POKHARA UNIVERSITY

Level: Bachelor | Semester: Fall | Year : 2013
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.

a) Is it required to convert an $\varepsilon - NFA$ to its equivalent DFA before writing a computer program? Justify your answer with a conversion example. 7

b) Describe the representations of Non-deterministic Finite Automata (NFA) and Deterministic Finite Automata (DFA) with the help of the Training Diagram (TD) and Transition Table (TT). Construct an NFA that accepts the language described by the Regular Expression $R = abc(a/b/c)^*cba$. 8

a) Use the pumping lemma to identify that the given language $L = \{a^n b^n | n \geq 0\}$ is Context Free. 7

b) When the grammar is ambiguous? Show that the given grammar is ambiguous: S->aB/ab, A->aAB/a, B->ABb/b. 8

a) How do you define the sentence and the sentential form in a CFG? Convert the grammar with the following set of production rules into Chomsky Normal Form (CNF). 8

$$S \rightarrow ABaC$$
$$A \rightarrow BC$$
$$B \rightarrow b \backslash \lambda$$
$$C \rightarrow D \backslash \lambda$$
$$D \rightarrow d$$

b) Reduce the following grammar G to CNF. S→aAD, A→aB/bAB, B→b, D→d 7

a) Show that any the Context Free Language (CFL) is closed under union, concatenation and star-closure. 7

b) Show that the language $L = a^n b^n c^n / n \geq 1$ is not context free.

5. a) Design a Turing machine that accepts the language
$L = 1^n 2^n 3^n / n \geq 0$

b) What are two computational complexities that matter in designing efficient program?

6. a) State and Illustrate the Church Turing Hypothesis.

b) Differentiate the Recursive Language from the Recursively Enumerable Language.

c) What are the NP-Hard and NP-Complete problem? Illustrate.

7. Write short notes on: (Any two)

a) Language of Finite Algorithm.

b) Decision algorithms for regular set.

c) Universal Turing machine.

POKHARA UNIVERSITY

Level: Bachelor | Semester: Spring | Year : 2013
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.

a) Differentiate the Non-deterministic Finite Automata (NFA) from the Deterministic Finite Automata (DFA) with the help of the Transition Diagram (TD) and Transition Table (TT). Construct an NFA that accepts the language $L = \{d^n : n \geq 1\} \cup \{b^n a : n \geq 1\}$. 7

b) Convert the NFA M=($\{q_0,q_1,q_2,q_3\}$,$\{0,1\}$, δ, q_0,$\{q3\}$) to its equivalent DFA. δ is given by 8

States	0	1
q_0	q_0, q_1	q_0
q_1	q_2	q_1
q_2	q_3	q_3
q_3	-	q_4

a) State and prove pumping lemma for regular sets. 7

b) Reduce the following CFG to Chomsky Normal Form. 8

S aB/bX
$A \longrightarrow Bad/bSX/a$
$B \longrightarrow aSB/bBX$
$X \longrightarrow SB/aBx/ad/B$

a) When a grammar is called ambiguous? Prove that the following grammar is ambiguous. 7

S ⟶ AB/aaB
A ⟶ a/Aa
B ⟶ b

b) Construct a Push Down Automata for the following language. 8

$L = \{a^n b^{n+1} / n = 1, 2, 3.....\}$

4. a) Only state the pumping lemma for CFL. Show that the language $L=\{ a^n b^n c^n / n>=1 \}$ is not a context free language.

   b) How do you identify the word w over alphabet $\sum$ is generated by a given CFG? Illustrate.

5. a) Distinguish Turing Machine from the Finite Automata and the Push Down Automata.

   b) Explain briefly about recursive and recursively enumerable language.

6. a) What are two computational complexities that matter in designing efficient program? Explain them.

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

7. Write short notes on: *(Any Two)*

   a) Church's Hypothesis

   b) Universal Turing Machine

   c) Derivation Tree.

POKHARA UNIVERSITY

Level: Bachelor | Semester: Fall | Year : 2014
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.

a) Consider the epsilon- NFA given by the following transition table. 8

Q\Σ	0	1	ε
→q0	q0	ϕ	q1
q1	ϕ	q1	q2
* q2	q2	ϕ	ϕ

Draw the transition diagram and find its equivalent NFA without epsilon moves.

b) Define regular expression. Construct a finite automata equivalent to the following regular expression. 7
(a)* a (b+aa) * b)* a (b + aa)* a

a) State the pumping lemma for regular set. Show that L = {0^i1^i i>0 } is not regular. 7

b) Explain Chomsky classification of language. If G is the grammar S→ SbS | a, show that G is ambiguous. 8

a) Show that the grammar S→aB| ab, A→aAB | a, B →AB | b is ambiguous. 7

b) Why was Pushdown Automata (PDA) introduced? Construct a PDA that accepts the language L={$x^iy^jz^k$: i,j,k>=0 and i=k or j=k}. 8

a) State and prove pumping lemma for Context Free Language (CFL). 7

b) Check if the language L={0^m1^m:m>=0} is regular or not. 8

a) Construct a Turing Machine that recognizes the language L= { $p^nq^mr^n$:m, n>=0}. 7

b) Describe the extensions of Turing Machine. 8

a) What is 'Undecidability' in computation? Explain about 5

undecidable problems of Turing Machine.

b) Differentiate between Recursive and Recursively enumerable languages.

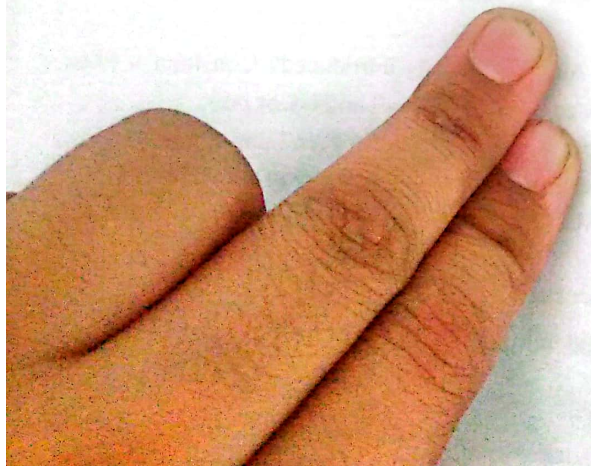
c) Define class P and class NP. What is NP-completeness?

Write short notes on: **(Any two)**

a) Halting problem

b) CNF & GNF

c) Church's Thesis.



POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Theory of Computation

Semester: Spring

Year : 2014
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.

a) Define DFA and NFA. Design a FA which accepts the language L {w/w has both an even number of 0's and an even number of 1's over alphabet Σ={0,1}. 8

b) Consider the NFA ($\{q_0,q_1,q_2\}$, {a,b,Є}, δ, q_0, $\{q_1\}$) with state transition table given as follows: 7

δ	a	b	Є
q_0	$\{q_1\}$	Φ	Φ
q_1	$\{q_1\}$	Φ	$\{q_2\}$
q_2	Φ	$\{q_0\}$	Φ

Convert this NFA to its equivalent DFA.

OR

a) Construct an NFA for the regular expression **01*+1**. 8

b) State and prove the pumping lemma for regular sets. 7

c) Prove that the language L={a^n ba^n for n=0,1,2,3,...} is not regular. 5

a) Define Parse Tree. When is a grammar called ambiguous? Explain with example. 5

b) Describe the normal forms with suitable examples. 5

c) Convert the following CFG to CNF. 5

$S \rightarrow abSb/a/aAb$

$A \rightarrow bS/aAAb$

a) Design a Pushdown Automata which accepts the language L = {w ∈ {a, b}* / w has equal number of a's and b's}. 8

b) Prove that the family of context free language is not closed under intersection and complementation.

OR

a) Explain the decision algorithms for context free languages.

5. a) What is a Turing Machine? Describe any three types of Turing Machine.

b) Discuss the Recursive function theory. Prove that the union of two recursive languages is recursive.

6. a) Describe the Computational Complexity theory.

b) What are tractable and intractable problems? Explain the NP complete problems with suitable examples.

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

a) Elimination of ∈ transition

b) Pushdown Automata

c) Church's Hypothesis

d) Universal Turing Machine

POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Theory of Computation

Semester: Fall

Year : 2015
Full Marks: 100
Pass Marks: 45
Time : 3hrs.

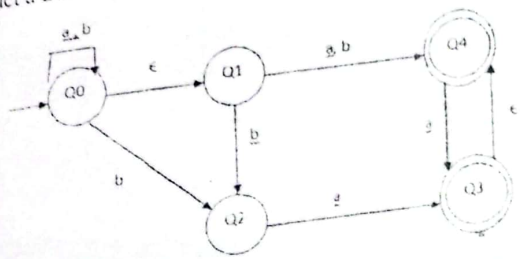
Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.
Attempt all the questions.

1. Define Regular Expression. Write regular expression for language L= {w ∈ {a , b}*: number of a is divisible by 3} 8

2. a) What is a finite automaton? Design a DFA that accepts the language given by L= {w ∈ {0, 1}*: w has neither '00' nor '11' as substring}

b) Hence test your design for 01011010.

c) Construct a DFA equivalent to NFA as shown:



3. a) What is CFG? Design CFG for language L(G)={$a^m b^n$:m>=n} along with parse tree. 7

b) State CNF and GNF. Convert following CFG into CNF, G=(V,∑,R,S) where 8
V={S,A,B,C,a,b,c},
∑={a,b,c},
R={S→ABA|abA|BC, A→aA|ϵ, B→baB|c, C→aC}

4. a) Formally define a PDA. Design a PDA which accepts the language 8

L={w∈{x,y}* | w has equal number of x's and y's}

b) State pumping lemma for context free language. Show that $\{a^n b^n c^n \mid n>=1\}$ is not context free language.

5. a) Define Turing machine. Design a Turing machine that accepts the language $L=\{2^n 3^n \mid n>=0\}$.

b) What is K-tapes Turing machine? Show that any K tapes Turing machine can be converted to an equivalent one tape Turing machine.

6. a) What is recursive and recursively enumerable language? Show that the complement of recursive language is also recursive.

b) Write about Church-Turing thesis. Explain about encoding of turing machine.

7. a) Write about computational complexity theory. What are tractable and intractable problems?

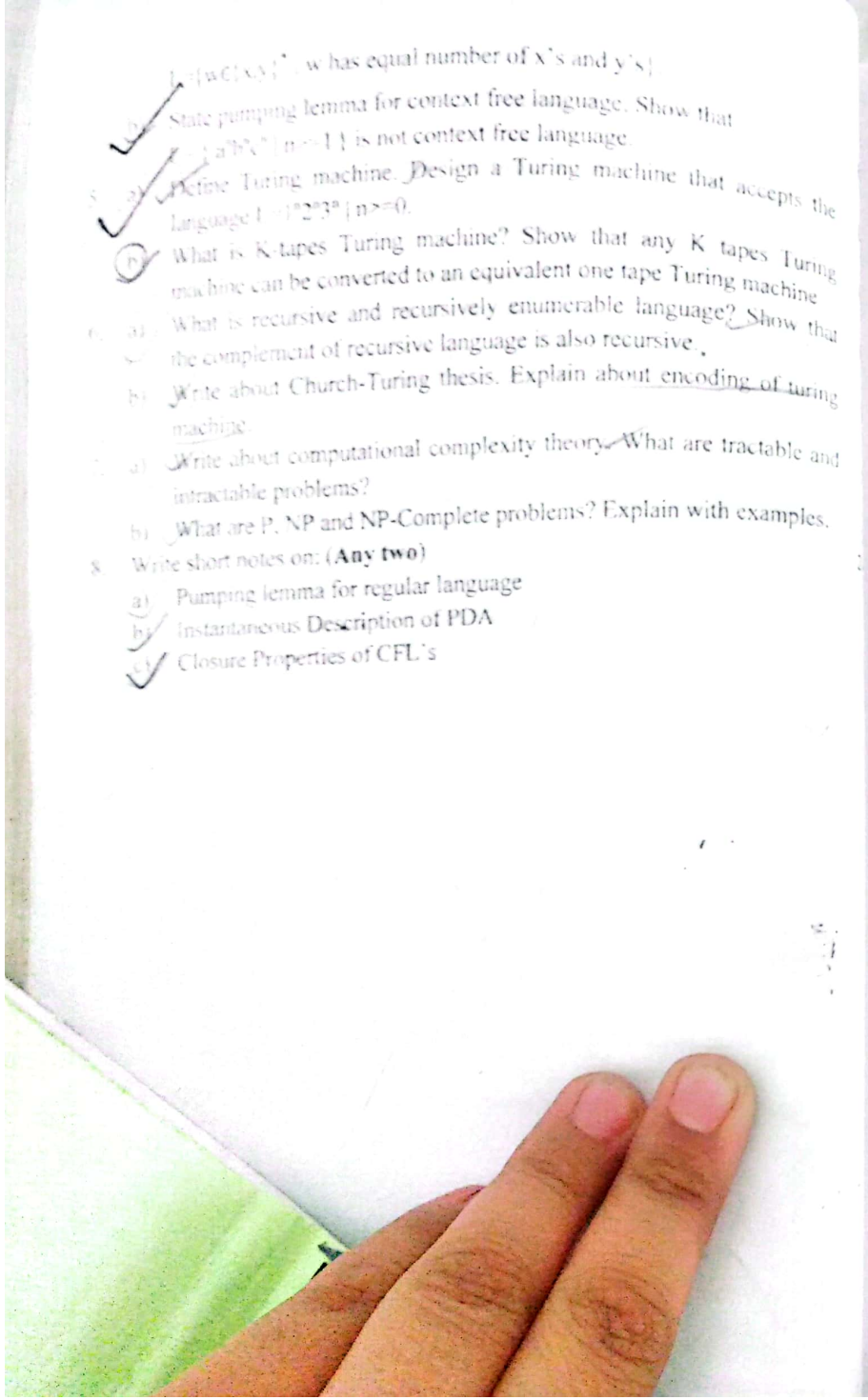
b) What are P, NP and NP-Complete problems? Explain with examples.

8. Write short notes on: **(Any two)**

a) Pumping lemma for regular language

b) Instantaneous Description of PDA

c) Closure Properties of CFL's



POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Theory of Computation

Semester: Spring

Year : 2015
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) Eliminate the epsilon transition from the DFNA $N=(\{1,2,3\}$ 8
$\{a,b,c\}, \delta, 1, \{3\})$ where the transition function is

State	a	b	c	Epsilon
1	2	∅	{1,3}	3
2	2	3	∅	
3	3	∅	∅	2

b) State and prove the pumping lemma for regular sets. 7

2. a) What is ambiguous grammer? Show that given grammer is ambiguous: 8

S →aB|ab
A→aAB|a
B →ABb|b

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|ϵ, B→ab|bA}

3. a) Design a Pushdown automata which accepts the language 8
L={w∈{a,b}*/w has equal number of a's and b's}.

b) Sate pumping lemma for CFL's. Mention the closure properties of 7
CFL's.

4. a) How can you represent Turing machine for computing a function? 8
Show that the function f(n)=n+1, is Turing computable.

b) Define Turing machine. Design a Turing machine that accepts the language $L = \{1^n 2^n 3^n \mid n>=0\}$

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

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

6. a) Write about church Turing thesis and Universal Turing machine.

b) In what aspect PDA is stronger than finite automata? State the closure properties of context free grammar.

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

a) Elimination of ϵ transition

b) Alphabet and Language

c) The Halting Problem

POKHARA UNIVERSITY

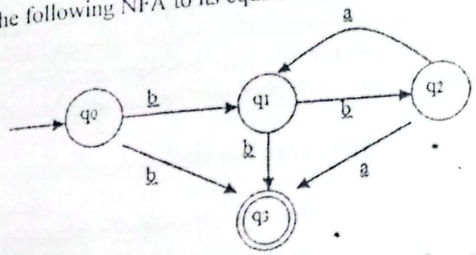
Level: Bachelor
Programme: BE
Course: Theory of Computation

Semester: Fall

Year : 2016
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. 8



b) State pumping lemma for regular expression. Mention the closure properties of regular expression. 7

2. a) Compare and contrast class P and class NP problems with examples for each. 8

b) Define Parse Tree. When a grammar is called ambiguous? Explain with example. 7

3. a) Define Chomsky Normal Form. Reduce the following grammar into CNF. 8

$S \rightarrow bA/aB$
$A \rightarrow bAA/aS/a$
$B \rightarrow aBB/bS/a$

b) Write a brief description of push down automata, with suitable example. 7

4. a) Design a Pushdown Automata which accepts the language $L = \{w \in \{a, b\}^* / w$ has equal number of a's and b's$\}$. 8

b) State pumping lemma for CFL. Show that the language $L = \{a^n b^n c^n / \ldots$ 7

$n>=0\}$ is not a context free language.

OR

"PDA is stronger than FA". Explain this statement.

5. a) How can you design a turing machine? Provide an example design. Also, state your understanding for turing machine extensions.

b) What is a Turing Machine? Describe any three types of Turing Machine.

6. a) What is recursive and recursively enumerable language? Write some properties of recursively enumerable language.

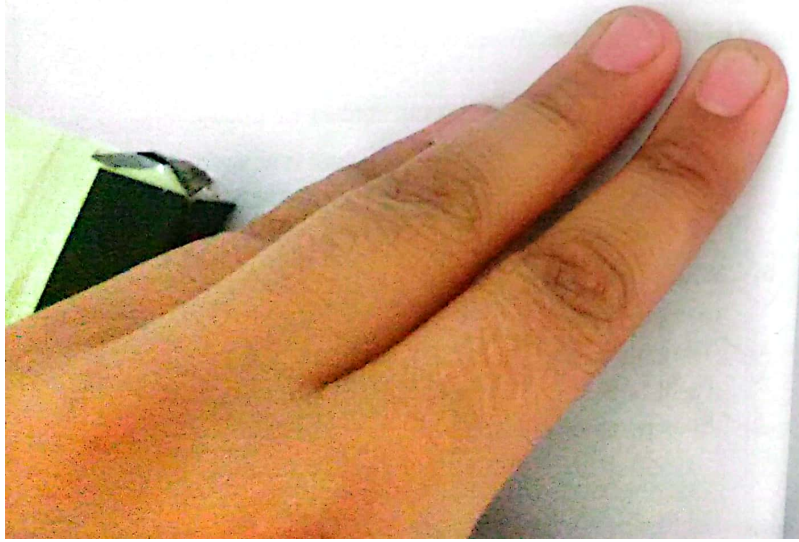
b) Describe church's Hypothesis. Also, illustrate your understanding of halting problem.

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

a) Alphabet and Language

b) Finite Automata

c) Computable Languages.



POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Theory of Computation

Semester: Spring

Year : 2016
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) Give the formal definition of DFA. Design a FA that accepts a set of string such that every string ends in 00, over alphabet {0,1}. 7

b) Write a CFG for the language $L(G)=\{WW^R : W \in \{0,1\}^*\}$. 8

2. a) Construct finite automata for the following regular expression. 8
a(a+b)*bb

b) Define regular language. State and prove pumping lemma for context free language. 7

3. a) Define ambiguity of a grammar. Prove that the following grammar is ambiguous 7
S→aB / ab
A→aAB / a
B→ABb / b

b) Consider the grammar G=(V, Σ, P, S), where, 8
G={S,A,B}
Σ={a, b} and the productions P are:
S→ bA | aB
A→ bAA | aS | a
B→ aBB | bS | b
Find an equivalent grammar in CNF.

4. a) Define push down automata. Design a PDA for the following language, $L = \{a^n b^{2n} : n \geq 0\}$. 7

b) Design a Turing machine which compute the function $f(m)=m+1$ for each m that belongs to the set of natural numbers. 8

5. a) Explain the properties of recursive and recursively enumerable languages. 7

b) Why PDA is stronger than FA? State the closure properties of context free languages.

6. a) Explain space complexity and time complexity with suitable examples.

b) Differentiate between tractable and intractable problems. Also write some examples of NP completeness problems.

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

a) Universal Turing Machine

b) Representation of TM by Instantaneous Description(ID)

c) Halting problems in TM

POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Theory of Computation

Semester: Fall

Year : 2017
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) Give the formal definition of DFA. Design a FA that accepts a set of string such that every string ends in 00, over alphabet {0,1}. 7

   b) Construct finite automata for the following regular expression a(a+b)*bb 8

2. a) Describe CNF and GNF in detail. Convert following grammar into CNF: 8

   S→bA/ aB
   B→bAA/aS/a
   C→c

   b) Define ambiguity in Grammar. Check ambiguity of the Grammar: 7

   S→aB/bA
   A→aS/bAA/a
   B→aBB/bS/b

3. a) Define derivation tree. Differentiate between right and left derivation tree with suitable example. 7

   b) Define push down automata. Design a PDA for the following language, $L = \{a^n b^{2n} : n > 0\}$. 8

4. a) State the Pumping lemma for context free language. Explain about decision properties of CFLs. 8

   b) Why PDA is stronger than FA? State the closure properties of context free languages. 7

5. a) How can you represent a Turing Machine? Describe about Universal Turung Machine. 7

   b) Design a Turing machine for computing a function f(w = w#w). 8

6. a) Explain the properties of recursive and recursively enumerable 7

languages.

b) Differentiate between tractable and intractable problems. Also write some examples of NP completeness problems

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

a) Relation and Function

b) Time and Space Complexity

c) Halting Problem

POKHARA UNIVERSITY

Level: Bachelor | Semester: Spring | Year : 2017
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 Finite Automata .Design a FA that accepts set of strings which doesn't starts with 0 and ends with 1 over the given alphabet ∑={0,1}. 8
   b) Minimize the following DFA by using state minimization method. Where ⟶ represents initial state and * represents final state. 7

δ / ∑	0	1
⟶q_0	q_1	q_2
*q_1	q_1	q_3
q_2	q_2	q_2
*q_3	q_5	q_2
*q_4	q_4	q_2
*q_5	q_4	q_2
q_6	q_5	q_6
q_7	q_5	q_6

2. a) What are applications of CFG? Write CFG for L = {w∈ {a, b}*: w is a palindrome} and also draw parse tree for the derivation of any string. 8
   b) Define Ambiguous Grammar. Prove that following grammar is ambiguous. 7

   S→iCtS
   S→iCtSeS
   S→a
   C→b

3. a) Define push down automata. Explain equivalence of push down automata with context free grammar,with suitable example. 8
   b) Design a PDA that accepts those strings "having total number of a 7

equal to the sum of number of b and c with sequence of a,b,c (i.e. $a^i b^j c^k : i=j+k$). Hence test your design for the string "aaaabbcc".

4. a) Explain properties of context free language. Show context free languages are closed under union.

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

5. a) Design a Turing machine that works as a simple eraser, which changes every non-blank symbols to blank with alphabet $\Sigma = \{0, 1, \#\}$. Hence test your design for #0101# to ######.

   b) Define universal Turing machine and explain its encoding technique in detail with suitable example.

6. a) Explain in brief the P and NP complete problems with suitable examples.

   b) Convert following CFG into CNF.

   G= (V, $\sum$, R, S), where

   V={S, A, B, a, b}

   $\sum$ = {a, b}

   R={S ASB|ϵ,

   A aAS|a,

   B SbS|A|bb}

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

   a) Alphabet and Language

   b) Church's thesis

   c) Applications of Regular expressions

POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Theory of Computation

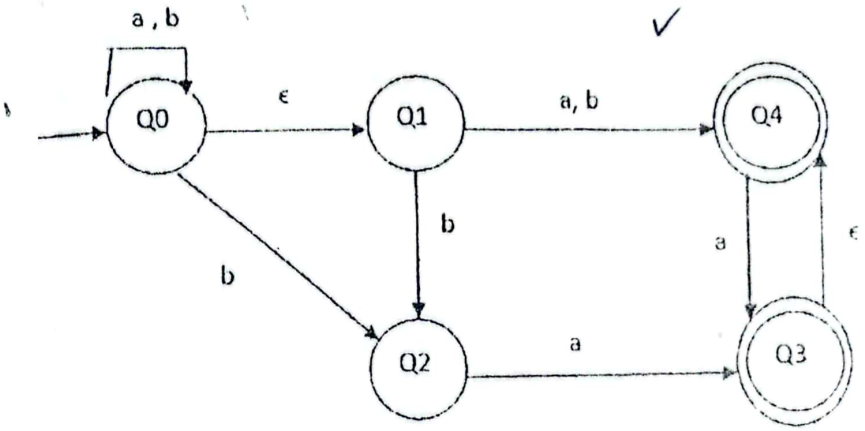
Semester: Fall

Year : 2018
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) What is a finite automaton? Design a DFA that accepts the language given by $L=\{w\epsilon\{0,1\}^* : w$ does not contain four consecutive 0's$\}$. Hence test your design for 01010001. 8

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



2. a) Why ambiguities are need to be removed from ambiguous grammar? 7
   Show that following grammar is ambiguous

   $$S \rightarrow AS| \in , \quad A \rightarrow A1|0A1|01$$

   b) What is Chomsky normal form? Convert the following grammar into CNF. 8

   $$S \rightarrow aAB, \quad A \rightarrow aA|B| \in, \qquad B \rightarrow bBc| \in$$

3. a) Give the formal definition of pushdown automata. Construct a PDA accepting the language $L = \{0^n1^n \mid n > 0\}$ 7

   b) State pumping lemma for context free language. Prove that language $L = \{a^nb^nc^n \mid n > 0\}$ is not context free language. 8

4. a) In what aspect PDA is stronger than finite automata? State closure properties of context free grammar.
   b) How can you represent a Turing Machine? Show that the function, $f(n) = x+1$, is Turing computable.
5. a) Describe about Universal Turing machine. What is the application of Turing Machine?
   b) Differentiate between Recursive & Recursively enumerable language. Explain the recursive properties of language in detail.
6. a) How does computability differ from complexity theory? Describe about the time and space complexity.
   b) What are P, NP and NP-Complete problems? Explain with examples.
7. Write short notes on: **(Any two)**
   a) Relation and Function
   b) Church's Thesis
   c) Closure properties of CFL's

POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Theory of Computation

Semester: Spring

Year : 2018
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 cartesian product and power set. 7
   b) Define DFA and NFA. Design a FA which accepts the language L={w/w has both and an even number of 0's and an even number of 1's over alphabet ∑={0,1}. 8
2. a) State and explain Arden's theorem with example. Also convert the following regular expresssion to finite automata: 00*(0*0+1) 7
   b) Define Parse Tree. When a grammar is called ambiguous? Explain with example. 8
3. a) Describe the normal forms with suitable examples. Convert the following CFG to CNF. 7
   S ⟶ **abSb/a/aAb**
   A ⟶ **bS/aAAb**
   b) Write about closure properties of context free language. 8
4. a) How to find a PDA from a CFG? Construct a PDA from the grammar: 7
   S→0S1S , S→1S0S, S→ ε
   b) Define Turing machine. Design a Turing machine that accepts the language $L=1^n2^n3^n \mid n>=0$. 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) Discuss the Recursive function theory. Prove that the union of two recursive languages is recursive. 8
6. a) Write about church turing thesis and universal turing machine. 8
   b) Define computability theory. Differentiate between P complete problem and NP complete problem with example. Does P problem equals to NP? 8

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

a) The halting problem

b) Pushdown Automata

c) Big O Notation

POKHARA UNIVERSITY

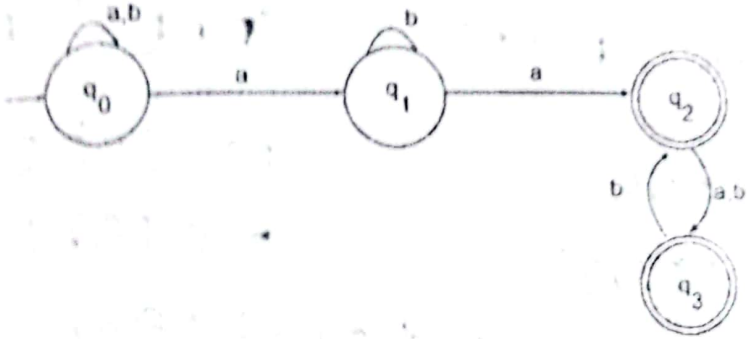
Level: Bachelor
Programme: BE
Course: Theory of Computation

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 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 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

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 languages? Show that the union of two recursive language is also recursive.
b) Write about church turing thesis and universal turing machines.
6. a) Using De Morgan's Law, prove the following:
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.
7. Write short notes on: **(Any two)**
a) Elimination of useless symbols
b) Regular expression
c) Pumping lemma for CFL

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

$x \in (A \cup B)'$
$x \notin (A \cup B)$
$x \notin A$ and $x \notin B$
$x \in \bar{A}$ and $x \notin \bar{B}$
$x \in \bar{A} \cap \bar{B}$

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

$x \in (A \cap B)'$
$x \notin (A \cap B)$
$x \notin A$ or $x \notin B$
$x \in \bar{A}$ or $x \in \bar{B}$
$x \in \bar{A} \cup \bar{B}$

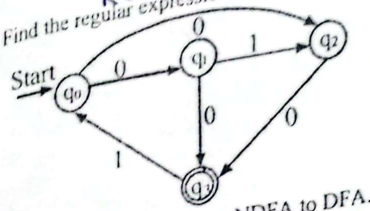
POKHARA UNIVERSITY

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

RE to FA



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.
3. Remove the ϵ-production(Null) from the following grammar.

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

C-c

3. What is instantaneous description of PDA? Design a PDA which accepts the language $L=\{wc\{0,1\}^* : w$ has equal number of 0's and 1's$\}$.
4. a) Write about closure properties of context free language.
b) How can you represent a Turing Machine? Show that the function $f(n) = x+1$, is Turing computable.
5. Design a Turing Machine as a right shift machine which transforms #w# into ##w# with alphabet $\Sigma=\{a,b,\#\}$.
5. a) What is recursive and recursively enumerable languages? Show that the union of two recursive language is also recursive.

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

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

c) Using De Morgan's Law, prove the following:

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

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

a) State computational complexity theory? Explain class Np with suitable example.

b) Write short notes on: (Any two)

i) Elimination of useless symbols

ii) Regular expression

iii) Pumping lemma for CFL

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

$x \in (A \cup B)'$

$x \notin (A \cup B)$

$x \notin A$ and $x \notin B$

$x \in \overline{A}$ and $x \in \overline{B}$

$x \in \overline{A} \cap \overline{B}$

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

$x \in (A \cap B)'$

$x \notin (A \cap B)$

$x \notin A$ or $x \notin B$

$x \in \overline{A}$ or $x \in \overline{B}$

$x \in \overline{A} \cup \overline{B}$

RE to FA

POKHARA UNIVERSITY

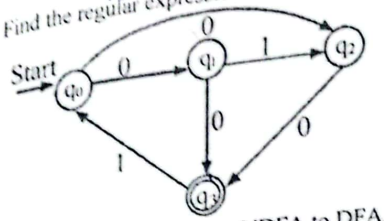
Level: Bachelor
Programme: BE
Course: Theory of Computation

Semester: Spring

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) 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. 8

b) What do you mean by Ambiguous Grammar? Explain with example. Remove the ϵ-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={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. 8

b) Design a Turing Machine as a right shift machine which transforms #w# into ##w# with alphabet Σ={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. 6

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

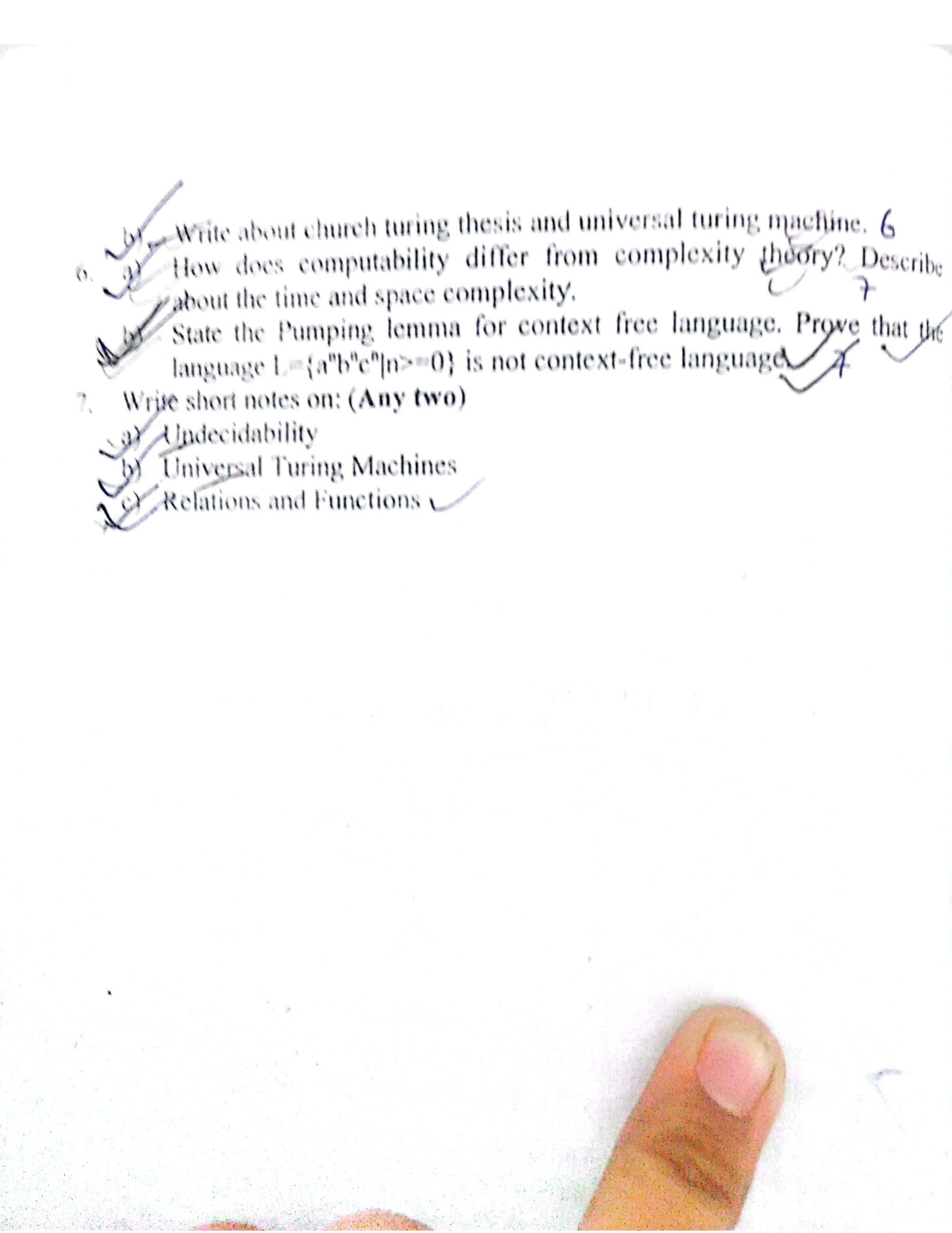
b) State the Pumping lemma for context free language. Prove that the language $L=\{a^n b^n c^n | n>=0\}$ is not context-free language. 7

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

a) Undecidability

b) Universal Turing Machines

c) Relations and Functions



POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Theory of Computation

Semester: Fall

Year : 2020
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) 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 $\sum$={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}, Σ= {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	-	-	-

NFA → RE

b) For the grammar given by G=(V,∑,P,S) 7
where, V={S}
∑={a,b,c}
and P is defined as S→Xa/Yb, X→Sb/b, Y→Sa/a
Design the PDA for the **following grammar.**

(4)

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.

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

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

$\Sigma=\{a,b\}$, (4)

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

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

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. (4)

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

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

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

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

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

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 neeessary 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

CPK 5th

POKHARA UNIVERSITY

Level: Bachelor | Semester: Fall | Year : 2022
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) What is Function? Explain different types of functions with examples

   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.

   c) Let G be the grammar

   $S \rightarrow ASA \mid B$

   $A \rightarrow a \mid b$

   $B \rightarrow aCb \mid bCa$

   $C \rightarrow ACA \mid A$

   Answer the following:

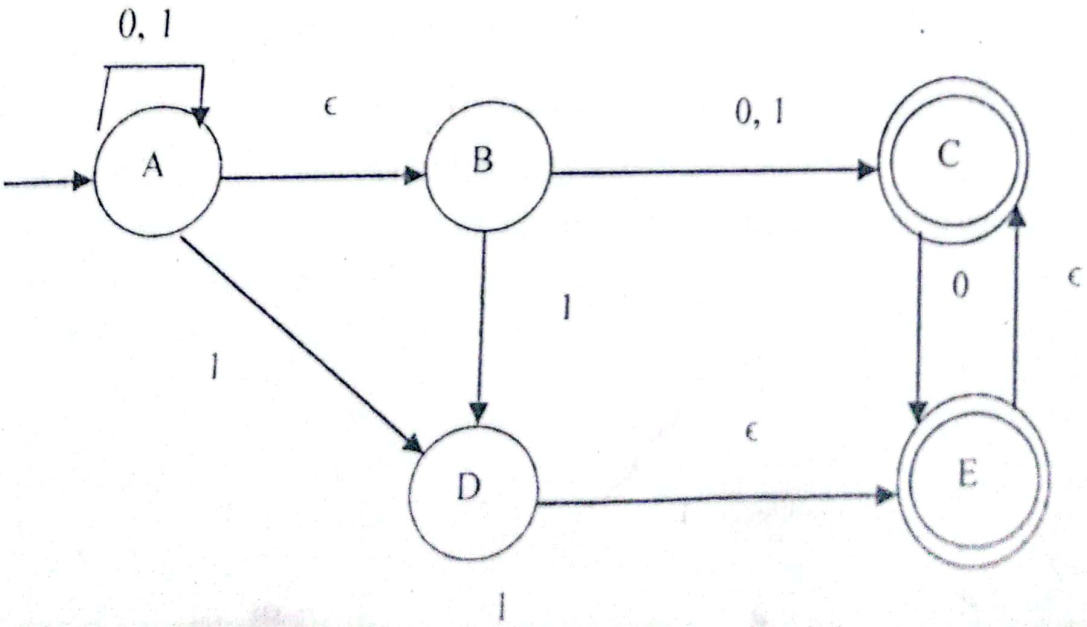
   i. What are the variables and terminals in G?

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

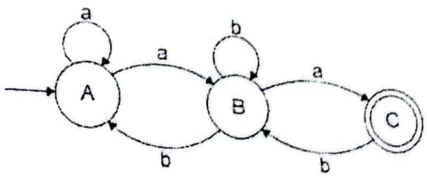
   iii. Are strings "aba" and "bbb" in L(G)?

   iv. Is empty in L(G) ?

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



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 ε {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 wϵ{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