B.TECH/CSE/5TH SEM/CSEN 3101/2016

FORMAL LANGUAGE & AUTOMATA THEORY
(CSEN 3101)

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 alternative for the following: **10 × 1 = 10**

(i) Which of the following is true?
(a) (01)*0 = 0(10)*
(b) (0+1)*0(0+1)*1(0+1) = (0+1)*01(0+1)*
(c) (0+1)*01(0+1)*+1*0* = (0+1)*
(d) All of above.

(ii) 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.

(iii) 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.

(iv) L and ~L are recursive enumerable then L is
(a) recursive enumerable (b) context free
(c) context sensitive (d) recursive.

(v) 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.

(vi) Which of the following conversion is not possible (algorithmically)?
(a) regular grammar to context-free grammar
(b) nondeterministic FSA to deterministic FSA
(c) nondeterministic PDA to deterministic PDA
(d) nondeterministic TM to deterministic TM.

(vii) Recognize the CFL for the given CFG.
S-> aB / bA,
A-> a / aS / bAA,
B-> b / bS / aBB
(a) Strings contain equal number of a's and equal number of b's
(b) Strings contain odd number of a's and odd number of b's
(c) Strings contain odd number of a's and even number of b's
(d) Strings contain even number of a's and even number of b's.

(viii) S1: $\{ 0^{2n} \mid n >= l\}$ is a regular language
S2: $\{ 0^m 0^n 0^{(m+n)} \mid m >= 1$ and $n >= 2\}$ is a regular language
Which of the following statements is correct?
(a) Only S1 is correct
(b) Only S2 is correct
(c) Both S1 and S2 are correct
(d) None of S1 and S2 is correct.

(ix) Which of the languages will not be accepted by a pushdown automata?
(a) $L = \{a^m b^n c^n : n>=1, m>=1\}$
(b) $L = \{a^n b^m c^n : n>=1, m>=0\}$
(c) $L = \{a^n b^{3n} : n>=1\}$
(d) $L = \{a^n b^n c^n : n>=1\}$

(x) Which of the following statements is false?
(a) Finite state machines when started with any input will always finally halt.
(b) Deterministic pushdown automata when started with any input will always finally halt.
(c) Nondeterministic pushdown automata when started with any input will always finally halt.
(d) Turing Machine when started with any input will always finally halt.

Group – B

2. Design a deterministic finite state acceptor (dfsa) M_1 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.

6 + 6 = 12

3. (a) Construct a deterministic finite automata for M whose transition table is given below (q_0 is the starting state and q_1 is the final state):

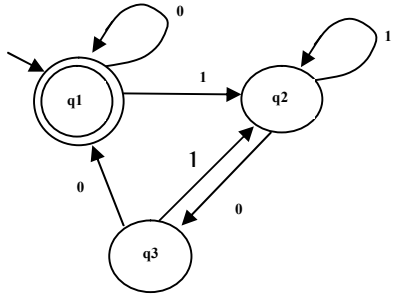
δ	a	b	c
q0	{q0, q1}	q1	-
q1	-	{q0, q1}	q1

(b) Construct FSA that accepts all string over {a, b} (Σ = {a, b}) that contain "aaa" as a substring.

6 + 6 = 12

Group – C

4. (a) Construct a Regular Expression for the given machine M.



(b) Construct a deterministic finite state acceptor (dfsa) M on the input alphabet { 0,1 } that accepts a string α if and only if α is contained in the language whose regular expression is (0+1)*(00+11)(0+1)*.

7 + 5 = 12

5. (a) Check out whether this language is regular or not :

$$\{0^{3x}1^{2y} \mid x, y \geq 0\}$$

Give proper justification for your answer.

(b) Show that regular languages are context free but converse need not be true.

6 + 6 = 12

Group – D

6. (a) Consider the language $L = \{ 0^m1^n 0^n 1^m \mid m, n > 0 \}$.
Is L a context free language?

If 'yes', then provide a context-free grammar for L thereby showing that L is a context-free language. If 'no', then prove it using pumping lemma.

(b) Consider the following context-free grammar G:
S → A
S → λ
A → BAB
A → BBB
B → 00C
B → 1
C → 1
Convert G to Chomsky Normal Form.

7 + 5 = 12

7. (a) Obtain a derivation tree for the string "0011000" using grammar:
S -> A0S | 0 | SS
A -> S | 1A | 10

(b) Suggest suitable grammars for the following languages:
(i) $\{a^ib^jc^kd^l \mid \text{where } i, j, k, l \geq 0\}$
(ii) $\{a^nb^{2n}c^m \mid \text{where } n \geq 0 \text{ and } m > n\}$

(c) Convert the following CFG to GNF form:
S -> aSb | a | b

3 + (3 + 3) + 3 = 12

Group – E

8. (a) Design a Turing machine M which can accept the language
$L_4 = \{a^nb^n : n>=1\}$.

(b) Can a Turing Machine perform addition? If 'yes' propose a design.

6 + 6 = 12

9. (a) Design a Turing machine M 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 + (3 + 3) = 12