TCS–402

B. TECH. (CSE)
(FOURTH SEMESTER)
END SEMESTER
EXAMINATION, June, 2023
FINITE AUTOMATA AND FORMAL LANGUAGES

Time : Three Hours
Maximum Marks : 100

Note : (i) All questions are compulsory.

(ii) Answer any *two* sub-questions among (a), (b) and (c) in each main question.

(iii) Total marks in each main question are **twenty**.

(iv) Each sub-question carries 10 marks.

1. (a) Using induction show that if for some state q and some string n, $\delta^*(q, n) = q$, then for every $n > 0, \delta^*(q, n^n) = q$. (CO1)

(b) (i) Design a DFA in which every 00 is followed immediately by a 1, for

example, the strings 101, 0010, 0010011001 are in the language, but 0001 and 00100) are not in the language.

(ii) Design a DFA for the language, containing strings in which leftmost symbol differ from rightmost symbol over alphabet {0, 1}.   (CO1)

(c) Convert the following NFA to a DFA and informally describe the language it accepts :   (CO1)

P/S	N/S	
	0	**1**
→ p	$\{p, q\}$	$\{p\}$
q	$\{r\}$	$\{r\}$
r	$\{s\}$	—
s^*	$\{s\}$	$\{s\}$

2. (a) Write a short notes on the following :   (CO2)

(i) CHOMSKY classification of the language

(ii) Kleene's theorem

(iii) Myhill-Nerode theorem

(b) State Pumping Lemma for regular sets. Show that the set $L = \{0^n \mid n$ is a prime) is not regular. (CO2)

(c) Design a Moore and Mealy machine for a binary input sequence such that if it has a substring 110 the machine outputs A, if it has a substring 101 machine output B, otherwise outputs C. (CO2)

3. (a) Construct a grammar in GNF which is equivalent to the grammar : (CO3)

$$S -> AA \mid a, A -> SS \mid b$$

(b) Find CFG for the following language :

(CO3)

   (i) $L = \{a^i b^j c^k : i = j \text{ or } i = k\}$

   (ii) $L = \{a^i b^j c^k : i = j - 1 \text{ or } i <= k$.

(c) Find the language generated by following grammar. Give leftmost and rightmost derivation of strings "aabbabba" : (CO3)

$$S \to aB \mid bA$$
$$A \to a \mid aS \mid bAA$$
$$B \to b \mid bS \mid aBB$$

4. (a) Construct PDA for the language : (CO4)

$$L = \{ww^R : W \in \{0, 1\} * \}.$$

(b) Prove that language recognized by final state PDA is also recognized empty stack PDA and vice-versa.   (CO4)

(c) Construct a grammar for the language which has equal no. of a's and b's. Then convert it into PDA.   (CO4)

5. (a) Write short notes on the following :

(CO5)

   (i)   Halting problem of TM

   (ii) Universal TM

   (iii) Church's thesis

(b) Design a Turing machine which will accept the following language :   (CO5)

   $L = \{a^n b^m a^{n+m} : n > 0, m > 0\}$

(c) Design a TM to reverse a string over alphabet $\{a, b\}$.   (CO5)