Registration No.: | | | | | | | | | | |

Total Number of Pages: 02

Course: M.Sc.I
Sub_Code: FMCF902

9^{th} Semester Regular Examination: 2024-25
SUBJECT: Theory of Computation
BRANCH(S): M.Sc.I (MC)
Time: 3 Hours
Max Marks: 70
Q.Code: R062
Answer Question No.1 (Part-I) which is compulsory, any five from rest (Part-II)
The figures in the right-hand margin indicate marks.

Part-I

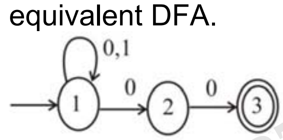
Q1 Answer the following questions: **(2 x 10)**

- **a)** Define a regular grammar with an example.
- **b)** State and explain the pumping lemma for regular sets.
- **c)** Explain the ambiguity in context-free grammars. Check whether the following grammar is ambiguous or not?
  $S \rightarrow aS \mid Sa \mid a$
- **d)** Differentiate between deterministic and nondeterministic pushdown automata.
- **e)** State and explain Ogden's lemma for context-free languages.
- **f)** Define regular expression. Find the regular expression for the set of binary strings consisting of even number of 0's.
- **g)** Define a Turing machine. Give an example of a basic Turing machine transition.
- **h)** Explain the Church-Turing hypothesis.
- **i)** What is the difference between recursively enumerable and recursive languages?
- **j)** Explain the Post correspondence problem (PCP).

Part-II

Long Answer Type Questions (Answer Any five)

Q2 (a) Differentiate between deterministic and nondeterministic finite automata. Consider the following NFA and find the equivalent DFA. **(5)**



(b) What are left-linear and right-linear grammars? Convert the following Right linear grammar into left linear grammar **(5)**
$S \rightarrow 00B \mid 11S$
$B \rightarrow 0B \mid 1B \mid 0 \mid 1$

Q3 (a) Explain the Chomsky hierarchy of languages. How does it classify languages? **(5)**

(b) Prove that regular languages are closed under Union, Intersection, concatenation and star closure operations. **(5)**

Q4 **(a)** Define pumping lemma for regular languages. Prove the following language is not regular using pumping lemma. **(5)**
$L = \{a^n b^n | n \geq 0\}$

(b) Explain the Cook-Younger-Kasami parsing algorithm with an example. **(5)**

Q5 **(a)** Define Push down Automaton (PDA). Design the PDA for the following language **(5)**
$L = \{wcw^r | w \in \{a, b\}^*\}$, where w^r is the reverse of w.

(b) Define Griebach Normal Form (GNF). Convert the following grammar into GNF **(5)**
S → XB | AA
A → a | SA
B → b
X → a

Q6 **(a)** Reduce the following Context Free Grammar (CFG). **(5)**
S→ aA | aBB
A→ aaA | ε
B→ bB | bbC
C→ B

(b) Explain Ogden's lemma. Prove the following language is not a context free language using Ogden's lemma. **(5)**
$L = \{a^n b^n c^n | n \geq 0\}$

Q7 **(a)** Define Turing machine. Explain the variants of Turing machines. **(5)**

(b) Prove that if a language L and its complement $\bar{L}$ both are recursive enumerable, then both languages are recursive. **(5)**

Q8 **(a)** Define linear bounded Automaton. Differentiate between recursive and recursive enumerable languages. **(5)**

(b) Design a Turing machine for the following language. Show the Instantaneous Description (ID) of the string "aaabbb". **(5)**
$L = \{a^n b^n | n \geq 0\}$