FORMAL LANGUAGE & AUTOMATA THEORY
(CSBS 3103)

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) A regular expression representing the language {ϵ, a, b} is
(a) a+b (b) ab (c) ϵ+ a+ b (d) ϵab.

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

(iii) The part of an PDA, where the input string is placed before it is run, is called?
(a) State (b) Transition (c) Input tape (d) Output tape.

(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) Regular Expression For All Strings Starts With ab and ends with b defined over {a,b}
(a) ab(a+b)b (b) ab(a+b)* b (c) ab* b (d) none of these.

(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) A Moore machine accepts a string of length k; the length of the output string is
(a) k (b) 2k (c) k+1 (d) k-1.

(viii) A CFG is not closed under:
(a) product (b) union (c) Complementation (d) kleen star.

(ix) The solution for the equation R = Q + RP is
(a) R = QP* (b) R = Q*P* (c) R = Q*P (d) R = QP.

(x) 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.

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) _____ is the acyclic graphical representation of a grammar.

(xiii) A turing machine that is able to simulate other turing machines called _____.

(xiv) Finite automata requires minimum _____ number of stacks.

(xv) The pumping length of string of length x is _____.

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)]*

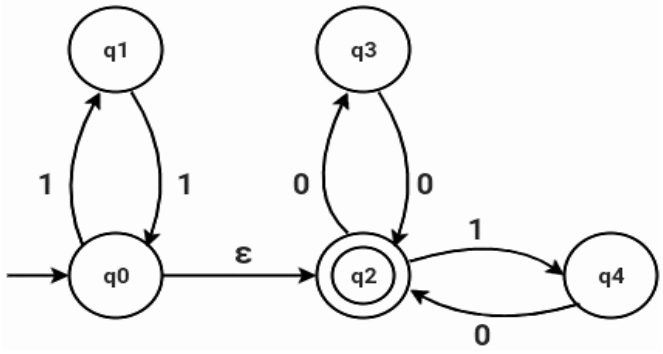
PS	Next State	
	X=0	X=1
q_0	q_0, q_1	q_0
q_1	q_2	q_1
q_2	q_3	q_3
q_3	__	q_2

5 + 7 = 12

3. (a) Consider the following Mealy machine as shown below. Convert it to equivalent Moore machine. *[(CO1)(Apply/IOCQ)]*

PS	Next State, O/P	
	X=a	X=b
q_1	q_1,1	q_2,0
q_2	q4,1	q_4,1
q_3	q_2,1	q_3,1
q_4	q_3,0	q_1,1

(b) Convert the following Epsilon-NFA into NFA using Epsilon closure:



[(CO1)(Apply/IOCQ)]

6 + 6 = 12

Group - C

4. (a) State Pumping Lemma. Show that the language L={ 0^i 1^i| i>=1} is not Regular using Pumping Lemma. *[(CO2)(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)]*

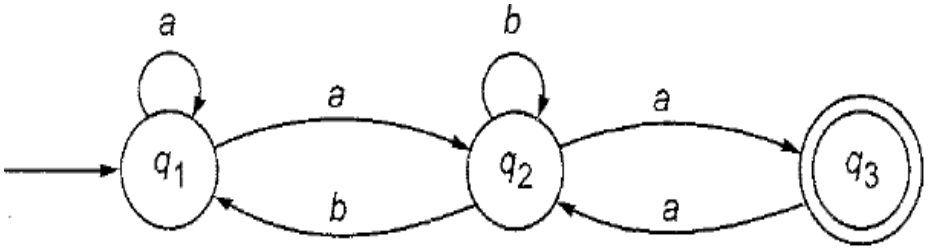
(3 + 3) + (3 + 3) = 12

5. (a) Convert the following Regular Grammar to Regular Expression:

   S→ 011A |101B
   A→ 110A |00
   B→ 11B | S *[(CO3)(Apply/IOCQ)]*

   (b) Find the Regular Expression over ∑ ={a,b} such that $|w_a| = 1 \pmod 3$. *[(CO3)(Apply/IOCQ)]*

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



[(CO3)(Apply/IOCQ)]

4 + 3 + (2 + 3) = 12

Group - D

6. (a) Design a PDA to accept the language L = {$a^n b^{2n}$ | n ≥1}. *[(CO5)(Create/HOCQ)]*

   (b) Show that the following grammar is ambiguous.

   S→ a | abSb| aAb
   A→ bS | aAAb *[(CO5)(Evaluate/HOCQ)]*

8 + 4 = 12

7. (a) Consider the following grammar:

   S→ aB |bA
   A→ aS | bAA | a
   B→ bS | aBB | b

   For the string aaabbabbba, find (i) left most derivation (ii) right most derivation *[(CO4)(Apply/IOCQ)]*

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

   S → aAD
   A → aB | bAB
   B → b
   D → d *[(CO4)(Apply/IOCQ)]*

(3 + 3) + 6 = 12

Group - E

8. (a) Design Turing Machine over ∑={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) What is Instantaneous Description (ID) in TM? Explain with example. *[(CO6)(Understand/LOCQ)]*

   (b) Design a Turing Machine that accepts the language L = {0^n 1^n| n>=1}. *[(CO6)(Create/HOCQ)]*

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	10.42	51.04	38.54

Course Outcome (CO):

After the completion of the course students will be able to

1. Demonstrate basic concepts of formal languages of finite automata techniques
2. Identify different formal language classes and their relationships
3. Design finite automata for different regular expressions and languages
4. Construct context free grammar for various languages
5. Design push down automata as a recognizer of languages
6. Interpret Turing machines as a language acceptor.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*