(v) The major difference between Moore Machine and Mealy Machine is that
(a) the output of the former depends on present state and present input.
(b) the output of the former depends on present state only.
(c) the output of the former depends on present input only.
(d) all of these.

(vi) The intersection of Context Free Language & Regular Language
(a) need not be regular but can be context free
(b) need not be Context Free but can be context sensitive
(c) is always regular
(d) none of these.

(vii) A deterministic finite state acceptor (dfsa) can be constructed to recognize any given language L of Type n, where n equals
(a) 0. (b) 1. (c) 2. (d) 3.

(viii) Which of the following pairs of machines given below *do not* have equal computing power?
(a) Deterministic and Nondeterministic finite state automata
(b) Deterministic and Nondeterministic pushdown automata
(c) Deterministic and Nondeterministic Turing Machine
(d) Multi tape Turing machine and Universal Turing machine.

(ix) A machine M has been designed that, given a positive integer n as input, accepts n if and only if n is a positive power of a prime number. Then which one of the following alternatives is false?
(a) M cannot be a deterministic pushdown acceptor (dpda).
(b) M cannot be a non-deterministic pushdown acceptor (ndpda).
(c) M cannot be a Turing machine.
(d) M cannot be a non-deterministic finite state acceptor (ndfsa).

(x) A deterministic finite state machine M on the input alphabet { 0.1 } has n states. Let L be the language accepted by M, and let G be a regular grammar for L. Then G can always be so designed that the number of production rules in G does not exceed
(a) n. (b) 2n. (c) 3n. (d) 4n.

Group - B

2. (a) Design a non-deterministic finite state acceptor (ndfsa) M that will accept only those strings on the alphabet {0,1} that both begin and

end with the substring '01'. Show both the state table and the state transition diagram of M and briefly explain how M works.

(b) Convert M to a deterministic finite state acceptor (dfsa) N. Again show both the state table and the state diagram.

(c) Minimize the number of states in N and thereby get a deterministic finite state acceptor (dfsa) P. Show the state diagram of P.

6 + 3 + 3 = 12

3. Design a deterministic finite state acceptor (dfsa) M_3 that will accept only those strings on the alphabet {0,1} that contains Even number of 0's and Even number 1's. Explain the design in brief with the help of suitable examples. Show both the state table and the state transition diagram of M_1 and briefly explain how M_1 works.

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Group - C

4. Provide regular expressions for the following regular languages on the alphabet { 0, 1 } :
(a) The language L_1 consists of all strings that do *not* contain the substring '00'.
(b) The language L_2 consists of all strings that contain an even number of 0's.
Explain with examples why the regular expressions provided by you for each case have the required properties.

6 + 6 = 12

5. (a) State and explain the Pumping Lemma for Regular Languages.
(b) Use the Pumping Lemma for Regular Languages to show that the language $L_1 = \{ a^m b^m \mid m > 0\}$ is not regular.

6 + 6 = 12

Group – D

6. (a) Provide a Type 2 (context-free) grammar G for the language $L = \{ 0^m 1^{2n} 0^n \mid m > 0, n > 0 \}$.
(b) Express the grammar G of part (a) in Chomsky Normal Form.

6 + 6 = 12

7. (a) Prove that Context Free Languages are closed under union operation.

   (b) Consider the language $L_3 = \{ 0^m1^n0^m1^n \mid m,n > 0 \}$. Use the Pumping Lemma for context-free languages to show that L_3 is not a context-free language.

5 + 7 = 12

Group - E

8. A positive integer n is written on a Turing machine tape in unary notation. At start the read/write head is positioned on the leftmost 1 of n. Give the state transition diagram of a Turing machine M that will compute the quantity 3n+2 in unary notation and place the result to the right of n separated by a blank. When M stops the read/write head should again scan the leftmost 1 of n. Explain your method clearly and state any assumptions made. Tape symbols in addition to 1 and blank can be used if needed.

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9. (a) Design a Turing machine M_{11} that recognizes the language $L_5=\{w\#w \mid w \in \{0,1\}^*\}$.

   (b) What do we mean by Nondeterministic Turing Machines? What do we mean when we say that the Halting Problem for Turing machines is unsolvable?

6 + 6 = 12

M.TECH/CSE/2ND SEM /CSEN 5201/2016
2016

THEORY OF COMPUTATION
(CSEN 5201)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following: **10 × 1=10**

   (i) A non-deterministic finite state machine (ndfsa) M on the input alphabet {0,1} has m states. Let M be converted into a reduced (i.e., minimized) deterministic finite state machine (dfsa) N with n states. Then n cannot exceed
   (a) M. (b) 2m. (c) m^2. (d) 2^m.

   (ii) Let N be a deterministic finite state machine (dfsa) with n states that accepts all strings in the regular expression 0*1*0 (and none others). Then the smallest possible value of n is
   (a) 3. (b) 4. (c) 5. (d) 6.

   (iii) L_1 and L_2 are two Type 3 (regular) languages on the input alphabet {0,1}. Let the language L consist of all strings that are neither in L_1 nor in L_2. Then
   (a) L is a Type 3 language.
   (b) L is a Type 2 language but not necessarily a Type 3 language.
   (c) L is not necessarily a Type 2 language.
   (d) L is a Type 0 language but not necessarily a Type 1 language.

   (iv) If it is known that the total number of strings of terminal symbols of length at most 4 equals 120, then the number of terminal symbols must be
   (a) 2. (b) 3. (c) 4. (d) 5.