Total number of printed pages: 02 **PG/5th /PCSE112 2023**

Automata Theory

Full Marks: 100

Time: Three hours

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

*Answer **Question 1 and any four** questions from the rest.*

Q1. Consider a language $L = a^p b^q c^r d^s$ where $p = q = r+s$, and $p, q, r, s > 0$.

a) Design a Turing Machine for the above-mentioned language.

b) Trace your machine with the input $a^5 b^5 c^4 d^1$.

(15+5)

Q2. Consider the following languages where $m, n > 0$

$L1 = a^n b^m c^n$

$L2 = a^n b^n c^n$

$L3 = a^m b^m c^n$

a) Identify the language types of *L1*, *L2*, and *L3*

b) What will be the following languages and their types?

i) L1 ∪ L2 ∪ L3

ii) L1 ∩ L2 ∩ L3

iii) L1 ∩ (L2 ∪ L3)

iv) (L1 ∩ L2) ∪ L3)

(6 + (3+3+4+4))

Q3.

a) Construct a PDA for the languages $L = a^x b^y c^z$, where $x = y + 2z$, $x >= 0$, $y >= 0$, $z >= 0$.

b) Write down the Pumping Lemma for Context-Free Language. Use it to prove $L = a^n b^n c^n$ is not Context-free.

(10+10)

Q4.

a) Consider the following Grammar and design a Finite Automaton for it.

A->abbdB | a, B->Be | C, C-> Cd | f, D->De | d, E->e

b) Consider the language L, where $L = a^x b^y c^z$, $x, y, z >= 0$, and $x = 2p$, $y = 3q$, $z = 2r$, where $p, q, r > = 0$. Justify whether the language is regular or not.

(10+10)

Q5.

a) Justify the following statement "All recursively enumerable languages are recursive".

b) Briefly discuss the halting problem of Turing Machine

c) Remove unit, null, and unnecessary productions from the grammar given below –

S → aAbBdDeE, A → B | a| ϵ, B →b | ϵ, D →d | ϵ

(5+5+10)

Q6.

a) With an example discuss the Satisfiability problem.

b) Define the terms – P, NP, NP-hard, NP-complete.

c) With an example discuss the reduction of an algorithm.

(5+10+5)

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