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Total Number of Pages: 2

B. Tech  
RCS5C001

5<sup>th</sup> Semester Regular/Back Examination 2021-22  
FORMAL LANGUAGES AND AUTOMATA THEORY  
Branch: CSE, CST, ELECTRICAL & C.E, IT  
Max Marks: 100  
Time: 3 Hours  
Q Code: OF220

Answer Question No. 1 (Part I) 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 Only Short Answer Type Questions (Answer All-10)

(02×10)

- Define the transition function of a non-deterministic finite automata.
- Find the  $\epsilon$ -NFA for the regular expression  $0(0^* + 1)^*1^*$ .
- Draw the DFA for the language over the alphabet  $\Sigma = \{0, 1\}$  having all strings that ends with either 01 or 11.
- Define Kleene closure of a language.
- What is meant by leftmost and rightmost derivation? Give example.
- Show that the grammar  $S \rightarrow a | abSb | aAb, A \rightarrow bS | aAAb$  is ambiguous.
- What are recursively enumerable languages?
- Differentiate between P and NP class of problems.
- Eliminate unit productions from the following context free grammar  
 $S \rightarrow Aa/B/c$   
 $B \rightarrow A/bb$   
 $A \rightarrow a/bc/B$
- What is meant by Halting Problem of a Turing Machine?

Part II

Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)

(06×08)

- Write a regular expression for a set of strings of 0's and 1's with even number of 0's. Further, construct the DFA for the same.
- Proof that if  $L_1$  and  $L_2$  are two regular languages then  $(L_1 \cdot L_2)^* \cdot L_1 = L_1 \cdot (L_2 \cdot L_1)^*$
- Construct a Mealy machine that generates 1's complement of a given binary number.
- Construct a minimal DFA, which accepts the set of all strings over  $\{0, 1\}$ , which when interpreted as binary number, is divisible by '3'. (For example: 1100 in binary is equivalent to 12 in decimal and 12 is divisible by 3)
- Reduce the following grammar to CNF:  $S \rightarrow ASA | bA, AB|S, B \rightarrow C$
- State and prove pumping lemma for Context free languages. Find out whether the language  $L = \{x^n y^n z^n | n \geq 1\}$  is context free or not.
- Consider the following productions:  
 $S \rightarrow aB | bA$   
 $A \rightarrow aS | bAA | a$   
 $B \rightarrow bS | aBB | b$   
For the string "aaabbabbba",  
Find  
(i) the leftmost derivation  
(ii) the rightmost derivation  
(iii) the parse tree
- How to convert Mealy machine to Moore machine and vice versa?

i. Consider the grammar

$$S \rightarrow abScB|\lambda$$

$$B \rightarrow bB|b$$

What language does it generate?

j. What is reducibility?

k. Show that  $L = \{a^p \mid p \text{ is a prime}\}$  is not regular with the help of pumping lemma.

### Part III

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

(02×16)

Q3. Explain the Chomsky's hierarchy of languages with suitable example in each case.

Q4. The state transition function of a NPDA is given below which accepts the language by empty stack.

Find the Context Free Grammar. (Here  $q_0$  is the initial state of the machine)

$$\delta(q_0, a, Z) \rightarrow (q_1, XZ)$$

$$\delta(q_1, a, X) \rightarrow (q_2, Y)$$

$$\delta(q_2, a, Y) \rightarrow (q_1, XY)$$

$$\delta(q_2, b, Y) \rightarrow (q_3, \lambda)$$

$$\delta(q_3, b, Y) \rightarrow (q_3, \lambda)$$

$$\delta(q_3, \lambda, Z) \rightarrow (q_3, \lambda)$$

Q5. Construct a PDA for the given CFG, and test whether  $0^310^4$  is acceptable by this PDA.

$$S \rightarrow 0BB$$

$$B \rightarrow 0S \mid 1S \mid 0$$

Q6. Design a Turing machine to compute  $f(x) = x/2$ , if  $x$  is even, and  $f(x) = (x+1)/2$ , if  $x$  is odd, where  $x$  is a positive integer represented in unary.