B.E COMPUTER SCIENCE AND ENGINEERING 3rd YEAR 1st SEMESTER EXAMINATION 2021

Formal Languages and Automata Theory

Full Marks: 100

The question paper is divided in **Part A & Part B**. All questions from both parts are to be answered.

Duration: **5 hours** including time for downloading the question paper and uploading the answer script

Start Time & Date: 11:00 AM on 25 Jan 2021

Part A

Full Marks: 70

1(a) Design a Turing Machine (TM) to determine whether an even length binary string is a palindrome.

(b) Define Recursively Enumerable languages and Recursive languages. Are all Recursively Enumerable languages Recursive? Under what condition a Recursively Enumerable language can be Recursive?

10+4

Or

State the Halting Problem for Turing Machines. Prove that the Halting Problem is undecidable.

14

2(a) Let **w** be the yield of a Parse tree formed by a grammar in Chomsky Normal Form. Also assume that the length of the longest path in the Parse tree is **n**. Then prove that $|w| \leq 2^{n-1}$.

(b) State the Pumping lemma for Context Free Languages (CFLs)

(c) Using the Pumping lemma, prove that

$$L=\{0^{n.m} | n \text{ and } m \text{ are prime numbers}\}$$

is not a CFL.

4+2+4.5

3(a) Give the state diagram of a Push Down Automaton (PDA) to accept $\{0^{2n}1^{3n} | n>0\}$

(b) Eliminate ϵ-productions from the following Context Free Grammar:

$$S \rightarrow aXbY$$
$$X \rightarrow aX | \epsilon$$
$$Y \rightarrow bY | \epsilon$$

(c) Give a Context Free Grammar (CFG) that generates

$$L=\{w \in \{0,1\}^{+} | w \text{ contains at least three 1's}\}$$

5+3+2.5

4(a) Prove that Regular languages are closed under Reversal.

(b) Given $E=01^{*}+10^{*}$, find E^{R} where R denotes Reversal of a Regular Expression.

4+3

5. Prove that if a Deterministic finite Automaton (DFA) has **n** states then there is a string of length in [n,2n-1], which is in L(A), and the language L(A) is infinite.

10.5

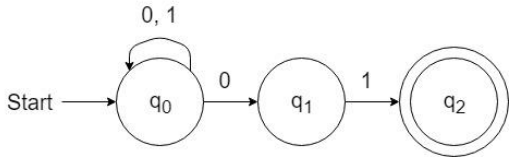
6(a) Construct a minimum state Deterministic Finite Automaton (DFA) for the following:

	0	**1**
→A	B	C
B	A	D
***C**	E	F
***D**	E	F
***E**	E	F
F	F	F

Asterisk marked states in the above State- transition-table are accept/final states

(b) Give a DFA with ∑={0,1,2} to accept any string with 001 as a substring

(c) Give the language accepted by the following Nondeterministic Finite Automaton (NFA)



Construct a DFA equivalent to the NFA shown above.

8+3+6.5

Part B
Full Marks: 30

1. Define Universal Turing Machine (UTM) and discuss its implementation.

6

2(a) Prove that Context Free Languages (CFLs) are not closed under intersection.

(b) How would you check if a CFL is infinite?

3+1.5

3(a) Give a Context Free Grammar (CFG) to define the language **$\{a^i b^j c^k | I,j,k \geq 0 \ \& \ i+j=k\}$**

(b) Give the transition diagram of the Push Down Automata (PDA) that accepts the language defined by the following grammar:

S→aAA
A→aS|bS|a

2.5+2

4. Assuming that L is a Regular language and h is a homomorphism on its alphabet, define h(L).

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5. Using Pumping Lemma, prove that **$L=\{0^{n!} | n \geq 0\}$** is not a Regular language.

4.5

6(a) Given an arbitrary Non -deterministic Finite Automaton (NFA) with n states, the maximum number of states in an equivalent minimized DFA is

(i) n^2
(ii) 2^n
(iii) 2n
(iv) n!

Explain your answer.

(b) Give a Regular expression representing all binary strings with an odd number of 1's.

4.5+3