B.E COMPUTER SCIENCE AND ENGINEERING 3rd YEAR 1st SEMESTER EXAMINATION 2021-2022

Formal Languages and Automata Theory

Full Marks: 70

Time: 3 hours

1. (a) The State Entry Problem for Turing Machines (TMs) is defined as follows:
Given a TM M over the input alphabet $\sum$, any state q and word w in $\sum^+$, does the computation of M on w visit the state q.
Reduce the Halting Problem to State Entry Problem to prove that State Entry Problem is Undecidable
(b) Design a TM to find 2's complement of a binary number.

Or

(a) Define P, NP, NP-hard, NP-complete classes of problems with examples. Discuss P=NP?
(b) How would you prove that a problem is in NP-hard? How would you prove that a problem is in NP-complete?

10+4

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 $|\mathbf{w}|\leq \mathbf{2^{n-1}}$.
(b) State the Pumping lemma for Context Free Languages (CFLs)
(c) Using the Pumping lemma, prove that

$$L=\{ww|w\epsilon\{0,1\}^*\}$$

is not a CFL.

4+2+4.5

3(a) Give the state diagram of a Deterministic Push Down Automaton (DPDA) to accept $L=\{0^n|n\geq 0\}U\{0^n1^n\,|n\geq 0\}$
(b) Eliminate ϵ-productions from the following Context Free Grammar:

$$\mathbf{S\rightarrow aXbY}$$
$$\mathbf{X\rightarrow aX|\ \epsilon}$$
$$\mathbf{Y\rightarrow bY|\ \epsilon}$$

(c) Give a Context Free Grammar (CFG) for $L=\{x\epsilon\{0,1\}^+|$ symbol at position i is same as symbol at position i+2 and $|x|\geq 2\}$

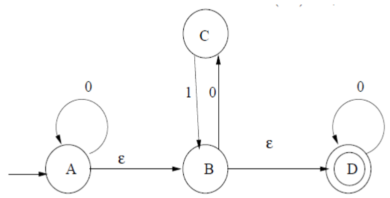
5+3+2.5

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

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

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

(b) Given the NFA below for $0^*(01)^*0^*$, construct a Deterministic Finite Automaton (DFA)



(c) Give a Nondeterministic Finite Automaton (NFA) for the language of all strings over $\{0,1\}^*$ that do not end in 01.

8+3+6.5

5(a) How would you decide if a Regular language is empty?

(b) Let L and M be two Regular languages and $[q_L, q_M]$ be a state of the product DFA produced out of the DFA for L and M. And also q_L and q_M are two states of the DFA for L and M respectively. How would you design the final/accept states of the product DFA to decide if L=M

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

2+2+3

6. Let A be a Deterministic finite Automaton (DFA) with **n** states. Prove that if there is string of length at least n in L(A) then there is a string of length between n and 2n-1in L.

10.5