Total number of printed pages: **Programme(UG)/5th /UCSE503 2024**

Formal Language and Theory of Automata

Full Marks: 100

Time: Three hours

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

*Answer **any five** questions*

Q1.

a) Formally define DFA and NFA.

b) Consider the following grammar and identify the language generated by the grammar

$S \rightarrow aS \mid P$

$P \rightarrow bP \mid Q$

$Q \rightarrow cC \mid R$

$R \rightarrow \epsilon$

c) Design a finite automata suitable for the above language.

(10+5+5)

Q2.

a) Define regular grammar with example.
b) Write down the pumping lemma for regular expression.
c) Use your pumping lemma to prove that the following expressions are not regular.
   i) $a^n b^n$ $(n > 0)$
   ii) $a^m b^n$ $(m, n > 0, m > n)$

(5+5+(5+5))

Q3.

a) Formally define Push Down Automata.
b) Construct a PDA that accepts any string w over the $\sum = \{x, y\}$ where the numbers of x are double of the number of y s.
c) Trace your PDA with inputs $x^4 y^n$

(5+10+5)

Q4.

a) Discuss the concept of left recursion in grammar using an example.

b) What makes left recursion removal essential while right recursion removal isn't deemed necessary?

c) Consider the following Moore machine and design an equivalent Mealy machine

Present state	x = 0	x = 1	O/P
	Next state	Next state	
□ q_0	q_1	q_2	a
q_1	q_3	q_0	b
q_2	q_4	q_5	a
q_3	q_6	q_4	a
q_4	q_0	q_4	b
q_5	q_6	q_7	a
q_6	q_3	q_0	b
q_7	q_2	q_1	b

d) Why state minimization is important in the context of finite automata.

(5+5+5+5)

Q5.

a) With suitable examples briefly discuss left linear grammar and right linear grammar.
b) Write a grammar that will generate WW^R, where W = {any string having ***a*** s and ***b*** s }.
c) Write down the pumping lemma for CFG.
d) Match the following -

i)	Regular Grammar	A)	Turing Machine
ii)	Context Free Grammar	B)	Push Down Automata
iii)	Context Sensitive Grammar	C)	Linear Bound Automata
iv)	Unrestricted Grammar	D)	Finite Automata

(5+5+5+5)

Q6.

a) Formally define a Turing Machine.

b) Design a Turing Machine for the language L = $\{a^n b^n c^n\ (n > 0)\}$

(5+15)

Q7. Write short notes on -

a) Recursive languages
b) Left factoring
c) Augmented grammar
d) Halting problem of TM

(4*5)