POKHARA UNIVERSITY

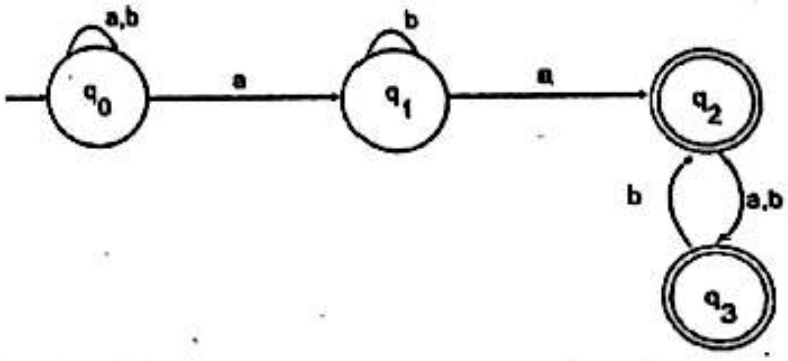
Level: Bachelor
Programme: BE
Course: Theory of Computation

Semester: Fall

Year : 2019
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) 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
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 than finite automata? State closure properties of context free grammar

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,

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

5. a) What is recursive and recursively enumerable language? Show that the union of two recursive language is also recursive. 1

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

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

i) $(A \cup B)' = A' \cap B'$ 1

ii) $(A \cap B)' = A' \cup B'$ 1

b) State computational complexity theory? Explain class NP with suitable example. 1

7. Write short notes on: (Any two) 2½

a) Elimination of useless symbols

b) Regular expression

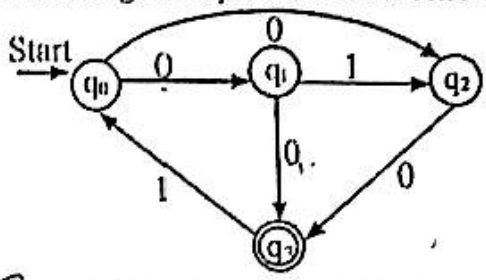
c) Pumping lemma for CFL

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.
The figures in the margin indicate full marks.
Attempt all the questions.

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



b) Convert above figure from NDFA to DFA.

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.

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

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

C-c

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

b) Write about closure properties of context free language.

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

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

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

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

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

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.

7 Write short notes on: (Any two) 2×5

a) Undecidability
b) Universal Turing Machines
c) Relations and Functions

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.
The figures in the margin indicate full marks.
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 $M=(K, \Sigma, \Delta, s, F)$, 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 $G=(V,\Sigma,P,S)$ 7
   where, $V=\{S\}$
   $\Sigma=\{a,b,c\}$
   and P is defined as $S\rightarrow Xa/Yb$, $X\rightarrow Sb/b$, $Y\rightarrow Sa/a$
   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,∑,R,S) where 7

V={S,A,B},

∑={a,b},

R={S→aAB|AaB|B, A→aA|c, B→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 $L=\{0^n1^n2^n | n>=0\}$ 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

Write short notes on: (Any two) 2×5

a) Relations and Functions

b) K-tape turing machine

c) Cartesian product, Relation and Function

POKHARA UNIVERSITY

Level: Bachelor | Semester – Spring | Year: 2020

Program: BE | Full Marks: 70

Course: Theory of Computation | Pass Marks: 31.5

Time: 2 hrs

Candidates are required to answer in their own words as far as practicable

The figures in the margin indicate full marks.

Group - A: Attempt all questions. (5×10=50)

Q N 1 How can you compare finite automata with today's sophisticated digital computer? What are polynomial and non-polynomial class problems? Explain with real world examples 10

OR

Discuss about CFG and the significance of Parse Tree. You are given a Context Free Grammar G=(v, ∑,P, S), where: V={S,A,B} , ∑ = {a,b} and the production rules are 10

S→aB |ab
A→aAB |a
B→aBb |b

Prove that the given grammar is ambiguous.

Q N 2 If a language is regular, all sufficiently long string in the language can be pumpedand the resulting string will still be in that language. The significance of the theory of pumping lemma is that its contrapositive gives us a way to prove the certain languages are not regular. Is there another theory of pumping lemma related to context free grammar? If so, discuss briefly about it.Using this concept, show that the language L={$a^{2n}b^n$, n≥0} is not context free. 10

Q N 3 CFG are always not in an optimized form. They can be simplified to normal forms like CNF and GNF. Briefly introduce CNF and GNF. Consider a grammar G=(V, ∑,P, S), where: V={S,A,B} , ∑ = {a,b} and the production rules are: 10

S→bA |aB
A→bAA |aS |a
B→aBB |bS |b

Find an equivalent grammar in CNF. While doing so, discuss the necessary steps clearly.

Q N 4 There are certain turing machines that can be programmed, about the same way that a general purpose computer. What would you call that? Explain with its characteristics and working principle. 10

Q N 5 Halting problem is undecidable. Do you agree? Illustrate your understanding about the Halting problem. Also show that the complement of recursive language is also recursive. Then design appropriate machine that recognizes L. . 10

Group - B: (1×20=20)

Q N 6 In this subject you have studied about various machines like Finite automata, Pushdown automata and Turing machine with ascending order of computational power. Till now, is there exist any other device which is stronger than Turing machine? If no, how can you say that Turing machine is ultimate calculating mechanism? Hence present your idea about problems which are solvable in principle but cannot be solved in practice. 20

POKHARA UNIVERSITY

Level: Bachelor | Semester: Spring | Year : 2024
Programme: BE | Full Marks:100
Course: Theory of Computation (New) | Pass Marks: 45
Time : 3hrs.

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

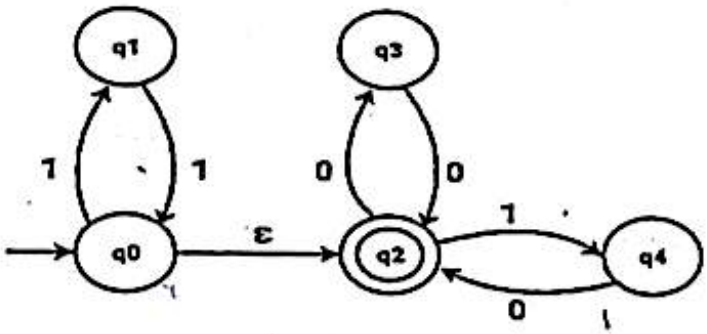
The figures in the margin indicate full marks.

Attempt all the questions.

1. a) State and prove the pigeonhole principle. Prove by mathematical induction that $n^2 - 3n + 4$ is even and true for all positive integers. 7

   b) Define Finite State Automata. Construct a DFA that recognizes. Language L that accepts the set of strings that starts and ends with different symbols over $\sum$={a, b}and test your design with a valid string. 8

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



   b) Describe the decision properties of regular languages. 8

3. a) What is CFL? Convert the given Grammar into CNF. 7
   S->ABAB A-> aA|ϵ B->bB|ϵ

   b) Design a PDA for the following language $L=\{a^n b^{2n+1} : n>0\}$ also check it for aabbbbbbb and aabbb. 8

OR

State the rules followed to design a PDA for a given CFG. Design a PDA that accepts L= $\{a^{3n} b^n : n>0\}$ and check the string aaaaaabb.

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) PDA is Stronger than FA and for every CFG there is an equivalent PDA. Justify this statement with an example. 8

5. a) Design a TM for L={WW^R: W^R is reverse of w ε (a,b)* for both even and odd palindrome}. 8

b) Differentiate between FA, PDA, and TM on the basis of string acceptance. Also, explain why does TM is considered functionally stronger among all of these? 7

OR

"Turing machine is believed to be the ultimate calculating mechanism", elaborate with the help of Church Turing thesis". Also, show that the function f(n)=n+2 is Turing computable.

6. a) Elaborate the properties of recursively enumerable and recursive languages. 8

b) Differentiate the time complexity of a Turing machine and time complexity of a language decision problem. Define the complexity classes *P* and *NP*. 7

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

a) Universal Turing Machine

b) Church-Turing Thesis

c) Halting Problem

POKHARA UNIVERSITY

Level: Bachelor | Semester : Spring | Year : 2023
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.

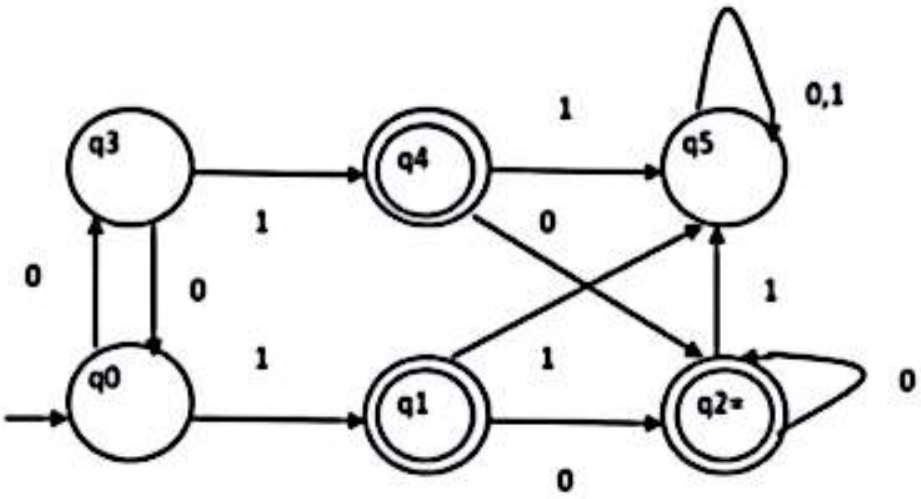
1. a) Define alphabet, string, and language with examples. 5
   b) Design a DFA for the language L = {w ∈ (a, b)* : w ends with bb} 5
   c) Define an ambiguous grammar. Check if below grammar is ambiguous: 5

   S→aB | ab

   A→aAB | a

   B→ABb | 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

3. a) Can production rules realize Context Free Grammar for the language given by L={$a^m b^n$: m>0 and n>0}. How? 7

b) Explain the process of simplifying Context Free Grammar. Simplify the following CFG, G=(V,∑,R,S) Where 8

V= {S, A}

∑ = {a, b}

R = { S->aAB | AaB | B

A->aA | ϵ

B->ab | bA}

4. a) Explain the concept of "epsilon transitions" in a Pushdown Automaton. How do they affect the computation? 7

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

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. 7

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*. 8

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

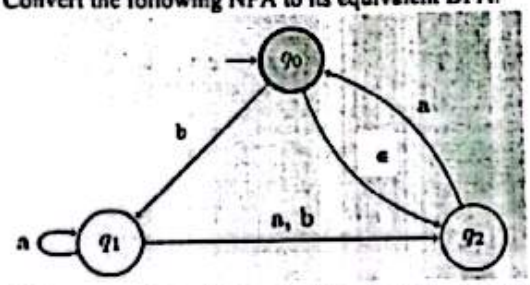
c) The Halting problem

POKHARA UNIVERSITY

Level: Bachelor | Semester: Spring | Year : 2024
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) What is function? Explain its types with examples. 7
   b) Differentiate between DFA and NFA? Design a DFA that accepts the language given by L={w∈{a,b}* : w contains neither 'aa' nor 'bb' as substring}. Hence test your design for abaabb. 8
2. a) Convert the following NFA to its equivalent DFA. 7



   b) Define pumping Lemma for regular language. Show that $L=\{a^n b^{2n}: n>1\}$ is not regular using pumping lemma for regular language. 8
3. a) What is CFG? Design CFG for language $L=\{a^m b^n : m>=1, n>=1\}$. Test the grammar for derivation of aaaabbb and also draw equivalent parse tree. 8
   b) Convert the following grammar into Chomsky Normal form. 7

   S→ bAD
   A→ aB/bAB
   B→ b
   D→ ε (Null)

4. a) Define PDA with block diagram. Design a PDA which accepts the language $L=\{a^{4n} : n>=1\}$ and test for strings aaaaaaaa and aaaaaa. 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
5. a) Define Turing machine. Design a Turing machine that accepts the language $L=\{a^n b^n c^n : n>=0\}$. 8
   b) How does a Turing machine compute a function of natural numbers? Describe. Show that the function $f(n) = n + 2$ is computable. 7
6. a) State the halting theorem and give the outline of its proof. 7
   b) What are P, NP and NP-Complete problems? Explain with examples. 8
7. Write short notes on: (Any two) 2×5
   a) Simplification of CFG
   b) Recursive and Recursively Enumerable Language
   c) Decision algorithm for CFL