Registration No :

Total Number of Pages : 02

B.Tech
PCS4I104

4^{th} Semester Regular / Back Examination 2018-19
FORMAL LANGUAGE & AUTOMATA THEORY
BRANCH : CSE
Time : 3 Hours
Max Marks : 100
Q.CODE : F843

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.
The figures in the right hand margin indicate marks.

Part- I

Q1 **Short Answer Type Questions (Answer All-10)** **(2 x 10)**

- **a)** Define DFA
- **b)** Write various ways to represent a Turing Machine.
- **c)** Represent the TM in 7-tuple characteristics.
- **d)** Differentiate PDA and TM.
- **e)** What is a multi-head TM?
- **f)** Which language is recognised by TMs as per Hierarchy of grammars?
- **g)** What is CYK algorithm?
- **h)** What is P,NP and
- **i)** What Is The Significance Of Pump in NP-Complete problem?
- **j)** What is Cantor-Godel numbering

Part- II

Q2 **Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 x 8)**

- **a)** Give a regular expression for the following language B over the alphabet {a, b}. B = {w | w does not contain the substring aaa}.
- **b)** Prove by induction that the number of subsets of a set with cardinality n is 2^n.
- **c)** Write the Context Free Grammars for each of the two expressions (00)*1* and 1*(00)*.
- **d)** Show that the lanaguge defined by $\{ba^nba^m \mid m > n\}$ is not regular.
- **e)** Explain the closure properties of Context Free languages.
- **f)** Construct a Turing machine which carries out proper subtraction (a-b=0, if a<b).
- **g)** Design a Turing machine that transforms a string containing only ***a***'s, ***b***'s, and ***c***'s by replacing each letter preceding an ***a*** to ***b***. (Do not worry about the case when the string begins with an ***a***.) Thus, ***bccb*** would remain unchanged while ***caccaa*** would change to ***bacbba***. The Turing machine should always eventually enter an accepting state to terminate.
- **h)** *Show that the *Post Correspondence Problem* is decidable over the unary alphabet S = {1}.*
- **i)** Apply the CYK algorithm for the following grammar to determine whether the string "babaa" is generated by this grammar.
  S => XY
  X => XA | a | b
  Y => AY | a
  A => a
- **j)** Prove that there are as many palindromes of length 2n as there are of length 2n-1.
- **k)** A recursive language is empty or a recursive language contains all strings over ∑*. Why this problem is undecidable?

l) The Ackermann function is a two place function A(x, y) defined on pairs of integers (x, y) where $x \geq 0$ and $y \geq 0$. More specifically,
A(x, y) is defined as follows:
A(0, y) = 1
A(1, 0) = 2
A(x, 0) = x + 2 if $x \geq 2$
A(x + 1, y + 1) = A(A(x, y + 1), y)
Determine the values A(4, 3) as possible for $0 \leq x, y \leq 9$.

Part-III

Long Answer Type Questions (Answer Any Two out of Four)

Q3 How would one simulate a PDA on a Turing machine? Please do not write the Turing machine itself, but rather write the key idea in plain English. **(16)**

Q4 We call a natural number composite if it is not prime, formally, the set of natural composite numbers is {hk | h, k ∈ N, h, k ≥ 2} Give a nondeterministic Turing machine of the alphabet of vertical bars Σ = {|} that recognizes the language of composite numbers encoded as unary numbers (i.e. a natural number n is encoded in the form $|^n$ n). You should not give a formal construction, but describe the idea behind it as precise as possible. **(16)**

Q5 Consider the context free grammar $G = (V,\Sigma,R,S)$ where V is $\{S,A,B,a,b,c\}$, Σ is $\{a,b,c\}$ and R consists of the following rules: **(16)**

$$S \to A \quad A \to aS \quad A \to a$$
$$S \to B \quad B \to bS \quad B \to b$$

Is this grammar ambiguous? Justify your answer.

Q6 Create a pushdown automaton that accepts the language $\{w \in \{0,1\}^* \mid w$ has twice as many 0s as 1s$\}$. **(16)**