Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 40395

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Fifth Semester

Computer Science and Engineering

CS 8501 — THEORY OF COMPUTATION

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Write regular expression to represent exponential constants of 'C' language.

2. Define extended transition diagram.

3. Write regular expression to recognize the set of strings over {a,b} having odd number of a's and b's and that starts with 'a'.

4. When two states are said to be distinguished? Give example.

5. Write CFG to accept the language defined by, $L = \{a^i b^j c^k \mid i, j, k >= 0 \text{ and } i = j + k\}$.

6. List out the steps for performing LL parsing.

7. Draw pushdown automata to accept all palindromes of odd length.

8. Formally define the pushdown automata based on the types of acceptance.

9. Draw Turing machine to compute double the value of an integer.

10. State Post's correspondence problem.

PART B — ($5 \times 13 = 65$ marks)

11. (a) Design an $\varepsilon - NFA$ (Nondeterministic finite automaton) to recognize the language L, containing only binary strings of non-zero length whose bits sum to a multiple of 3. Convert $\varepsilon - NFA$ into an equivalent minimized deterministic finite automaton. Illustrate the computation of your model on any sample input.

Or

(b) (i) State and prove the theorem of mathematical induction. (5)

(ii) In a programming language, all the following expressions represent Integer and floating point literals. Construct a finite automata that will accept all the different formats and convert the same to deterministic finite automata, if required. (8)

12. (a) (i) Prove that regular expressions are closed under union, intersection and Kleene closure. (8)

(ii) Identify a language L, such that L* = L+. (5)

Or

(b) Find a minimum State Deterministic Finite Automata recognizing the language corresponding to the regular expression (0*10 + 1 * 0) (01)*.

13. (a) What language over {0, 1} does the CFG with productions

$S \rightarrow 00S \mid 11S \mid S00 \mid S11 \mid 01S01 \mid 01S10 \mid 10S10 \mid 10S01 \mid \epsilon$ generate? Justify your answer.

Or

(b) Design an pushdown automata to recognize the language, L defined by, L $L = \{wcw^c \mid w \in \{0,1\}^*$ and w^c is the one's complement of $w\}$.

14. (a) Convert the following grammar to Chomsky Normal form.

$S \rightarrow A \mid AB0 \mid A1A$

$A \rightarrow A0 \mid \epsilon$

$B \rightarrow B1 \mid BC$

$C \rightarrow CB \mid CA \mid 1B$.

Or

(b) Construct an appropriate model to recognize the language L defined by, $L = \{a^n b^m c^m d^n \mid n, m >= 0\}$.

15. (a) With proper examples, explain P and NP complete problems.

Or

(b) State and prove that "Diagnoalization language is not recursively enumerable".

PART C — (1 × 15 = 15 marks)

16. (a) Design appropriate automation model for the language defined by the grammar given below.

$S \rightarrow aSBC$
$CB \rightarrow BC$
$bB \rightarrow bb$
$cC \rightarrow cc$

$S \rightarrow aBC$
$aB \rightarrow ab$
$bC \rightarrow bc$

Or

(b) Design appropriate automation model for the language defined by the grammar given below.

$S \rightarrow abc \mid aAbc$
$Ab \rightarrow bA$
$Ac \rightarrow Bbcc$
$bB \rightarrow Bb$
$aB \rightarrow aa \mid aaA.$

Reg. No. :

Question Paper Code : X 10319

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2020
Fifth Semester
Computer Science and Engineering
CS 8501 – THEORY OF COMPUTATION
(Regulations 2017)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A **(10×2 = 20 Marks)**

1. Define Deterministic Finite Automaton.

2. State any four types of proofs.

3. Write the regular expression for all strings that contain no more than one occurrence of aa.

4. Write a regular expression for even number of a's and even number of b's of a string w = {a, b}*.

5. Write a Context Free Grammar for the language consisting of equal number of a's and b's.

6. Define Deterministic PDA.

7. What are the two normal forms of CFG ? Write their productions format.

8. Define the language recognized by any Turing Machine.

9. What are recursive languages ?

10. Define the classes P and NP problem. Give example problems for both.

PART – B **(5×13 = 65 Marks)**

11. a) Prove that for every L recognized by an NFA, there exists an equivalent DFA accepting the same language L.

(OR)

b) Prove that for every L recognized by an $\in$-NFA, there exists an equivalent DFA accepting the same language L.

12. a) Prove that the following languages are not regular using pumping lemma.
    i) All unary strings of length prime. **(7)**
    ii) $L = \{uu \mid u \in \{0, 1\}^*\}$. **(6)**

(OR)

b) State and Prove any two closure properties of Regular Languages.

13. a) How $\in$-productions are eliminated from a grammar whose language doesn't have empty string ? Remove $\in$-productions from the grammar given below.

$S \to a \mid aA \mid B \mid C \quad A \to aB \mid \in \quad B \to Aa \quad C \to aCD \quad D \to ddd$

(OR)

b) Write procedure to find PDA to CFG. Give an example for PDA and its CFG.

14. a) How a CFG for L is converted into CNF accepting the same language ? Convert the following CFG into CFG in CNF.

$S \to b\,A \mid a\,B \quad A \to b\,A\,A \mid a\,S \mid a \quad B \to a\,B\,B \mid b\,S \mid b$

(OR)

b) Construct a Turing Machine for proper subtraction, which is defined as m – n if m > n and 0 otherwise.

15. a) Prove that Universal language is recursively enumerable but not recursive.

(OR)

b) Define PCP and prove that PCP is undecidable.

PART – C **(1×15 = 15 Marks)**

16. a) Construct a Turing Machine for multiplying two non negative integers using subroutine.

(OR)

b) How PDA is converted into CFG ? Convert the following PDA into CFG.

$P = (\{p, q\}, \{0, 1\}, \{Z, X\}, \delta, p, Z, \Phi)$

$\delta(p, 1, Z) = \{(p, XZ)\}$, $\delta(p, \in, Z) = \{(p, \in)\}$ $\delta(p, 1, X) = \{(p, XX)\}$,

$\delta(q, 1, X) = \{(q, \in)\}$, $\delta(p, 0, X) = \{(q, X)\}$, $\delta(q, 0, Z) = \{(p, Z)\}$

19/11/19 FN

Reg. No. :

Question Paper Code : 90159

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019

Fifth Semester

Computer Science and Engineering

CS 8501 – THEORY OF COMPUTATION

(Regulations 2017)

Time : Three Hours   Maximum : 100 Marks

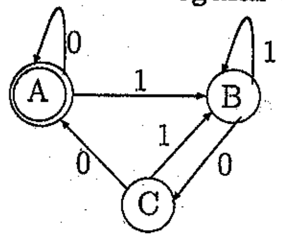
Answer ALL questions

PART – A   **(10×2=20 Marks)**

1. Prove by induction on $n \geq 1$ that $\sum_{i=1}^{n} \frac{1}{i(i+1)} = \frac{n}{n+1}$.

2. Formally define deterministic finite automata.

3. Construct regular expression corresponding to the state diagram.



4. State pumping lemma for regular languages.

5. When do you say a CFG is ambiguous ?

6. Give a formal definition of PDA.

7. What are the advantages of having a normal form for a grammar ?

8. Define the language recognized by the Turing machine.

9. When do you say a Turing machine is an algorithm ?

10. Define NP-Class.

PART – B (5×13=65 Marks)

11. a) Construct DFA equivalent to NFA ({p, q, r, s}, {0, 1}, δ, p, {s}), where δ is defined as

δ	0	1
p	{p, q}	{p}
q	{r}	{r}
r	{s}	–
s	{s}	{s}

(OR)

b) Give non-deterministic finite automata accepting the set of strings in $(0 + 1)^*$ such that two 0's are separated by a string whose length is 4i, for some $i \geq 0$.

12. a) i) Prove that any language accepted by a DFA can be represented by a regular expression. (7)

ii) Construct a finite automata for the regular expression $10 + (0 + 11)0^*1$. (6)

(OR)

b) Prove that the following languages are not regular :

i) $\{w \in \{a, b\}^* \mid w = w^R\}$ (7)

ii) Set of strings of 0's and 1's, beginning with a 1, whose value treated as a binary number is a prime. (6)

13. a) Suppose L = L(G) for some CFG G = (V, T, P, S), then prove that $L - \{\epsilon\}$ is L(G′) for a CFG G′ with no useless symbols or ϵ-productions.

(OR)

b) Prove that the languages accepted by PDA using empty stack and final states are equivalent.

14. a) State and prove Greibach normal form.

(OR)

b) Design a Turing machine to compute proper subtraction.

15. a) Prove that Post Correspondence Problem is undecidable.

(OR)

b) Prove that the universal language L_u is recursively enumerable but not recursive.

PART – C (1×15=15 Marks)

16. a) i) Suppose L = N(M) for some PDA M, then prove that L is a CFL. (7)

ii) Give a CFG for the language N(M) where $M = (\{q_0, q_1\}, \{0, 1\}, \{Z_0, X\}, \delta, q_0, Z_0, \Phi)$ and δ is given by

$\delta(q_0, 1, Z_0) = \{(q_0, XZ_0)\}$ $\delta(q_0, \epsilon, Z_0) = \{(q_0, \epsilon)\}$

$\delta(q_0, 1, X) = \{(q_0, XX)\}$ $\delta(q_1, 1, X) = \{(q_1, \epsilon)\}$

$\delta(q_0, 0, X) = \{(q_1, X)\}$ $\delta(q_1, 0, Z_0) = \{(q_0, Z_0)\}$ (8)

(OR)

b) i) Design a Turing machine to compute multiplication of two positive integers. (8)

ii) Design a Turing machine to recognize the language $\{0^n1^n0^n \mid n \geq 1\}$. (7)

Reg. No. [ ]

Question Paper Code : 57255

24-05-2016

AN

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2016

Fifth Semester

Computer Science and Engineering

CS 6503 – THEORY OF COMPUTATION

(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions.

PART – A (10 × 2 = 20 Marks)

1. Draw a non-deterministic automata to accept strings containing the substring 0101.
2. State the pumping Lemma for regular languages.
3. What do you mean by null production and unit production ? Give an example.
4. Construct a CFG for set of strings that contain equal number of a's and b's over $\Sigma = \{a,b\}$.
5. Does a pushdown Automata has memory ? Justify.
6. Define a pushdown automaton.
7. What are the differences between a finite automata and a Turing machine ?
8. What is a Turing machine ?
9. When is a recursively enumerable language said to be recursive ?
10. Identify whether Tower of Hanoi' problem is tractable or intractable. Justify your answer.

PART – B (5 × 16 = 80 Marks)

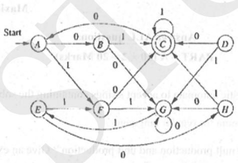
11. (a) (i) Construct a NFA that accepts all strings that end in 01. Give its transition table and the extended transition function for the input string 00101. Also construct a DFA for the above NFA using subset construction method. (10)

(ii) Prove the following by principle of Induction. $\Sigma_{x=1}^{n} x^2 = \frac{n(n+1)(2n+1)}{6}$. (6)

OR

(b) (i) What is a Regular Expression ? Write a regular expression for set of strings that consists of alternating 0's and 1's. (8)

(ii) Write and explain the algorithm for minimization of a DFA. Using the above algorithm minimize the following DFA. (8)



12. (a) (i) Construct a reduced grammar equivalent to the grammar G = (N, T, S, P) where

N = {S, A, C, D, E}

T = {a, b}

P = {$S \rightarrow aAa$, $A \rightarrow Sb$, $A \rightarrow bCC$, $A \rightarrow DaA$, $C \rightarrow abb$, $C \rightarrow DD$, $E \rightarrow aC$, $D \rightarrow aDA$} (6)

(ii) When is a grammar said to be ambiguous ? Explain with the help of an example. (5)

(iii) Show the derivation steps and construct derivation tree for the string 'ababbb' by using leftmost derivation with the grammar (5)

$S \rightarrow AB \mid \varepsilon$

$A \rightarrow aB$

$B \rightarrow Sb$

OR

(b) (i) What is the purpose of normalization ? Construct the CNF and GNF for the following grammar and explain the steps. (10)

$S \rightarrow aAa \mid bBb \mid \varepsilon$

$A \rightarrow C \mid a$

$B \rightarrow C \mid b$

$C \rightarrow CDE \mid \varepsilon$

$D \rightarrow A \mid B \mid ab$

(ii) Construct a CFG for the regular expression (011 + 1) (01). (6)

13. (a) (i) Construct a pushdown automaton to accept the following language L on $\Sigma = \{a, b\}$ by empty stack. $L = \{ww^R \mid w \in \Sigma^+\}$ (10)

(ii) What is an Instantaneous description of a PDA ? How will you represent it ? Also give the three important principles of ID and their transactions. (6)

OR

(b) (i) Explain acceptance by final state and acceptance by empty stack of a pushdown automata. (8)

(ii) State pumping Lemma for CFL. Use pumping lemma to show that the language $L = \{a^i b^j c^k / 1 < j < k\}$ is not a CFL. (8)

14. (a) (i) Construct a Turing machine to accept palindromes in an alphabet set $\Sigma = \{a, b\}$. Trace the strings "abab" and "baab". (8)

(ii) Explain the variations of Turing machines. (8)

OR

(b) (i) Explain Halting problem. Is it solvable or unsolvable problem ? Discuss. (8)

(ii) Describe Chomsky hierarchy of languages with example. What are the devices that accept these languages ? (8)

15. (a) What is a Universal Turing machine ? Bring out its significance. Also construct a Turing machine to add two numbers and encode it. (16)

OR

(b) What is a post correspondence problem (PCP) ? Explain with the help of an example. (16)

Reg. No. :

11/05/18
AN

Question Paper Code : 40911

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018

Fifth/Eighth Semester

Computer Science and Engineering

CS 6503 – THEORY OF COMPUTATION

(Common to Information Technology)

(Regulations 2013)

Time : Three Hours   Maximum : 100 Marks

Answer ALL questions

PART – A   (10×2=20 Marks)

1. Define Non-deterministic Automata (NFA).
2. Write the regular expression for the set of all strings of 0's and 1's not containing 101 as substring.
3. Define Ambiguity.
4. State Chomsky normal form theorem.
5. When is PDA said to be deterministic ?
6. What are the ways of language acceptance in PDA ?
7. Define Turing Machine.
8. Define Chomsky hierarchy of language.
9. What do you mean by Universal Turing machine ?
10. When is a language said to be recursively enumerable ?

PART – B (5×13=65 Marks)

11. a) Describe the closure properties of regular languages. (13)

(OR)

b) Determine DFA from a given NFA : (13)

$M = (\{q_0, q_1\}, \{0, 1\}, \delta, q_0, \{q_1\})$ where δ is given by

$\delta(q_0, 0) = \{q_0, q_1\}$, $\delta(q_0, 1) = \{q_1\}$, $\delta(q_1, 0) = \varphi$, $\delta(q_1, 1) = \{q_0, q_1\}$

12. a) With an example convert CFG to Greiback Normal form. (13)

(OR)

b) Explain simplification of CFG with examples. (13)

13. a) i) Construct PDA for the language $\{WCW^R/W \in \{0,1\}\}$. (8)

ii) Construct CFG for the constructed PDA. (5)

(OR)

b) i) Explain pumping lemma for Context Free Languages with example. (7)

ii) Show that Deterministic PDA is less powerful than nondeterministic PDA. (6)

14. a) Construct a Turing machine that perform unary multiplication (Say 111 × 11 = 111111). (13)

(OR)

b) i) Elaborate on programming techniques for Turing machine construction. (5)

ii) Construct turing machine for the language $\{WW/W \in \{a,b\}\}$. (8)

15. a) i) Prove that the diagonalization language (L_d) is not a recursively enumerable. (7)

ii) Write note on primitive recursive functions. (6)

(OR)

b) Write note on NP complete problems and Polynomial time reduction. (13)

PART – C (1×15=15 Marks)

16. a) Analyze the limitation of automata for Type 3, Type 2, Type 0 languages. (15)

(OR)

b) i) Show that Halting problem is undecidable. (10)

ii) Compare Tactable and untactable problems. (5)

07/05/19

Reg. No. :

Question Paper Code : 52868

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY, 2019.

Fifth/Eighth Semester

Computer Science and Engineering

CS 6503 — THEORY OF COMPUTATION

(Common to Information Technology)

(Regulation 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Construct Finite Automata for the regular expression : $(a \mid b)^* abb$.
2. Prove that $L = \{0^n 1^n \mid n >= 1\}$ is not a regular language.
3. What is ambiguous grammar? Give example.
4. Find an unambiguous grammar for the following grammar : $E \rightarrow E + E \mid E * E \mid (E) \mid id$.
5. Define Push Down Automata (PDA).
6. What is meant by Instantaneous Description for a PDA.
7. What is recursive enumerable language? Give example.
8. Write the applications of Turing Machine.
9. What is unsolvable problem? Give example.
10. What is Primitive Recursive Function? Give example.

PART B — (5 × 13 = 65 marks)

11. (a) Construct E-NFA for the regular expression (01 | 10) *101 and convert it into DFA. (13)

Or

(b) Elaborate the steps to convert the DFA into Regular expression with suitable example. (13)

12. (a) (i) Convert the following CFG into Griebach Normal Form: (10)

$X_1 \to X_2X_3$

$X_2 \to X_3X_1 \mid b$

$X_3 \to X_1X_2 \mid a$

(ii) Remove $\in$ - production from the following grammar

$S \to ASA \mid aB \mid b,\ A \to B,\ B \to b \mid \in$. (3)

Or

(b) (i) Write short notes on Chomsky hierarchy of grammar. (5)

(ii) Convert the following grammar in to CNF: (5)

$S \to bA \mid aB$

$A \to bAA \mid aS \mid a$

$B \to aBB \mid bS \mid b$

(iii) Eliminate left recursion for the following grammar : (3)

$A \to A + B \mid A * B \mid B \mid a$

13. (a) (i) Construct PDA for $L = \{a^n b^n \mid n >= 0\}$. (6)

(ii) Construct PDA for $L = \{w \in (a \mid b)^* \mid \text{where 'w' is a PALINDROME}\}$. (7)

Or

(b) (i) Construct PDA for $L = \{0^n\ 1^m\ 2^{n+m} \mid \text{where } n, m >= 1\}$. (6)

(ii) Illustrate the equivalence between PDA and CFL with example. (7)

14. (a) Discuss about the techniques for constructing the various types of Turing Machine. (13)

Or

(b) (i) Construct Turing Machine for $L = \{w\varepsilon\ (a \mid b)^* \mid \text{where 'w' is a PALINDROME}\}$. (8)

(ii) Construct Turing Machine for $L = \{1^n\ 2^n\ 3^n \mid \text{where } n >= 1\}$. (5)

15. (a) (i) Explain in detail about the various properties of recursive and recursive enumerable languages. (8)

(ii) How does a primitive recursive function help to identify computable function. (5)

Or

(b) Describe in detail about NP-Hard and NP-Complete problems with example. (13)

PART C — (1 × 15 = 15 marks)

16. (a) (i) Construct Turing machine for language over the input alphabet $\Sigma = \{a, b\}$ to shift the input symbol two positions left. (5)

(ii) Analyze and brief the concept of tractable and intractable problems. (10)

Or

(b) (i) State and prove the pumping lemma for CFL. (7)

(ii) Write an algorithm for minimization of DFA. (8)

CSE 9/11/16 F.N

Reg. No. :

Question Paper Code : 80298

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Fifth Semester

Computer Science and Engineering

CS 6503 — THEORY OF COMPUTATION

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define Deterministic Finite Automata (DFA).
2. What are the closure properties of regular languages?
3. What is meant by Context Free Grammar (CFG)?
4. State Chomsky normal form theorem.
5. When is Push Down Automata (PDA) said to be deterministic?
6. What are the conventional notations of Push Down Automata?
7. What are the required fields of an instantaneous description of a Turing machine?
8. List the primary objectives of Turing machines.
9. Define Universal Turing machine.
10. Define NP-hard and NP-completeness problem.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Given $\Sigma = \{a, b\}$, construct a DFA which recognize the language $L = \{b^m a b^n : m, n > 0\}$. (6)

(ii) Determine the DFA from a given NFA $M = (\{q_0, q_1\}, \{a, b\}, \delta, q_0, \{q_1\})$ with the state table diagram for δ given below. (10)

δ	a	b
q_0	$\{q_0, q_1\}$	$\{q_1\}$
q_1	ϕ	$\{q_0, q_1\}$

Or

(b) Discuss the basic approach to convert from NFA to Regular expression. Illustrate with an example. (16)

12. (a) (i) Construct a Context Free Grammar for the language $L = \{a^n \mid n \text{ is odd}\}$ (6)

(ii) Define derivation tree. Explain its uses with an example. (10)

Or

(b) Obtain a grammar in Chomsky Normal Form (CNF) equivalent to the grammar G with the productions P given.

$S \to aAbB$

$A \to aA \mid a$

$B \to bB \mid b.$ (16)

13. (a) (i) Outline an instantaneous description of a PDA. (6)

(ii) State and explain the pumping lemma for CFG. (10)

Or

(b) With an example, explain the procedure to obtain a PDA from the given CFG. (16)

14. (a) Discuss the various techniques for Turing machine construction. (16)

Or

(b) (i) Write about Multi tape Turing machines. (10)

(ii) Explain highlight the implications of halting problems. (6)

15. (a) (i) Elaborate on primitive recursive functions with an example. (10)

(ii) Compare recursive languages with recursively enumerable languages. (6)

Or

(b) (i) What are tractable problems? Compare it with intractable problems. (10)

(ii) Outline the concept of polynomial-time reductions. (6)

07/11/17 (FN)

Reg. No. :

Question Paper Code : 50393

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2017

Fifth/Eighth Semester

Computer Science and Engineering

CS 6503 : THEORY OF COMPUTATION

(Common to : Information Technology)

(Regulations 2013)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

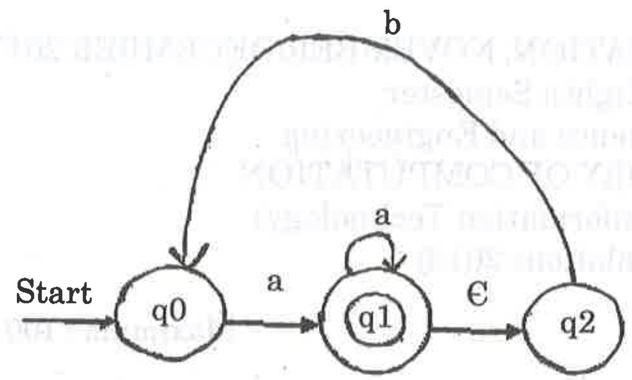
1. Define finite automata.
2. State the definition of pumping lemma for regular set.
3. What are the closure properties of context-free languages ?
4. Derive a string 'aababa' for the following Context Free Grammar (CFG).

   $S \rightarrow aSX / b$;

   $X \rightarrow Xb / a$
5. Give the steps to eliminate useless symbols.
6. Show that $L = \{a^p / p \text{ is prime}\}$ is not context free.
7. Define Turing Machine.
8. Give the configuration of Turing machine.
9. List the properties of recursive and recursive enumerable language.
10. Write short notes on tractable problem.

PART – B (5×13=65 Marks)

11. a) Convert the ∈-NFA to DFA and list the difference between NFA and DFA. (10+3)



(OR)

b) Show that the regular language are closed under : (13)

i) Union

ii) Inter section

iii) Kleen closure

iv) Complement

v) Difference.

12. a) i) Construct a CFG to generate even and odd set of palindromes over alphabet {a, b}. (7)

ii) Generate CFG for the language $L = \{0^i 1^j 0^k \mid j > i + k\}$. (6)

(OR)

b) i) Find an equivalent grammar in CNF for the grammar : (7)

$S \to bA / aB$

$A \to bAA / aS / a$

$B \to aBB / bS / b$.

ii) Eliminate the unit production of the following grammar : (6)

$S \to A / bb$

$A \to B / b$

$B \to S / a$.

13. a) i) Find PDA that accept the given CFG : (7)

$S \to xaax$

$X \to ax / bx / \in$.

ii) Construct PDA for the language $a^n b^m a^{n+m}$. (6)

(OR)

b) i) Prove that deterministic and non deterministic PDA are not equivalent. (8)

ii) Explain pumping Lemma for CFL. (5)

14. a) Construct Turing Machine (TM) that replace all occurrence of 111 by 101 from sequence of 0's and 1's. (13)

(OR)

b) i) Explain techniques for Turing Machine Construction. (7)

ii) Illustrate the Chomsky grammar classification with necessary example. (6)

15. a) Explain universal Turing Machine. (13)

(OR)

b) Explain how to measure and classify complexity. (13)

PART – C (1×15=15 Marks)

16. a) Prove that Halting problem is undecidable. (15)

(OR)

b) Consider two-tape Turing machine (TM) and determine whether the TM always writes a nonblank symbol on its second tape during the computation on any input string 'w'. Formulate this problem as a language and show it is undecidable. (15)

PART C — (1 × 15 = 15 marks)

16. (a) Give the regular expression of the language generated by the context free grammar (CFG) given below:

$S \to aS \mid bS \mid a \mid b$

Convert the regular expression to an $\in$–NFA. (7)

(b) Design a Turing machine that accepts the language $L = \{a^n b^n c^n \mid n >= 1\}$. (8)

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02/11/18

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Reg. No. :

Question Paper Code : 20369

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

Fifth/Eighth Semester

Computer Science and Engineering

CS 6503 – THEORY OF COMPUTATION

(Common to Information Technology)

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Give the difference between a deterministic finite automaton (DFA) and a non deterministic finite automaton (NDFA).

2. State pumping lemma for regular languages.

3. Consider the context-free grammar (CFG) given below. Give the leftmost derivation for the string *bbaa* using the grammar.

$S \to bS \mid aT \mid \in$
$T \to aT \mid bU \mid \in$
$U \to aT \mid \in$

4. Show that the following grammar is ambiguous: $S \to SbS \mid a$.

5. What is an instantaneous description (ID) of a push down automaton (PDA)?

6. Convert the following CFG to a push down automaton:

$S \to aS \mid bS \mid a \mid b$.

7. Differentiate multihead and multitape Turing machines.

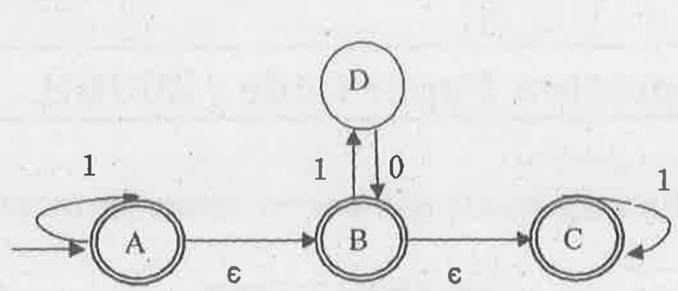
8. Give the Chomskian hierarchy of languages.

9. If L and its complement are recursively enumerable languages, prove that L is recursive.

10. Define the primitive recursion operation.

PART B — (5 × 13 = 65 marks)

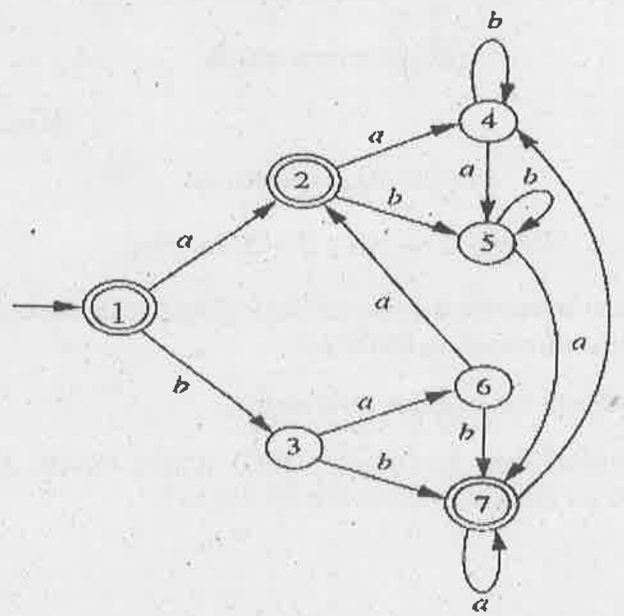
11. (a) Convert the following $\in$-NFA to NFA and then convert the resultant NFA to DFA. (13)



Or

(b) (i) Prove that a language L is accepted by some NDFA if and only if L is accepted by some DFA. (6)

(ii) Minimize the following automaton: (7)



12. (a) Simplify the following grammar by eliminating null productions, unit productions and useless symbols and then convert to Chomsky Normal Form (CNF). (13)

$S \rightarrow ABC \mid BaB$

$A \rightarrow aA \mid BaC \mid aaa$

$B \rightarrow bBb \mid a \mid D$

$C \rightarrow CA \mid AC$

$D \rightarrow \in$

Or

(b) Convert the following grammar to Greibach normal form (GNF): (13)

$S \rightarrow AB, A \rightarrow BS \mid b, B \rightarrow SA \mid a.$

13. (a) (i) Prove that the language $L = \{a^n b^n c^n \mid n >= 1\}$ is not context free using pumping lemma: (8)

(ii) What is a deterministic push down automaton? Comment on the language accepting capabilities of a deterministic push down automaton. (5)

Or

(b) Convert the following PDA M to CFG: (13)

$M = (\{q_0, q_1\}, \{0,1\}, \{X, Z_0\}, \delta, q_0, Z_0, \Phi)$ and δ is given by

$\delta(q_0, 0, Z_0) = \{(q_0, XZ_0)\}, \delta(q_1, 1, X) = \{(q_1, \in)\},$

$\delta(q_0, 0, X) = \{(q_0, XX)\}, \delta(q_1, \in, X) = \{(q_1, \in)\},$

$\delta(q_0, 1, X) = \{(q_1, \in)\}, \delta(q_1, \in, Z_0) = \{(q_1, \in)\}.$

14. (a) (i) Give the five-tuple representation of a Turing machine and explain the representation. Define the language accepted by a Turing machine. (5)

(ii) Consider the following Turing machine $M = (\{q_1, q_2, q_3, q_4\}, \{0, 1\}, \{0, 1, X, B\}, \delta, q_1, B, q_4)$ where δ is given as

$\delta(q_1, 0) = (q_2, X, R)$

$\delta(q_2, 0) = (q_2, X, R)$

$\delta(q_2, 1) = (q_3, X, R)$

$\delta(q_3, 0) = (q_2, X, R)$

$\delta(q_3, 1) = (q_3, X, R)$

$\delta(q_3, B) = (q_4, X, R)$

What will be the initial and final configurations of the Turing machine for the input string w = 0101? (8)

Or

(b) Design a Turing machine that accepts the language $L = \{ss \mid s$ is in $\{a, b\}^*\}$. (13)

15. (a) (i) If L1 and L2 are recursively enumerable languages, prove that the union of L1 and L2 is also recursively enumerable. (8)

(ii) Write notes on polynomial-time reductions. (5)

Or

(b) What is a universal Turing Machine? Explain the procedure to construct the universal Turing machine. (13)

Reg. No. :

Question Paper Code : 91403

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019
Fifth/Eighth Semester
Computer Science and Engineering
CS6503 – THEORY OF COMPUTATION
(Common to Information Technology)
(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

1. Define a deterministic finite automaton.
2. Draw the transition diagram for the deterministic finite automaton accepting all strings with a substring 01.
3. Define context free grammar.
4. What is a parse tree ? Give example.
5. Define pushdown automaton.
6. When a pushdown automaton can be defined to be deterministic ?
7. What is a Turing machine ?
8. Present an outline of multi-tape Turing machine.
9. When is a language L recursively enumerable ?
10. What are polynomial-time algorithms ?

PART – B (5×13=65 Marks)

11. a) Outline the steps in converting nondeterministic finite automaton to deterministic finite automaton. **(13)**

(OR)

b) "Not every language is a regular language". Using pumping lemma prove that many different languages are not regular. **(13)**

12. a) i) What are ambiguous grammars ? Give example. **(6)**

ii) When is a context free grammar said to be in Chomsky normal form ? Explain with an example. **(7)**

(OR)

b) i) Outline unit production and null production in a context free grammar with an example. **(6)**

ii) When is a context free grammar said to be in Greibach normal form ? Explain with an example. **(7)**

13. a) Given a context free grammar G, outline the steps to construct a pushdown automaton that simulates the left most derivations of G with an example. **(13)**

(OR)

b) Show that the language $L = \{0^n1^n \mid n \geq 1\} \cup \{0^n1^{2n} \mid n \geq 1\}$ is a context-free language that is not accepted by any deterministic pushdown automaton. **(13)**

14. a) Design a Turing machine that will accept the language $\{0^n1^n \mid n \geq 1\}$ and draw the transition diagram for the Turing machine. **(13)**

(OR)

b) i) Outline the halting problem for Turing machines. **(5)**

ii) Present an outline of the Chomsky hierarchy of languages. **(8)**

15. a) i) Present a detailed note on primitive recursive functions. **(8)**

ii) Highlight the features of universal Turing machine. **(5)**

(OR)

b) i) Outline tractable and intractable problems with an example. **(8)**

ii) Show that any problem in P is also in NP but not the other way around. **(5)**

PART – C **(1×15=15 Marks)**

16. a) Write regular expression for the following languages :

i) The set of all strings of 0's and 1's not containing 101 as a substring. **(6)**

ii) The set of strings of 0's and 1's, whose number of 0's is divisible by five and whose number of 1's is even. **(9)**

(OR)

b) Give transition tables for pushdown automata accepting each of the following languages :

i) $\{a^ib^j \mid i \leq j \leq 2i\}$ **(7)**

ii) $\{x \in \{a, b\}^* \mid n_a(x) < n_b(x) < 2n_a(x)\}$. **(8)**
