

M.Sc. Examination 2018
Semester-I
Computer Science
Course : MCSC-11
(Theory of Computation)

Time : 3 Hours

Full Marks : 40

Questions are of value as indicated in the margin
Answer question No.1 and **any four** from the rest

1. a) Show that the family of regular languages is closed under intersection.
b) Define universal Turing Machine.
c) Present Chomsky's Normal Form
d) Describe Chomsky hierarchy of formal languages? 4×2=8
 2. a) Is the following grammar ambiguous? Justify
 $E \rightarrow N | (E) | E + E | E - E | E * E | E / E$
 $N \rightarrow 0 | 1 | 2 | \dots | 9$
b) State and prove pumping lemma for regular languages.
c) Define LR(1) grammar. How is it important? Can all programming language constructs be expressed as context-free grammars? 2+3+3=8
 3. a) Design a Turing Machine to compute the following function where x and y are positive integers.
$$f(x, y) = \begin{cases} x - y, & x > y, \\ 0, & x \leq y. \end{cases}$$

b) Show that the set of all Turing Machines with tape unbounded only in one direction is equivalent to the class of Turing Machines with tape unbounded in both directions. 4+4=8
 4. a) Prove that the set of all Turing Machines, although infinite, is countable.
b) Prove that a language and its complement are both recursively enumerable if and only if both languages are recursive. 4+4=8
 5. a) Define Turing decidability of a problem.
b) Prove that halting problem is Turing decidable. 2+6=8
 6. a) Prove that if Q is a primitive recursive function, then so are its bounded existential and universal quantifications.
b) Define a primitive recursive function.
c) Prove that there exists a Turing Computable function that is not primitive recursive. 2+2+4=8
 7. Write short notes on **any two** : 2×4=8
 - a) Turing's thesis
 - b) Countable set and enumeration procedure
 - c) μ -recursive functions
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