FORMAL LANGUAGE & AUTOMATA THEORY
(CBS3104)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) If Q is the number of states of a NFA, the equivalent DFA can have a maximum number of states
(a) Q (b) Q-1 (c) 2Q (d) 2^Q

(ii) The basic limitation of finite automata is that
(a) It can't remember arbitrary large amount of information
(b) It sometimes recognize grammar that are not regular
(c) It sometimes fails to recognize regular grammar
(d) None of the above

(iii) Regular expression a / b denotes the set
(a) {a} (b) {∈ , a, b } (c) {a,b} (d) {ab}

(iv) Which one of the following languages over the alphabet {0,1} is described by the regular expression: (0+1)*0(0+1)*0(0+1)*?
(a) The set of all strings containing the substring 00
(b) The set of all strings containing at most two 0's
(c) The set of all strings containing at least two 0's
(d) The set of all strings that begin and end with either 0 or 1.

(v) The logic of pumping lemma is a good example of
(a) The pigeon-hole principle (b) The Divide and Conquer technique
(c) Recursion (d) Iteration

(vi) The set $\{a^n b^n \mid n>=1\}$ is generated by the CFG:
(a) S → aSb | ab (b) S → aSb | ab | ε
(c) S → aaSbb | ab (d) S → aaSbb | aabb | ab

(vii) Which of the following statement is correct?
(a) All Regular grammar are context free but not vice versa
(b) All context free grammar are regular grammar but not vice versa
(c) Regular grammar and context free grammar are the same entity
(d) None of these

(viii) Turing machine (TM) is more powerful than Finite State Machine because
(a) tape movement is confined to one direction
(b) it has no finite state
(c) it has the capability to remember arbitrarily long sequences of input symbols
(d) None of the above

(ix) Turing machine consist of:
(a) Input tape (b) Blank symbol
(c) Tape head (d) All of these

(x) Which automata takes stack as storage?
(a) Finite automata (b) Push down automata
(c) Turing machine (d) Regular expression

Fill in the blanks with the correct word

(xi) A grammar that produces more than one parse tree for the same sentence is called _____.

(xii) An automaton that presents output based on previous state or current input called _____.

(xiii) Regular expression can be generated from finite automata using _____ Theorem.

(xiv) Push down automata accepts _____ languages.

(xv) A pushdown automata is _____ if there is at most one transition to each configuration.

Group - B

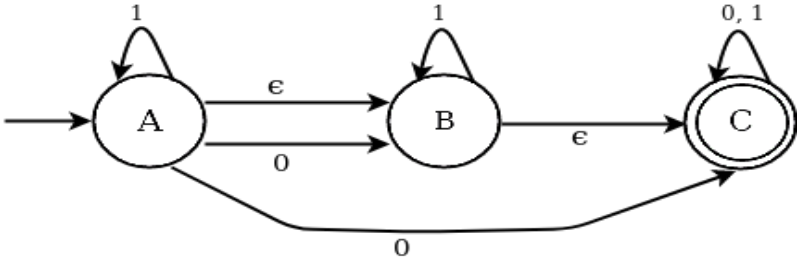
2. (a) Design a DFA over $\sum$ ={a,b} such that every string accepted must end with ab.
[(CO1)(Create/HOCQ)]

(b) Convert the following NFA into equivalent DFA where q_0 is initial state and q_3 is final state.
[(CO1)(Apply/IOCQ)]

PS	Next State	
	X=0	X=1
q_0	q_0, q_1	q_0
q_1	q_2	q_1
q_2	q_3	q_3
q_3	_	q_2

5 + 7 = 12

3. (a) Convert the following Epsilon-NFA into NFA using Epsilon closure:



[(CO1)(Understand/LOCQ)]

(b) Design a DFA over $\sum$ ={a,b} such that every string accepted must hold following condition:
(i) |w|= 1 (mod 5) (ii) $|w_b|$= 2 (mod 3) *[(CO1)(Create/HOCQ)]*

(3 + 3) + (3 + 3) = 12

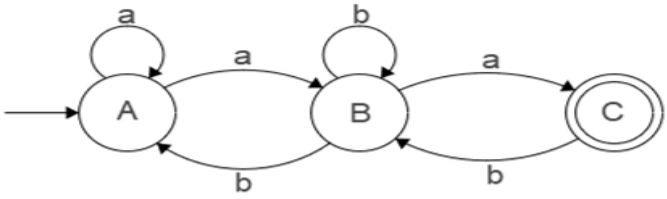
Group - C

4. (a) State Pumping Lemma. Show that the language L={ ww | w ∈ {a,b}*} is not Regular using Pumping Lemma. *[(CO3)(Understand/Apply/IOCQ)]*

(b) Draw Finite Automata Transition Diagram of the following Regular Expression:
(i) $(ab)^* + (a+ab)^*b^*(a+b)^*$ (ii) [a+ba(a+b)]*a(ba)*b* *[(CO3)(Create/HOCQ)]*

(3 + 3) + (3 + 3) = 12

5. (a) State Arden's Theorem. Find the regular expression for the following FA using Arden's Theorem:



[(CO3)(Understand/LOCQ/Apply/IOCQ)]

(b) Define grammar with a proper example. *[(CO3)(Remember/LOCQ)]*

(c) Differentiate between regular grammar and CFG. *[(CO3)(Analyze/IOCQ)]*

(2 + 4) + 4 + 2 = 12

Group - D

6. (a) Write all the Steps to Convert CFG to CNF. *[(CO5)(Understand/LOCQ)]*

(b) Remove the null production and unit production for the following grammar:

$S \rightarrow ASB$
$A \rightarrow aAS \mid a \mid \varepsilon$
$B \rightarrow SbS \mid A \mid bb$

[(CO4)(Apply/IOCQ)]

6 + 6 = 12

7. (a) Define Chomsky's Normal Form (CNF) and Greibach Normal Form(GNF) with an example. *[(CO4)(Understand/LOCQ)]*

(b) Convert the following Context Free Grammar (CFG) to Chomsky's Normal Form (CNF):

$S \rightarrow aAbB$
$A \rightarrow aA \mid a$
$B \rightarrow bB \mid b$

[*(CO4)(Apply/IOCQ)]*

(3 + 3) + 6 = 12

Group - E

8. (a) Design Turing Machine over $\sum$={0,1} to accept the language L={0^m1^n|m,n are even} *[(CO6)(Create/HOCQ)]*

(b) Define turing machine model. *[(CO6)(Remember/LOCQ)]*

8 + 4 = 12

9. (a) Explain halting problem. *[(CO6)(Remember/LOCQ)]*

(b) What are the application of turing machine? *[(CO6)(Remember/LOCQ)]*

(c) Why Turing machine is more powerful than Finite automata? *[(CO6)(Analyse/IOCQ)]*

4 + 4 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	35.41	32.29	32.29