No. of Printed Pages—3

**50 (FLA)**

**[ 19-HBPGKOW–M3S(O) 20M ]**

**MCA/MScIT 3rd Semester (Old) Exam., 2019 (W)**

# FORMAL LANGUAGES AND AUTOMATA

[ MCA/MScIT (S3) 11 ]

*Full Marks* : 80

*Time* : 3 hours

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

**1.** Answer any *five* from the following questions : 2×5=10

*(a)* Define non-deterministic finite automata.

*(b)* Write down the steps needed for proving that a given set is not regular.

*(c)* What is a transition system?

*(d)* Explain the conventions used to combine Turing machines.

*(e)* Write down the steps involved in Church's thesis.

*(f)* What are recursively enumerable languages?

**2.** Answer any *three* from the following questions : 4×3=12

*(a)* Construct a context-free grammar which generates palindrome for binary numbers.

*(b)* Design a Turing machine to accept the language

$$L = \{a^n b^n a^n \mid n \geq 1\}$$

*(c)* Show that the factorial function is primitive recursive.

*(d)* What is the problem of computability and decidability?

**3.** Answer any *three* from the following questions : 6×3=18

*(a)* Construct a DFA equivalent to the regular expression given below : 6

$$(a^* b + b^* a)^* a$$

*(b)* Write the regular expression for the following : 2+2+2=6

*(i)* Set of all strings over $\Sigma = \{0, 1\}$ that has exactly two 0's.

*(ii)* Set of strings over $\Sigma = \{0, 1\}$ that has at least one pair of consecutive zeros.

*(iii)* Set of all strings of $a$'s and $b$'s that contains at least two $a$'s.

*(c)* Why are Turing machines used? What problems cannot be solved by Turing machines? 3+3=6

*(d)* What is the significance of Turing's thesis? Write the uses of Universal Turing Machine. 3+3=6

**4.** Answer any *four* from the following questions : 10×4=40

*(a)* Find all strings of length 5 or less in a regular set represented by the following : 4+3+3=10

*(i)* $(ab+a)^*(aa+b)$

*(ii)* $(a^*b+b^*a)$

*(iii)* $a^* + (ab+a)^*$

*(b)* Consider the grammar $G$ with production

$$S \rightarrow aAb$$
$$A \rightarrow aBb$$
$$B \rightarrow bb$$

for the string *aaaabbbb*. Construct the derivation tree. 10

*(c)* Design a Turing machine that computes the function $f(n) = n-2$, if $n \geq 3$ and $f(n) = 0$ for $n = 0, 1, 2$. 10

*(d)* Write a note on primitive recursive functions and μ-recursive functions. 10

*(e)* Explain the closure properties of context-free grammars. 10

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