B.TECH / CSE /5TH SEM/ CSEN 3101/2017
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) If L_1 and L_2 are two Context Free Languages then which one is not true?
(a) Union of L_1 and L_2, i.e., $L_1 \cup L_2$ is a Context Free Language
(b) Intersection of L_1 and L_2, i.e., $L_1 \cap L_2$ is a Context Free Language
(c) Concatenation of L_2 and L_1, i.e., L_2L_1 is a Context Free Language
(d) Star closure of L_1, i.e., L_1^* is a Context Free Language.

(ii) A minimum state DFA accepting the language **L = {w | w ∈ (0,1)***, where the number of 0's and 1's of w are divisible by 3 and 4, respectively} has
(a) 9 states (b) 12 states (c) 15 states (d) 16 states.

(iii) If the regular set A is represented by **A = (01 + 1)*** and the regular set B is represented as **B = (01)*1*** then
(a) $A \subset B$ (b) $A \supset B$ (c) A and B are incomparable (d) A = B.

(iv) A compiler must check the following syntactic error in a program :
Every opening curly bracket, i.e., '{' must be associated with a closing curly bracket, i.e., '}'.
Which machine is sufficient (according to computation power) to decide it?
(a) Deterministic Finite Automata
(b) Non Deterministic Finite Automata
(c) Pushdown Automata
(d) Turing Machine.

(v) Recognize the language for the given grammar.
S → XY
X → aX / bX / a
Y → Ya / Yb / a
(a) has at least one 'b' (b) should end in a 'a'
(c) has no consecutive a's or b's (d) has at least two 'a' s.

(vi) Pumping lemma for Context Free Languages is used for proving whether
(a) a given language is Context Free
(b) a given language is not regular.
(c) two given Context Free Languages are equivalent
(d) a given language is not Context Free.

(vii) Suppose that L_4 and L_5 are two languages (over the same alphabet) given to you such that both L_4 and L_4L_5 are regular. Then which of the following is correct?
(a) L_5 must be regular too.
(b) L_5 can never be regular
(c) L_5 need not be regular
(d) Cannot say anything about L_5.

(viii) Consider the following three languages:
L_1 = {wwR | w ∈ (0,1)*}
L_2 = {w # wR | w ∈ (0,1)*}, where # is a special symbol
L_3 = {ww | w ∈ (0,1)*}
Which one of the following is false?
(a) L_1 is a deterministic CFL (b) L_2 is a deterministic CFL
(c) L_3 is a CFL (d) both (a) and (c).

(ix) Which of the following regular expressions best represent the language L over **∑ = {a, b}** such that all the string do not contain the substring **"ab"**.
(a) a*b* (b) b*a* (c) (ab)* (d) (ba)*.

(x) Which of the following machines can accept the language L_6 which is the set of all palindromes from **{a, b}*** ?
(a) Nondeterministic Finite Automata
(b) Deterministic Pushdown Automata
(c) Nondeterministic Pushdown Automata
(d) None of the above

Group - B

2. (a) Construct a deterministic finite automata for the language given below:
All binary strings divisible by 2 or 3.

(b) Design a one-input one-output sequence detector that produces an output value 1 every time the sequence **"1110"** is detected, over output symbols **{0, 1}.**

(c) State the differences between NFA and DFA if exists any.

5 + 5 + 2 = 12

3.(a) A finite state machine M_1 has the state transition diagram shown in fig. 1. The start state is **a** and the final states are **c, d, e**. Minimize the number of states in the machine.

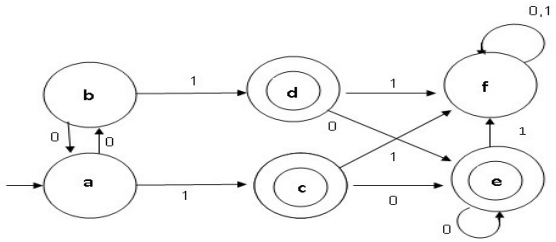

fig.1

(b) Consider the set of strings L_{12} on the alphabet **{0 , 1}** that contains even number of 0's . Consider another set of strings L_{13} on the alphabet **{0, 1}** that contains odd number of 1's. Design a deterministic finite state acceptor (dfsa) M_2 (using state table or state transition diagram) that will accept $\mathbf{L_{12} \cap L_{13}}$.

6 + 6 = 12

Group - C

4. (a) Construct a Regular Expression for the given machine M_3 shown in fig. 2.

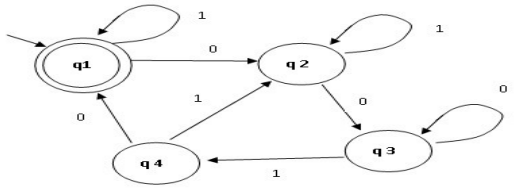

fig.2

(b) Construct a deterministic finite state acceptor (dfsa) M_4 on the input alphabet **{ 0, 1 }** that accepts a string α if and only if α is contained in the regular expression **(0 + 1)* (00 (11 + 0)*) (01)*.**

7 + 5 = 12

5. (a) Check out whether this language is regular or not :
$L = \{0^m 1^n 0^p \mid m, n, p \geq 0\}$
Give proper justification for your answer.

(b) Design a FSA, which will accept the following regular expression:
$\mathbf{r_1^* r_2 (r_4 + r_3 r_1^* r_2)^*}$

(c) "Pumping lemma can be used to prove that a given language is regular." – is the statement correct? If so then explain.

5 + 5 + 2 = 12

Group – D

6.(a) When a Context free grammar will be called ambiguous? Explain your answer with an example.

(b) Consider the following context-free grammar G:
S →AB
A → aA | bB | b
B → b
Convert G to Greibach Normal Form (GNF).

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

(2 + 3) + 4 + 3 = 12

7.(a) Determine whether the following grammar is ambiguous or not :
S → a/ Sa/ bSS/ SSb/ SbS

(b) Design a push down automata that will accept the following language:
$L = \{a^i b^j c^k \mid j = i + k$ and $i, k \geq 0\}$

6 + 6 = 12

Group – E

8. (a) Design a Turing machine M_5 which copies string of 1's . More precisely find a machine that performs the following operation:
$\mathbf{q_o w \vdash^* q_f ww}$

(b) Given two positive integers **x** and **y**, design a Turing Machine that computes **(x + y)**.

6 + 6 = 12

9.(a) Design a Turing Machine M_6 that accepts the following language.
$L = \{a^n b^n c^n \mid n > 0\}$

(b) Is "The halting problem" of Turning machine solvable, or deciable? Explain.

6 + 6 = 12