$\Delta$ = { (s, a, e) , (s, a)), ((s, b, e), (s, b)), ((s, c, e), (f, e)),
((f, a, a), (f, e)), ((f, b, b), (f, e))}

Show that ababcbaba, abbcbba$\in$L(M) but abc ab$\notin$L

UNIT-IV

7. a) Explain Chomsky hierarchy of grammars and give the production rules in each category. 6

   b) Design Turing Machine for the Language, 8
   L = { $a^n b^n c^n$ } where $n \geq 1$

8. a) Define Turing Machine (TM). Construct a TM for checking the palindrome of the string of even length. 3+11=14

UNIT-V

9. a) Discuss the Halting problem of Turing Machine and undecidable problems for recursive enumerable languages. 10

   b) What do you mean by primitive recursive functions? Explain. 4

10. Write short notes on the following: 14
   i) Church-Turing thesis
   ii) Computational complexity.





**PG / INTEGRATED (CBCS) ODD SEMESTER EXAMINATION, 2021**
**Held in April 2022**

COMPUTER SCIENCE
**7th Semester / 1st Semester**

COURSE NO. MCSCC - 701 / MS - 101
**( Theory of Computation )**

Full Marks : 70
Pass Marks : 28

Time : 3 hours

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

(Answer any five questions, taking one from each unit)

UNIT-I

1. a) Define 5
   i) One-to-one function
   ii) Bijection

   b) Give example of each of the following (with justification) 5
   i) A binary relation that is transitive but not reflexive
   ii) A binary relation that is reflexive and transitive but not symmetric

c) Design deterministic finite automata accepting each of the following languages. 4

i) $\{ w \in \{a, b\}^* : \text{each a in w is immediately preceded by a b} \}$

ii) $\{ w \in \{0, 1\}^* : \text{w does not contain three consecutive 1's} \}$

2. a) What do you mean by 4

i) NFA

ii) Binary relation

Explain with examples.

b) Write the regular expression for the language containing all the strings *a* and *b* that ends either with *aa* or with *bb*. 3

c) Show by induction that 7

$$1^2 + 2^2 + 3^2 + ..... + n^2 = \frac{n (n + 1) (2n + 1)}{6}$$

UNIT-II

3. a) State and prove pumping lemma for regular language. Using pumping lemma for the regular language prove that

$L = \{ a^m b^n : m > n \}$ is not regular. 10+4=14

4. a) Show that the class of languages accepted by finite automata is closed under 10

i) union

ii) concatenation



b) Design a FA from given regular expression

$10 \cup (0 \cup 11)\ 0^*1$ 4

UNIT-III

5. a) What are context free grammar (CFG) and Chomsky's normal form (CNF)? Explain with examples. 4+4=8

b) Convert the given CFG to CNF 4

$S \rightarrow a \mid aA \mid B$

$A \rightarrow a\ BB \mid e$

$B \rightarrow Aa \mid b$

c) What is ambiguous grammar? Check the ambiguity of the following grammar - 2

$S \rightarrow a\ s \mid a\ s\ b\ s \mid e$

6. a) State pumping theorem for context-free languages. Prove that $L = \{ a^n : n \geq 1 \text{ is a prime} \}$ is not context free. 6

b) Explain the difference between deterministic and non deterministic push down automata with example.

Consider the pushdown automaton 3+5=8

$M = (K, \Sigma, \Gamma, s, F)$, where

$K = \{ s, f \}$

$F = \{ f \}$

$\Sigma = \{ a, b, c \}$

$\Gamma = \{ a, b \}$

*Contd ....*