POKHARA UNIVERSITY

Level: Bachelor | Semester: Fall | Year : 2023
Programme: BE | Full Marks: 100
Course: Theory of Computation | Pass Marks: 45
Time : 3 hrs.

Candidates are required to give their answers in their own words as far as practicable.

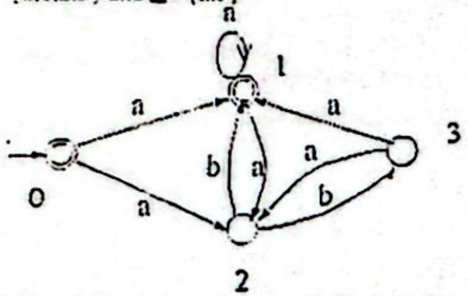
The figures in the margin indicate full marks.

Attempt all the questions.

1. a) Define Finite State Automata. Construct a DFA to recognize a language L that accepts the set of strings which contains neither aa nor bb as substring over $\Sigma = \{a, b\}$ and also test your design with a valid string. 7

   b) What are Regular Expressions (RE)? Construct an NFA for the RE $(a|b)^*.ab^*.(a|b)$ 8

2. a) Convert the following NFA to its equivalent DFA where $Q = \{0,1,2,3\}$ and $\Sigma = \{a,b\}$ 7



   b) What is an empty language? Convert the following context-free grammar (CFG) into its equivalent Chomsky's normal form (CNF) 8

   i. $S \rightarrow a \mid aA \mid B$
   ii. $A \rightarrow aBB \mid \varepsilon$
   iii. $B \rightarrow Aa \mid b$

3. a) What is a Parse tree (Derivation tree)? How is it useful to show the grammar is ambiguous ? Give an Example. 7

   b) Explain PDA? Design a PDA which accepts the language $L = \{ ww^R : w \in \{a,b\}^*$, w is a string and w^R represents reverse of w} and test for strings bbaabb and ababa. 8

4. a) Show that the language $L = \{a^n b^n c^n : n > 0\}$ is not context free using the concept of pumping lemma. 7

   b) *"For every CFG there is an equivalent Pushdown Automata".* Justify this statement with an example. 8

5. a) Design a Turing machine for computing function: 7
   $F(x, y) = x + y$ and show your validation for $x = 2$ and $y = 4$.

   b) Briefly explain the idea of designing the Turing Machine that accepts the language $L = \{a^n b^n : n > 0\}$. Show the state transition diagram for it. 8

6. a) What is computational complexity of a problem? Explain P, NP and NP-Complete problems. 7

   b) Explain the Halting Paradox in Turing Machine. What are Space and Time complexity? 8

7. Write short notes on: (Any two) 2×5

   a) Power set and Kleene Closure
   b) Recursive and Recursively Enumerable Language
   c) Universal Turing Machine

POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Theory of Computation

Semester : Spring

Year : 2023
Full Marks: 100
Pass Marks: 45
Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable.

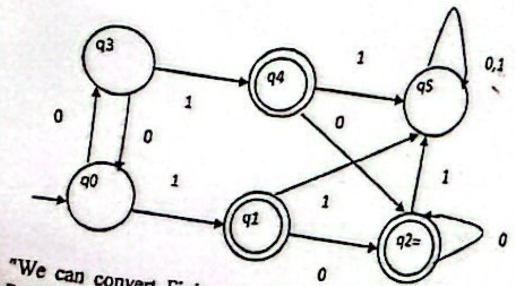
The figures in the margin indicate full marks.

Attempt all the questions.

1. a) Define alphabet, string, and language with examples. 5
   b) Design a DFA for the language $L = \{w \in (a, b)^* : w \text{ ends with bb}\}$ 5
   c) Define an ambiguous grammar. Check if below grammar is ambiguous: 5

   $S \rightarrow aB \mid ab$
   $A \rightarrow aAB \mid a$
   $B \rightarrow ABb \mid b$

2. a) What is the significance of minimizing a DFA? Minimize below DFA and analyze your finding. 7



   b) "We can convert Finite Automata to Regular Expression and also Regular Expression to Finite Automata ". Justify this suitable with suitable examples. 8
   c) Can production rules realize Context Free Grammar for the language given by $L=\{a^m b^n : m>0 \text{ and } n>0\}$. How? 7

   b) Explain the process of simp... Grammar. Sim... the following CFG, $G=(V,\Sigma,R,S)$ Where

   $V= \{S, A\}$
   $\Sigma = \{a, b\}$
   $R = \{ S \rightarrow aAB \mid AaB \mid B$
   $A \rightarrow aA \mid \epsilon$
   $B \rightarrow ab \mid bA \}$

4. a) Explain the concept of "epsilon transitions" in a Pushdown Automaton. How do they affect the computation?
   b) Define PDA with block diagram? Design a PDA which accepts the language $L=\{ a^{3n}b^n : n>=1 \}$ and test for strings *aaaaaabb* and *aaabb*.

5. a) Describe the concept of an "accepting state" and a "halting state" in a Turing Machine. Show that the function, $f(n) = 2n$ is a turing computable.
   b) Define Turing Machine. Construct a Turing machine that accepts the language of strings over (a, b) with each string of even length. Also show it accepts string *abab*.

6. a) Define the concept of "Recursive Functions" and explain their significance in the theory of computation. 7
   b) Is P=NP? Explain. Also differentiate between Tractable and Intractable problems with examples. 8

7. Write short notes on: **(Any two)** 2×5
   a) Pumping lemma for CFL
   b) Universal Turing Machine
   c) The Halting problem

POKHARA UNIVERSITY

Level: Bachelor | Semester: Fall | Year : 2022
Programme: BE | Full Marks: 100
Course: Theory of Computation | Pass Marks: 45
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Attempt all the questions.

1. a) What is Function? Explain different types of functions with examples 5

   b) Define FA. The C programming language has 3 key words *while*, *for* and *do* that are used to write loop statements. Construct a Deterministic Finite Automat (DFA) that recognizes the the three loop key words in C. 5

   c) Let G be the grammar 5

   $S \rightarrow ASA \mid B$

   $A \rightarrow a \mid b$

   $B \rightarrow aCb \mid bCa$

   $C \rightarrow ACA \mid A$

   Answer the following:

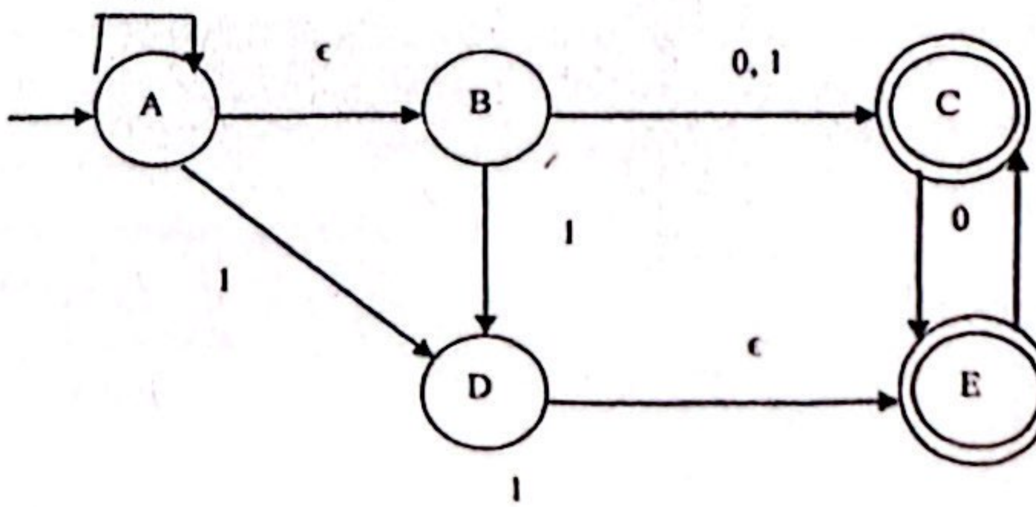
   i. What are the variables and terminals in G?

   ii. Generate two strings that are recognized by G of length 7?

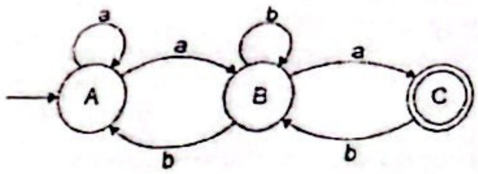
   iii. Are strings "aba" and "bbb" in L(G)?

   iv. Is empty in L(G) ?

2. a) Construct a DFA equivalent to NFA as shown: 7



b) *Explain Arden's Theorem. Find the expression for the following FSA using this method.* 8



3. a) What is Context Free Grammar? Design CFG for language $L = \{ a^m b^n : m>=1, n>=1\}$. Test the grammar for derivation of ***aaabbbb*** and also draw equivalent parse tree. 8

   b) Show that the language $L=\{a^n b^n c^n: n>0\}$ is not context free using the concept of pumping lemma. 7

4. a) Design a PDA which accepts the language given by 8

   $L=\{w \varepsilon \{a,b\}^* : w$ has equal number of a's and b's$\}$. Consider $Z_0$to be the bottom of the stack. Also show verification for an accepted string.

   b) *"For every CFG there is an equivalent Push Down Automata"*. Justify this statement with an example. 7

5. a) Define Turing machine. Design a Turing machine to decide whether or not any input string $w\epsilon\{a,b\}^*$ is a palindrome. Also test your design for strings ababa and bbaab. 8

   b) Turing machines are functionally stronger than Pushdown Automata. Justify. Also show TM are function computable. 7

6. a) State Church-Turing Thesis. Compare and contrast the relationship of Recursive and Recursively Enumerable Language. 7

   b) Explain Computational Complexity Theory. What are P, NP and NP-Complete problems? Explain with examples. 8

7. Write short notes on: **(Any two)** 2×5

   a) Importance and scope of Theory of Computation

   b) Decision algorithm of CFLs

   c) The halting problem

POKHARA UNIVERSITY

Level: Bachelor | Semester: Spring | Year : 2021
Programme: BE | Full Marks: 100
Course: Theory of Computation | Pass Marks: 45
Time : 3hrs.

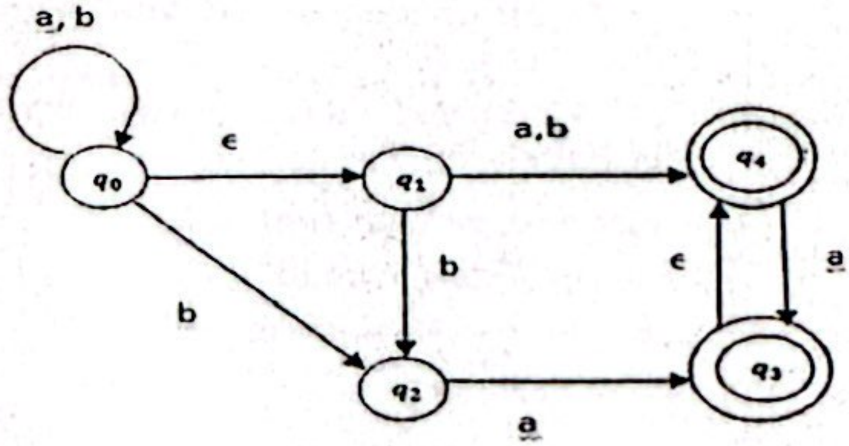
Candidates are required to give their answers in their own words as far as practicable.

The figures in the margin indicate full marks.

Attempt all the questions.

1. a) Explain finite automata along with is uses and applications. Construct a DFA that recognizes language L that accepts the set of strings that neither has "aa" nor "bb" as substring over $\Sigma = \{a, b\}$ and test your design with a valid string. 7

   b) Convert a DFA equivalent to NFA as shown: 8



2. a) Define pumping Lemma. Show that $L=\{a^n b^{2n} : n>1\}$is not regular using pumping lemma for regular language. 7

   b) Define Derivation Tree. When a grammar is called ambiguous? Explain with an Example. 8

3. a) Reduce the following CFG to CNF 7

   S→aB/bX

   A→Bad/bSX/a

   B→aSB/bBX

$X \to SB/aBx/ad/B$

b) Define PDA. Design a PDA which accepts the language $L=\{a^n b^{m+n} c^m | n,m \geq 1\}$. 8

OR

Why PDA is designed? Design a PDA to accept set of all palindromes over alphabets $\Sigma=\{0,1\}$.

4. a) For the grammar given by $G=(V,\Sigma,P,S)$ 8

where, $V=\{S\}$

$\Sigma=\{a,b,c\}$

and P is defined as $S \to aSa$, $S \to bSb$, $S \to c$

Design the PDA for the following grammar

b) Define a Turing Machine. Design a TM that accepts the language 7

$L=1^n 2^n 3^n | n \geq =0$.

5. a) Design a TM which computes the function $f(m)=m+1$ for each m that belongs to set of natural numbers. 7

b) Briefly explain about properties of CFL. Describe briefly about recursive and recursively enumerable language. 8

6. a) Describe Church's Hypothesis. Also illustrate your understanding of Halting Problem. 8

b) Explain computational complexity. What are Space and Time complexity? 7

7. Write short notes on: **(Any two)** 2×5

a) Multi-tape Turing Machine

b) Integer bin-packing problems

c) Regular expressions

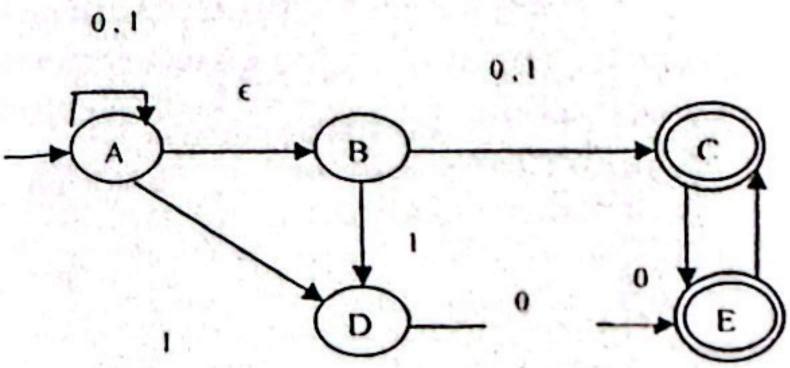
POKHARA UNIVERSITY

Level: Bachelor | Semester: Fall | Year : 2021
Programme: BE | Full Marks: 100
Course: Theory of Computation | Pass Marks: 45
Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.
Attempt all the questions.

1\. a) Differentiate between DFA and NFA? Design a DFA that accepts the language given by L={w∈{0,1}* : w contains '00' or '11' as substring}. Hence test your design for 101001. 8

b) Construct a DFA equivalent to NFA as shown: 7



2\. a) Illustrate the simplification algorithm for a Context Free Grammar (CFG). Convert the grammar with below productions into Chomsky Normal Form. 8

$S \rightarrow abSb \mid a \mid aAb$

$A \rightarrow bS \mid aAAb$

b) Let G be the grammar 7

$S \rightarrow aB \mid bA$

$A \rightarrow a \mid aS \mid bAA$

$B \rightarrow b \mid bS \mid bBB$

Construct the leftmost derivation and the rightmost derivation trees using G for an input string "aaabbababba".

3. a) *Define PDA with block diagram? Design a PDA which accepts the language $L=\{a^n b^{2n} : n>=1\}$ and test for strings aabbbb and aab.* 8

b) *Prove that each context-free language is accepted by some pushdown automaton.* 7

4. a) What is pumping lemma for CFL? Show that language $L=\{a^n b^n c^n : n>0\}$ is not a CFL using pumping lemma for CFL. 7

b) Design a deterministic Turing machine to accept the language $L = \{0^i 1^i 2^i \mid i \geq 0\}$. 8

5. a) How can you represent Turing machine for computing a function? Show that the function f(n)=n+1, is Turing computable 7

b) Construct E-NFA for the regular Expression (0+1)*1(0+1) 8

6. a) When are problems said to be NP-Complete? Illustrate with suitable examples. 7

b) Write about church Turing thesis and universal Turing machine. 8

7. Write short notes on: **(Any two)** 2×5

a. Tractable vs. Intractable problem
b. K-tape Turing machine
c. Language and Alphabets

POKHARA UNIVERSITY

Level: Bachelor	Semester: Fall	Year : 2020
Programme: BE		Full Marks: 100
Course: Theory of Computation		Pass Marks: 45
		Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable.

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Attempt all the questions.

1. a) What is set? Show the different types of set operation with examples. 7

   b) Explain finite automata along with is uses and applications. Construct a DFA that recognizes language L that accepts the set of strings containing exactly four 1's in every string over alphabet $\Sigma=\{0, 1\}$and test your design with a valid string. 8

2. a) Find the regular expression from NFA M= (K, Σ, Δ, s, F), where K= $\{q_0, q_1, q_2, q_3, q_4, q_5\}$, $\Sigma=\{a, b\}$, s = q_0, F = { q_5} and Δ is given as follows. 8

δ / Σ	a	b	∈
→q_0	-	-	q_1
q_1	q_2	q_4	-
q_2	-	q_3, q_4	-
q_3	q_3	q_3	q_5
q_4	q_2, q_4	-	-
*q_5	-	-	-

   b) For the grammar given by G=(V,Σ,P,S) 7

   where, V={S}

   Σ={a,b,c}

   and P is defined as S→Xa/Yb, X→Sb/b, Y→Sa/a

   Design the PDA for the following grammar.

3. a) *What is CFG? Design CFG for language $L=\{wcw^R : w \in \{a,b\}^*\}$. Test the grammar for derivation of baacaab and also draw equivalent parse tree.* 8

b) *What is CNF? Convert following CFG into CNF, $G=(V,\Sigma,R,S)$ where* 7

$V=\{S,A,B\}$,

$\Sigma=\{a,b\}$,

$R=\{S\rightarrow aAB|AaB|B,\ A\rightarrow aA|\epsilon,\ B\rightarrow ab|bA\}$

4. a) In what aspect PDA is stronger than finite automata? State closure properties of context free grammar. 7

b) State the Pumping lemma for context free language. Prove that the language $L=\{0^n1^n2^n \mid n>=0\}$ is not context-free language. 8

5. a) Design a Turing machine that transforms #w# to ##w#. Where # represents blank symbol and w is any string of a and b. 7

b) What is configuration of Turing machine? Show that $f(x) = x+1$ is Turing computable. 8

6. a) Write about church turing thesis and universal turing machine. 7

b) Explain in brief the P and NP complete problems with suitable examples. 8

7. Write short notes on: **(Any two)** 2×5

a) Relations and Functions

b) K-tape turing machine

c) Cartesian product, Relation and Function

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POKHARA UNIVERSITY

Level: Bachelor	Semester: Spring	Year : 2019
Programme: BE		Full Marks: 100
Course: Theory of Computation		Pass Marks: 45
		Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable.

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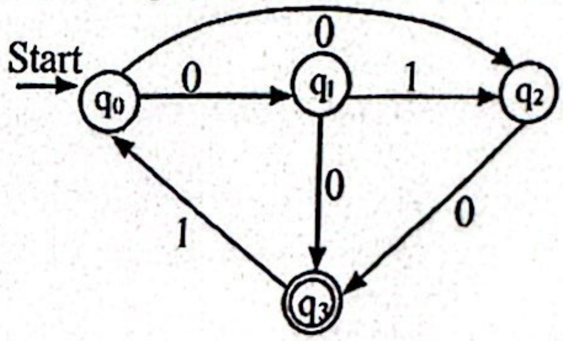
Attempt all the questions.

1. a) Find the regular expression for the following Finite Automata **8**



b) Convert above figure from NDFA to DFA. **7**

2. a) Using the principle of Context Free Grammar, capture the expression $\left(x_1 + \frac{x_2}{x_1}\right) * (x_1 * x_2 + x_1)$and draw its parse tree. **7**

b) What do you mean by Ambiguous Grammar? Explain with example. Remove the €-production(Null) from the following grammar. **8**

$$S \rightarrow ABAC$$
$$A \rightarrow aA/€$$
$$B \rightarrow bB/€$$

C-c

3. a) What is instantaneous description of PDA? Design a PDA which accepts the language L={w∈{0,1}* : w has equal number of 0's and 1's}. **8**

b) Write about closure properties of context free language. **7**

4. a) How can you represent a Turing Machine? Show that the function, f (n) = x+1, is Turing computable. **7**

b) Design a Turing Machine as a right shift machine which transforms #w# into ##w# with alphabet ∑={a,b,#}. **8**

5. a) What is recursive and recursively enumerable language? Show that the union of two recursive language is also recursive. **8**

b) Write about church turing thesis and universal turing machine. 7

a) How does computability differ from complexity theory? Describe about the time and space complexity. 7

b) State the Pumping lemma for context free language. Prove that the language $L=\{a^n b^n c^n | n>=0\}$ is not context-free language. 8

Write short notes on: **(Any two)** 2×5

a) Undecidability

b) Universal Turing Machines

c) Relations and Functions

POKHARA UNIVERSITY

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Course: Theory of Computation		Pass Marks: 45
		Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable.

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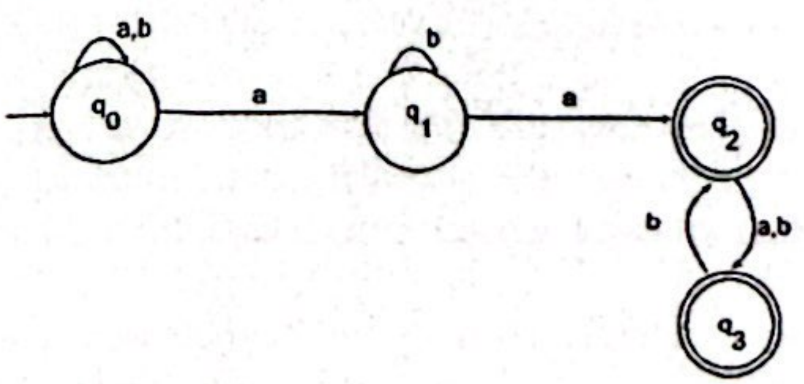
Attempt all the questions.

1. a) Convert the following NFA to its equivalent DFA. 7



b) Define pumping Lemma. Show that $L = \{a^n b^{2n} : n \geq 1\}$ is not regular using pumping lemma for regular language. 8

2. a) Define language of context free grammar L (G). Write CFG for L= {w∈ {a, b}*: w has equal number of 'a' and 'b'}. Hence derive any string using same grammar and also draw parse tree. 7

b) Convert following CFG into CNF. G= (V, Σ, R, S), where 8
V={S, A, B, a, b},
Σ = {a, b},
R= {S→ASB|b, A→AbS|a|∈, B→SbS|A|bb}.

3. a) In what aspect PDA is stronger thán finite automata? State closure properties of context free grammar 7

b) State the Pumping lemma for context free language. Prove that the language L= $\{0^n1^n2^n / n>=0\}$ is not context-free language. 8

4. a) Define Turing machine. Design a Turing machine that accepts the language L=$1^n2^n3^n$ | n>=0. 8

b) How can you represent turing machine for computing a function? Show that the function f(n)=n+1, is turing computable. 7

5. a) What is recursive and recursively enumerable language? Show that the union of two recursive language is also recursive. 8

b) Write about church turing thesis and universal turing machine. 7

6. a) Using De Morgan's Law, prove the following: 7

i) $(A \cup B)' = A' \cap B'$

ii) $(A \cap B)' = A' \cup B'$

b) State computational complexity theory? Explain class NP with suitable example. 8

7. Write short notes on: (Any two) 2×5

a) Elimination of useless symbols

b) Regular expression

c) Pumping lemma for CFL