

CSE 181503

Roll No. of candidate

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2023

B.Tech. 5th Semester End-Term Examination

CSE

FORMAL LANGUAGE AND AUTOMATA THEORY

Full Marks – 70

Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer Question No. 1 and any four from the rest.

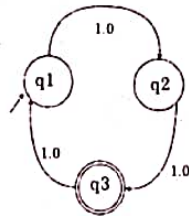
1. Answer the following questions :

(10 × 1 = 10)

(i) Which of the following language is regular?

- (a) $\{a^i b^j \mid i \geq 0\}$ (b) $\{a^i b^j \mid 0 < i < 5\}$
 (c) $\{a^i b^j \mid i \geq 1\}$ (d) None of the mentioned

(ii) Which of the following will the given DFA won't accept?



- (a) ϵ (b) 11010
 (c) 10001010 (d) String of letter count 11

(iii) Which of the following statement is false?

- (a) Context free language is the subset of context sensitive language
 (b) Regular - language is the subset of context sensitive language
 (c) Recursively enumerable language is the super set of regular language
 (d) Context sensitive language is a subset of context free language

[Turn over

(iv) A CFG is not closed under

- (a) Dot operation (b) Union Operation
 (c) Concatenation (d) Iteration

(v) Which of the following does not have left recursions?

- (a) Chomsky Normal Form (b) Greibach Normal Form
 (c) Backus Naur Form (d) All of the mentioned

(vi) Grammar is checked by which component of compiler?

- (a) Scanner (b) Parser
 (c) Semantic Analyzer (d) None of the mentioned

(vii) The language accepted by a turing machine is called _____

- (a) Recursive Enumerable (b) Recursive
 (c) Both (a) and (b) (d) Type 7

(viii) A turing machine operates over:

- (a) Finite memory tape (b) Infinite memory tape
 (c) Depends on the algorithm (d) None of the mentioned

(ix) Which of the following is correct?

Statement 1 : ϵ represents a single string in the set.

Statement 2 : Φ represents the language that consist of no string.

- (a) Statement 1 and 2 both are correct
 (b) Statement 1 is false but 2 is correct
 (c) Statement 1 and 2 both are false
 (d) There is no difference between both the statements ϵ and Φ are different notation for same reason

(x) Production Rule: $aAb \rightarrow agb$ belongs to which of the following category?

- (a) Regular Language
 (b) Context free Language
 (c) Context Sensitive Language
 (d) Recursively Enumerable Language

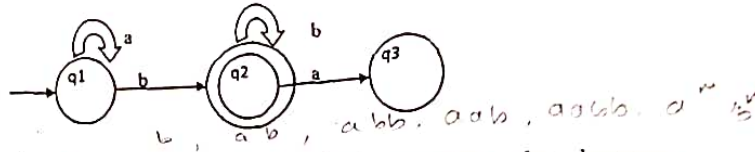
2. (a) Construct a DFA that will accept strings on {a, b} where the number of b's divisible by 3.

(b) Construct a NFA for regular expression $(ab)^*abb$ and draw its equivalent DFA.

(c) State pumping lemma and its advantages. Verify whether $L = \{a^{2^n} \mid n \geq 1\}$ is regular or not.
 (5+5+5=15)

3. (a) Define regular expression. Construct RE for the language 'L' which accepts all the strings with atleast two b's over $\Sigma = \{a, b\}$.

(b) Construct RE from the given DFA.



- (c) Construct context free Grammar that generate the language $\{WCW^R \mid W \text{ belongs to } \{a, b\}^*\}$. (5+5+5=15)

4. (a) What are the applications of context free grammar? Find whether the language $\{a^m b^n c^m, m \geq 0\}$ is context free or not.

(b) Remove useless symbols from the following grammar:

$$S \rightarrow A11 \mid 11A$$

$$S \rightarrow B \mid 11$$

$$A \rightarrow 0$$

$$B \rightarrow BB.$$

- (c) Construct the production rules for defining a language $L = \{a^x b^y \mid x \neq y\}$. (5+5+5=15)

5. (a) Define Push Down Automata. Design a PDA that accepts a string of well formed parenthesis. Consider the parenthesis as $(,), [,], \{, \}$.

(b) What Context sensitive language? Explain with example.

(c) Construct PDA from the following CFG.

$$S \rightarrow AB$$

$$A \rightarrow CD$$

$$B \rightarrow b$$

$$C \rightarrow a$$

$$D \rightarrow a.$$

(5+5+5=15)

6. (a) Define Turing machine. Construct a TM for the language $L = \{a^n b^n\}$ where $n \geq 1$.

(b) When do you say a problem is NP hard? What are P class and NP class problems?

(c) Define Recursive language. What are decidable languages and undecidable languages? (7+4+4=15)

7. Write short notes on :

(a) Greibach Normal Form.

(b) Chomsky hierarchy.

(c) Arden's Theorem.

(5+5+5=15)

Total No. of printed pages = 4

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2021

B.Tech. 5th Semester End-Term Examination
Computer Science and Engineering
FORMAL LANGUAGE AND AUTOMATA THEORY
(New Regulation & New Syllabus)

Full Marks – 70

Time – Three hours

The figures in the margin indicate full marks
for the questions.

Answer question No. 1 and any *four* from the rest.

1. Choose the correct option :

(10 × 1 = 10)

(i) In a context-free grammar

- (a) ϵ can be the right hand side of any production
- (b) terminal symbols can't be present in the left hand side of any production
- (c) number of grammar symbols in the left hand side is not greater than the number of grammar symbols in the right hand side
- (d) all of these

(ii) CFG can be recognized by a

- (a) push-down automata ✓
- (b) 2-way linear bounded automata
- (c) both (a) and (b)
- (d) none of these

(iii) The production $aAbcD \rightarrow abcDbcd$ is of

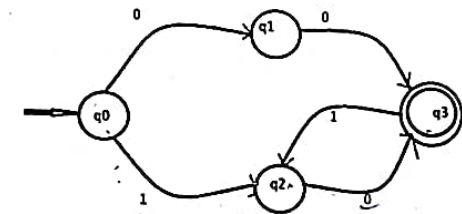
- (a) type 0
- (b) type 1
- (c) type 2
- (d) type 3

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(iv) Any given Transition graph has an equivalent

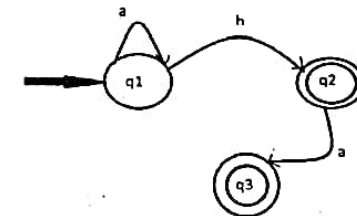
- (a) DFA
- (b) N DFA
- (c) Regular expression
- (d) All of the given

(v) Which of the following string is accepted by the DFA?



- (a) 10110
- (b) 0011
- (c) 101011
- (d) 101010 ✓

(vi) The regular expression represented by the given DFA is



- (a) ab^*aa
- (b) a^*ba ✓
- (c) a^*b+a^*ba
- (d) ab^*a

(vii) A given grammar is called ambiguous if

- (a) two or more productions have the same non-terminal on the left hand side
- (b) a derivation tree has more than one associated sentence
- (c) there is a sentence with more than one derivation tree corresponding to it
- (d) brackets are not present in the grammar

(viii) The intersection of CFL and regular language

- (a) is always regular
- (b) is always context free
- (c) both (a) and (b)
- (d) need not be regular

(ix) If every string of a language can be determined, whether it is legal or illegal in finite time, the language is called

- (a) decidable (b) undecidable
(c) interpretive (d) non-deterministic

(x) If $\delta(q, x_i) = (p, y, L)$ then

- (a) $x_1x_2 \dots x_{i-1}qx_i \dots x_n \vdash x_1x_2 \dots x_{i-2}px_{i-1}yx_{i+1} \dots x_n$
(b) $x_1x_2 \dots x_{i-1}qx_i \dots x_n \vdash x_1x_2 \dots x_{i-3}px_{i-2}yx_{i+1} \dots x_n$
(c) $x_1x_2 \dots x_{i-1}qx_i \dots x_n \vdash x_1x_2 \dots x_{i-1}ypx_{i+1} \dots x_n$
(d) $x_1x_2 \dots x_{i-1}qx_i \dots x_n \vdash x_1x_2 \dots x_{i+1}pyx_{i+2} \dots x_n$

2. (a) Construct the grammar accepting the following set. (5)

The set of all strings over $\{a, b\}$ consisting of an equal number of a's and b's. 42

(b) Reduce the following grammar to CNF: (10)

$S \rightarrow 1A|0B, A \rightarrow 1AA|0S|0, B \rightarrow 0BB|1S|1.$

3. (a) Construct a reduced grammar equivalent to the grammar. (5)

$S \rightarrow aAa, A \rightarrow Sb|CC|DaA, C \rightarrow abb|DD, E \rightarrow aC, D \rightarrow aDA, F \rightarrow A.$

(b) Give the formal definition of TM? What are the different types of TMs? Explain. (10) 38

4. (a) Using pumping lemma show that the set $\{a^n b^n c^n | n > 0\}$ is not context free. (7)

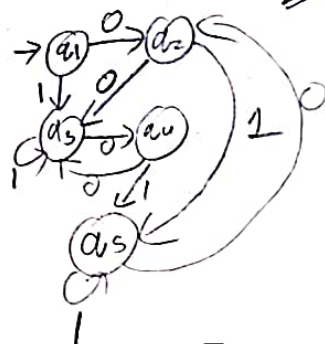
(b) Design a DFA to accept the language. (8)

$L = \{w | w \text{ is of even length and begins with } 01\}$

5. (a) Consider the DFA given by the transition table: (8)

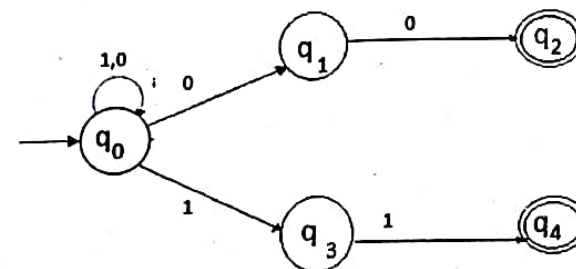
δ	0	1
$\rightarrow q_1$	q_2	q_3
q_2	q_3	q_5
$*q_3$	q_4	q_3
q_4	q_3	q_5
$*q_5$	q_2	q_5

Construct minimum state equivalent DFA.



(b) Consider the grammar $G(\{S, A\}, \{a, b\}, \{S \rightarrow AS, A \rightarrow aa|ab|ba|bb\}, S)$ and give leftmost and rightmost derivations for the string $aabbbba$. Draw the parse tree for the string for leftmost derivation. (7)

6. (a) Convert the given NFA to its equivalent DFA. (6)



(b) Convert the mealy machine given in the following table to its equivalent Moore machine. (7)

Current state	Input symbol			
	a	Output	b	Output
$\rightarrow q_0$	q_0	1	q_2	1
q_1	q_2	0	q_1	1
q_2	q_1	1	q_1	0

(c) Given a grammar $G = (\{S, C\}, \{a, b\}, P, S)$, where P consists of $S \rightarrow aCa, C \rightarrow aCa|b$ then, find $L(G)$. (2)

7. (a) Prove that regular languages are closed under union. (5)

(b) Prove that The union of two recursive languages is recursive and the union of two recursively enumerable languages is recursively enumerable. (10)