TE/comp/sem-I/CBCGS/R-19/c-scheme/TCS/SH-2024 11/11/2024 Lib

(3 hours) [80 marks]

NOTE:

1. **Question No 1 is compulsory.**
2. **Attempt any three questions from remaining.**
3. **Assume suitable data if necessary and state the same.**

QP-10067276

Q1 Solve all questions below 20

a) Design a Mealy Machine to identify if string starts with prefix ab over {a,b}*.

b) Construct a DFA for accepting all strings over {a,b} with substring abb.

c) Explain Universal Turing Machine.

d) Compare DFA and PDA

Q2

a) Find regular expression (RE) for all strings starting with b and ending in ba over {a,b}. Design NFA with epsilon moves for this RE. Convert it to equivalent DFA. 10

b) Find the Context Free Grammar for following 10
i. $L = \{a^i b^j c^k \mid i = j+k\}$ ii. $L = \{x \in \{0,1\} \mid x$ has equal number of zeros and ones $\}$

Q3

a) Convert following grammar to Chomky Normal Form 10
$S \rightarrow AACD$, $A \rightarrow aAb \mid \varepsilon$, $C \rightarrow aC \mid a$, $D \rightarrow aDa \mid bDb \mid \varepsilon$.

b) State closure properties of Regular languages and Context Free Languages. 10

Q4

a) Design PDA for $\{a^n x^n \mid n >= 0, x \in \{b\}^*\}$. Comment if it is deterministic or not. 10

b) Find minimum state Finite Automata accepting (01*0 + 10*). First deign a NFA with epsilon moves. 10

Q5

a) State pumping lemma for context-free-languages. Apply pumping lemma to $L = \{ss \mid s \in \{a,b\}^*\}$. 10

b) Design a Turing Machine to add two unary numbers. Show simulation of the machine 10

Q6 Write Detailed note on (Any two) 20

a) Applications of FA, PDA and TM.

b) Types of Turning Machines.

c) Chomsky Hierarchy.

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Duration: 3 Hours **[Max Marks: 80]**

N.B : (1) **Question No 1 is Compulsory**.
(2) Attempt any **three** questions out of the remaining **five**.
(3) All questions carry equal marks.
(4) Assume suitable data, if required and state it clearly.

1 **[20]**

a Explain the ways of acceptance by a PDA. **[05]**

b Discuss difference in transition function of PDA, TM and FA **[05]**

c Design DFA that accepts Strings that contain "ba" or "ab" as suffix over ∑={a,b}. **[05]**

d Construct CFG to generate the language $L = \{a^i b^j c^k \mid k=i+j, i, j >=1\}$ **[05]**

2 a Represent RE epsilon for L = {w : w has prefix bab and suffix abb and w is a string over {a,b}. Design NFA with epsilon moves for accepting L. Convert it to minimized DFA. **[10]**

b Explain Pumping Lemma for regular languages. Prove that given language is not a regular language. $L=\{ a^n b^{n+1} \mid n>=1\}$ **[10]**

3 a The grammar G is $S \rightarrow aB \mid bA$, $A \rightarrow a \mid aS \mid bAA$, $B \rightarrow b \mid bS \mid aBB$
Derive using Left Most Derivation(LMD) and Rightmost Derivation (RMD) for the following string "aaabbb". Draw Parse Tree. **[10]**

b Give formal definition of Push Down Automata. Design PDA that accepts odd palidromes over {a,b,c}, where c exists only at the center of every string. **[10]**

4 a i) Design DFA that accepts Strings that are multiples of 4 ∑={0,1}. **[10]**
ii) Design NFA that accepts strings starting with a and ending with a or starting with b and ending in b.

b Design a Mealy machine to change every occurrence of a with x, b with y and c is kept unchanged. Convert the same to equivalent Moore machine. **[10]**

5 a Consider following CFG. Is it already simplified ? Explain you answer. Convert it to CNF form. **[10]**

$S \rightarrow ASB \mid a \mid bb$
$A \rightarrow aSA \mid a$
$B \rightarrow SbS \mid bb$

b Design a TM for converting a input binary number to its one's complement of a binary **[10]**

number.

6 Write Short notes (**Any Four)** **[20]**

a Chomsky Hierarchy

b Post Correspondence Problem.

c Arden's Theorem

d TM-Halting Problem.

e Variants of Turning Machines

COMP/ SEM-V/ R-19 C-scheme/ Q.P. Code - 27752/ 23-05-23

(3 hours) [80 marks]

NOTE:

1. Question No 1 is compulsory
2. Attempt any three questions from remaining.
3. Assume suitable data if necessary and state the same.

Q1. [20]

a) Show that grammar represented by production rules given below is ambiguous.
$S \rightarrow S + S \mid S - S \mid S * S \mid S/S \mid (S) \mid a$

b) Construct a Moore machine to output remainder modulo 4 for any binary number.

c) Differentiate between NPDA and PDA.

d) Explain Chomsky Hierarchy.

Q2.

a) Write steps for converting CFG to CNF form. Convert the following CFG to CNF. [10]
$S \rightarrow ASB|\epsilon \quad A \rightarrow aAS|a \quad B \rightarrow SbS|A|bb$

b) Convert following RE to NFA-ϵ and convert it to minimised DFA corresponding to it
$(0+11)^*(10)(11+0)^*$ [10]

Q3.

a) Construct a PDA for accepting $L = \{a^n b^m c^n \mid m,n >= 1\}$ [10]

b) Give formal Definition of Pumping Lemma for Regular Language. Prove that the following language is not regular. $L = \{wrw^r \mid w \epsilon \{a,b\}^*, r \epsilon \{c\}, |w| >= 1\}$ [10]

Q4.

a) Construct CFG for following

i. Alternate sequence of 0 and 1 starting with 0 [03]

ii. Do not contain 3 consecutive a over {a,b} [04]

iii. $L=\{x \epsilon \{0,1\}^* \mid x$ has equal number of 0's and 1's$\}$ [03]

b) Explain applications for FA, PDA and TM [10]

Q5.

a) Construct a Moore machine to convert all occurrences of 100 to 101 in a string over {0,1}*. convert it to equivalent Mealy Machine [10]

b) Design a TM accepting all palindromes over {0,1} [10]

Q6. Write short note (Solve Any 4) [20]

a) Decision Properties of Regular Languages

b) Post Correspondence Problem

c) Variants of Turing Machine

d) Acceptance by a PDA

e) Conversion of Moore to Mealy Machines

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Duration: 3 hrs **[Max Marks: 80]**

N.B. : (1) Question No 1 is Compulsory.
(2) Attempt any three questions out of the remaining five.
(3) All questions carry equal marks.
(4) Assume suitable data, if required and state it clearly.

1 **[20]**

a Differentiate Finite Automata, Push Down Automata and Turing Machine.

b Discuss different applications of Finite Automata

c Design DFA that accepts Strings with at least 3 a's. over $\sum$={a,b}.

d Simplify the given grammar
S → ASB | ϵ
A → aAS | a
B → SbS | A | bb

2 a Compare and Contrast Moore and Mealy Machines. Design Moore machine for $\sum$={0,1}, print the residue modulo 3 for binary numbers. **[10]**

b Design Push Down Machine that accepts $L = \{a^m b^n c^n d^m \mid m, n>0\}$ **[10]**

3 a i) Construct CFG for given language. $L = \{ 0^i 1^j 0^k \mid j>i+k\}$ **[10]**
ii) The grammar G is S → aB | bA A → a| aS | bAA B → b | bS | aBB
Obtain parse tree for the following string "aababb" and check if the grammar is ambiguous.

b Explain Pumping Lemma with the help of a diagram to prove that given language is not a regular language. $L=\{0^m 1^{m+1} \mid m>0\}$ **[10]**

4 a i) Design DFA that accepts Strings that ends in either "110" or "101" over $\sum$={0,1}. **[10]**
ii) Design NFA that accepts strings starting with "abb" or "bba"

b Given NFA with epsilon, Find equivalent DFA. q1 is the initial state, q3 is final state **[10]**

	0	1	2	ϵ
→q1	{q1}	-	-	{q2 }
q2	-	{q2}	-	{ q3}
*q3	-	-	{ q3}	-

5 a Find Equivalent Greibach Normal Form (GNF) for given CFG. **[10]**
S → AA | a
A → SS | b

b Define and design Turing Machine to accept $0^n 1^n 2^n$ over $\sum$={0,1,2}. **[10]**

6 Write Short notes **(Any Two)** **[20]**

a Explain with example Chomsky Hierarchy.

b Post Correspondence Problem.

c Recursive and Recursive enumerable languages.

d TM-Halting Problem.

TE(COMP) / SEM V / R-19 / TCS / 02.06.22

QP CODE : 91225

University of Mumbai

Examinations Summer 2022

Time: 2 hour 30 minutes | Subject: TCS | Max. Marks: 80

Q1.	**Choose the correct option for following questions. All the Questions are compulsory and carry equal marks**
1.	**If L1 and L2 are context free language and R is a regular set, then which one of the languages below is not necessarily a context free language?**
Option A:	$L_1 L_2$
Option B:	$L_1 \cup L_2$
Option C:	$L1 \cap L2$
Option D:	$L_1 \cap R$
2.	**A Context Free Grammer G = (V , T , P , S) is said to be in _____, if every productions is of the form : $A \rightarrow a\alpha$ where a € T is a Terminal and α is a string of zero or more variables.**
Option A:	Unit production.
Option B:	Chomsky Normal form.
Option C:	Null production.
Option D:	Greibach Normal form.
3.	**Consider the following statements : I : Each Turing Acceptable language is need not to be Turing Decidable. II : Every Turing Decidable is Turing acceptable.**
Option A:	Only I is true.
Option B:	Only II is true.
Option C:	Both are false.
Option D:	Both are true.
4.	**FSM can recognize :**
Option A:	Only Context free grammer
Option B:	Only Context sensitive grammer
Option C:	Only regular grammar
Option D:	Any grammar
5.	**Recursively enumerable languages are not closed under :**

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Option A:	Concatenation
Option B:	Complementation
Option C:	Homomorphism
Option D:	Union
6.	**If P , Q , R be the three regular expressions then the equation R = Q + RP has a unique solution given by :**
Option A:	R = RP
Option B:	R = QP*
Option C:	R = Q*P
Option D:	R= P*R
7.	**Every Context free language can not be recognized by a _____ , but it can be recognized by _____.**
Option A:	NPDA , DPDA .
Option B:	DPDA , NPDA .
Option C:	NPDA , NPDA .
Option D:	DPDA , DPDA .
8.	**If a language is denoted by a regular expression** L = (x)* (x | y x) , **then which of the following is not a legal string within L ?**
Option A:	yx
Option B:	xyx
Option C:	x
Option D:	x y x y x
9.	**Algorithmically , Which of the following conversion is not possible ?**
Option A:	Regular grammar to context-free grammar
Option B:	Non-deterministic PDA to deterministic PDA
Option C:	Non-deterministic TM to deterministic TM
Option D:	Non-deterministic FSA to deterministic FSA
10.	_____ **is the Type 1 grammer according to Chomsky Hierarchy.**

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Option A:	Unrestricted Grammer.
Option B:	Regular Grammer.
Option C:	Context free Grammer.
Option D:	Context sensitive Grammer.

Q2	
A	***Solve any TWO*** ***5 marks each***
i	*Compare and Contrast Moore and Mealy Machine.*
ii	*Find the GNF equivalent to CFG :* $S \rightarrow AB$ $A \rightarrow aA \mid bB \mid b$ $B \rightarrow b$
iii	State and explain pumping lemma theorem for regular languages.
B	**Solve any One** **10 marks each**
i	Give the Moore and Mealy machine for the following processes : "For input from (0 + 1)* , if inputs ends in 101 , output x ; if input ends in 110 , output y ; otherwise output z " .
ii	Let G be the grammer : S → aB | bA A → a | aS | bAA B → b | bS | aBB Find : i) Left most derivation ii) Right most derivation iii) Parse tree iv) Is the grammer unambiguoous ? , for the given string 00110101 .

Q3	
A	***Solve any TWO*** ***5 marks each***
i	*Explain Non-deterministic PDA.*
ii	*Obtain DFA to accept strings of 0's and 1's with even no. of 0's and even no. of 1's.*

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iii	Explain halting problem of Turing Machine.
B	**Solve any One** **10 marks each**
i	Design a Turing Machine to accept the language given by a regular expression 0 (0 + 1) * 1 1 .
ii	Construct the PDA accepting following language : $L = a^n b^m c^n \mid m , n >= 1$.

Q4	
A	***Solve any TWO*** ***5 marks each***
i	*Explain Chomsky Hierarchy.*
ii	*Describe Finite State Machine.*
iii	Construct left linear and right linear grammer for the regular expression : (((01 + 10) * 11) * 00)*
B	**Solve any One** **10 marks each**
i	Design a TM which recognizes words of the form $a^n b^n c^n \mid n >= 1$.
ii	Convert the following RE to €- NFA and then convert it to DFA : R = ((0 + 1) * 1 0 + (0 0) * (1 1) *) * .

Time : 3.00 Hrs. **Marks : 80**

N.B. : (1) Question **No. 1** is **compulsory**.
(2) Attempt any **three** questions out of the remaining **five** questions.
(3) Assumptions made should be clearly stated.
(4) **Figures** to the **right** indicate **full** marks.
(5) **Assume** suitable **data** whenever required but **justify** the same.

1. **a)** Differentiate between NFA and DFA. 5
b) Compare and contrast Moore and Mealy machines. 5
c) Explain variants of Turing Machine. 5
d) Show that the following grammer is ambiguous :
S --> aSbS | bSaS | ε . 5

2. a) Convert the following RE into NFA with ϵ- moves and hence obtain the DFA :
RE = (0 + ϵ) (1 0)*(ϵ + 1) . 10
b) Consider the following grammer G = { V , T , P , S) , V = { S , X } , T = { a , b } and productions P are : S --> aSb | aX
X --> Xa | Sa | a .
Convert the grammer in Greibach Normal Form. 10

3. a) Construct PDA accepting the language L = { $a^{2n}b^n$ | n >= 0 } . 10
b) Construct TM to check well formedness of parenthesis. 10

4. a) Design Mealy machine to recognize r = (0 + 1) * (00 + 11) and then convert it to Moore machine. 10
b) Consider the following grammer :
S --> i C t S | i C t S e S | a
C --> b .
For the string " ibtaeibta" , find the following :
i) Left most derivation ,
ii) Right most derivation ,
iii) Parse tree ,
iv) Check if the above grammer is ambiguous or not. 10

5. a) Design a Turing machine that computes a function f(m,n) = m + n , the addition of two integers. 10
b) Give the formal definition of pumping lemma for regular language and then prove that the following language is not regular :
L = { 0^m1^{m+1} | m > 0 } . 10

6. Write short note on following (Any two) : 20
a) Chomsky Hierarchy.
b) Decision properties of regular languages.
c) Rice's theorem.
d) Definition and working of PDA.