable problems? Explain with examples. 2.75
   c) In TOC there is a hypothetical machine, able to simulate the behavior of any other machine, that is used as a model for understanding the limits of what computers can do and cannot do. What is the name of that machine? 1.25
   d) For the language $a^p: p$ is a prime number, which machine is required to recognize? Explain. What do you mean by null production and unit production? 2.75

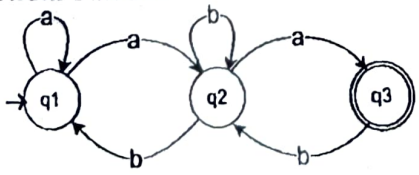
2. a) Define Finite Automata (FA). 2
   b) Construct a DFA for the language over $\{0,1\}^*$ such that it contains "000" as a substring. 3
   c) Prove that there exists a DFA for every ε-NFA. 3.75

3. a) Convert an NFA to DFA for the language containing all strings over {0, 1} ending with 001. 3.25
   b) Given a regular expression a(b|c)*|a. Convert it to an ε-NFA using Thomson's construction method. 2.5
   c) Construct an ε-NFA for the language $\{0^l 1^m 2^n | l, m, n \geq 0\}$. Then convert it to NFA applying ε-Closure property. 3

4. a) Write down the steps of partitioning method for minimizing a DFA. Accordingly, minimize the following DFA: 4



   b) Define regular expression. Convert following FA to a regular expression using Arden's method: 4.75



Section-B

5. a) What is Mealy and Moore machine? Define them mathematically. 3
   b) Construct a Mealy machine that accepts any strings over {0,1}. Print 'A' if the input string is ending either with '00' or '11', otherwise print 'B'. 2.75
   c) Convert the above Mealy machine to Moore machine. 3

6. a) Define and classify formal grammars. Construct context-free grammars that generate the following languages: 4.25
      i) set of all strings over {0,1} starting and ending with same symbol
      ii) {w ∈ {0, 1}*| length of w is divisible by 3}
      iii) $\{0^n1^n: n \geq 1\}$.
   b) Given the following Left-linear grammar (LLG) what is the language represented by the LLG: i) A→aB|bΛ|b iii) B→aC|bB iii) C→aΛ|bC|a 4.5

7. a) Let G= (V, Σ, R, S) be the CSG with Σ = {a, b,C} and R consists of the rules: 2.5
      i) S → aSBC|aBC ii) CB → BC iii) aB → ab iv) bB → bb v) bC → bc vi) cC →cc.
      Prove that the string '*aaabbbccc*' is in L(G).
   b) Construct pushdown automata (PDA) for the following context-free languages: 3.25
      $L = \{a^{2n}b^n | n \geq 1\}$, $M = \{a^n b^l c^m | l, m, n \geq 1\}$
   c) Write down instantaneous description (ID) for the string 'aaaabb' accepting by the PDA of the above language L. 3

8. a) What is Turing machine? Explain the different types of Turing machines. 3
   b) What are the differences between a Finite automata and a Turing machine? 2
   c) Design a Turing machine that accepts the language of all strings over the alphabet Σ={a,b} whose second letter is b. 3.75

University of Rajshahi

Department of Computer Science and Engineering

B. Sc. (Engg) Part-II Even Semester Examination 2021

Course: CSE2211 (Theory of Computation)

Full Marks: 52.5 Duration: 3 (Three) Hours

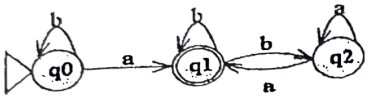
Answer 06(Six) questions taking any 03(Three) questions from each section in separate answer script

Section - A

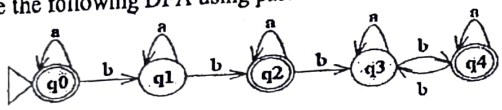
1. a) Define alphabet and string. Explain the operation of string. 2.00
   b) Construct DFAs for the following regular languages: 4.75
      i) {w ϵ {0, 1}*|w is starting and ending with same symbol}
      ii) {accepting any base-3 number whose decimal equivalent is divisible by 2}
      iii) $\{a^{2m}b^n : m, n \geq 1\}$.
   c) Explain that FA is a memory less machine. 2.00

2. a) Define finite automata. How can you represent FA? Explain with example. 3.00
   b) Discuss the various operations of DFA. 1.75
   c) Construct a DFA that accepts a language containing the strings $w\epsilon\{a,b\}^*$ where the no. of a's of w is even and w is started with 'ab'. 4.00

3. a) Define ε-NFA. Construct an ε-NFA accepting the language $\{a^m b^n c^l | m, n, l \geq 0\}$. Prove that the string '$abca$' can't be accepted by the ε-NFA. 4.00
   b) Derive a regular expression from the following FA using Arden's theorem: 3.00



   c) Minimize the following DFA using partition method: 1.75



4. a) What is Moore machine and Mealy machine? 2.00
   b) Differentiate NFA and DFA. 2.75
   c) Prove that (a+b)* = a*(ba*)*. 4.00

Section – B

5. a) Construct a FA from the following left-linear grammar: 3.50
      i) A→ Aa|Ab|Ba ii) B→ Cb iii) C→ ϵ.
      Which language will be generated by the above grammar?
   b) Give the classification of problems. What is tractable and intractable problems? Explain with examples. 3.00
   c) Explain Moore's law on the evolution of computation. 2.25

6. a) What is computation? Briefly discuss the evolution of theory of computation. 3.75
   b) Define Chomsky normal form. Convert the following CFG grammar with the following indicated productions: i) $S \rightarrow SaS|b| \epsilon$ 3.00
      ii) $S \rightarrow aAa|bAb|a|b| \epsilon, A \rightarrow aA|bA| \epsilon$
   c) Compare NFA and PDA. 2.00

7. a) Define pushdown automata. Explain the operations of pushdown automata. 3.50
   b) Construct pushdown automata for the following context-free languages: 5.25
      i) $\{a^n b^l c^m | l, m, n \geq 1\}$ ii) $\{a^n b^{2n} c^m | m, n \geq 1\}$
      ii) {w ϵ {a, b}*| where no. of 'a' is equal to no. of 'b' of w}.

8. a) Let G= (V, Σ, R, S) be the CSG with Σ = {a, b, C} and R consists of the rules: 2.75
      i) S → aSBC|aBC ii) CB → BC iii) aB → ab iv) bB → bb v) bC → bc vi) cC →cc.
      Prove that the string '$aaabbbccc$' is in L(G). 4.00
   b) Construct a Turing machine (TM) accepting the following language: $\{a^n b^n c^m | m, n \geq 1\}$. 2.00
   c) Distinguish between PDA and TM

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) $\{w \in \{0, 1\}^* | w$ ending with '01'$\}$
      ii) $\{ w \in \{0, 1\}^* | w$ 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)$\{w \in \{a, b\}^* | w$ 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

Q

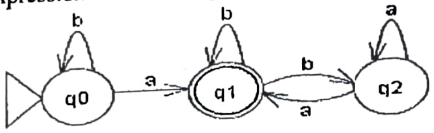
University of Rajshahi
Department of Computer Science and Engineering
B.Sc. Engg. Part - II, Semester – Even, Examination 2019
Course: CSE2211 (Theory of Computation)
Full Marks-52.5 Time: 3 hours

[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) $\{w \in \{a, b\}^* | w$ is consists of even number of a's and odd number of b's$\}$
      ii) $\{w \in \{0, 1, 2\}^* | w$ is a ternary number whose decimal equivalent is divisible by 2$\}$
      ii) $\{ a^n b^m c^l | l, m, n \geq 0\}$
   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

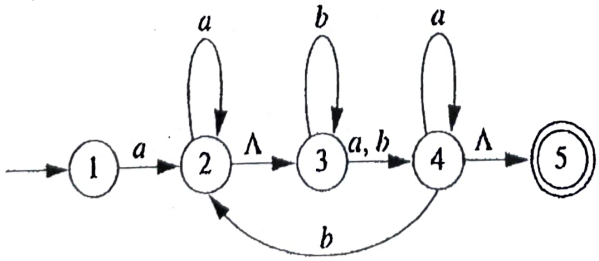


Figure 3.1: NFA

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 ∈ {a, b}*|w is any string starting and ending with same symbols}
   ii) {w ∈ {a, b}*|w is odd length string}
   iii) $\{0^l 1^l 2^n 3^n | \ l, n>0\}$.
   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) $\{a^n b^l c^m | \ l, m, n \geq 1\}$ ii) $\{a^n b^{2n} c^m | \ m, n \geq 1\}$ ii)$\{0^{n+m} 1^m 2^n | \ m, n \geq 1\}$
   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

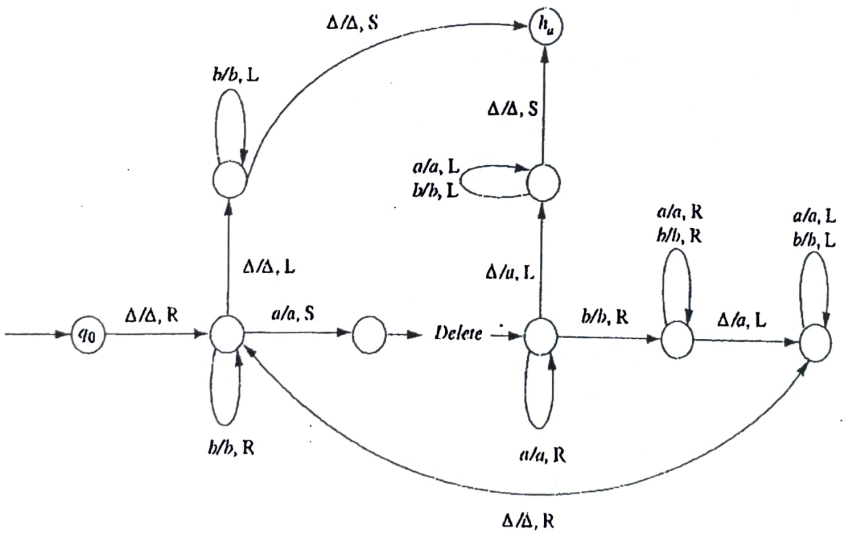


Figure 8.1: TM

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