FORMAL LANGUAGE & AUTOMATA THEORY
(INFO 3104)

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) Which of the following is the language generated by the grammar
$S \rightarrow aSb$, $S \rightarrow A$, $A \rightarrow aA$?
(a) $a^m b^m$ (b) Φ (c) $a^n b^m$ (d) $a^m b^n$.

(ii) Which of the following production is in CNF
(a) S →aA (b) SA → AS (c) S → AB (d) All of (a), (b) & (c).

(iii) When are 2 finite states equivalent?
(a) Same number of transitions
(b) Same number of states
(c) Same number of states as well as transitions
(d) Both are final states.

(iv) A push down automaton employs _____ data structure.
(a) Queue (b) Linked List (c) Hash Table (d) Stack

(v) The language accepted by finite automata is
(a) type 0 (b) type 1 (c) type 2 (d) type 3.

(vi) If ∑= {0,1}, then Φ* will result to:
(a) ε (b) Φ (c) ∑ (d) None of (a), (b) & (c)

(vii) The production of the form A->B , where A and B are non terminals is called
(a) Null production (b) Unit production
(c) Greibach Normal Form (d) Chomsky Normal Form

(viii) The Grammar can be defined as: G=(V, ∑, p, S)
In the given definition, what does S represents?
(a) Accepting State (b) Starting Variable
(c) Sensitive Grammar (d) None of (a), (b) & (c).

(ix) Number of states require to accept string ends with 10.
(a) 3 (b) 2 (c) 1 (d) can't be represented.

(x) If P, Q, R be regular expression over ∑, P is not ε, then R=Q + RP has a unique solution:
(a) Q*P (b) QP* (c) Q*P* (d) (P*O*) *

Fill in the blanks with the correct word

(xi) Context free language recognized by_____.

(xii) In mealy machine, the O/P depends upon_____.

(xiii) A Language for which no DFA exist is a_____.

(xiv) A DFA is represented by _____.

(xv) In grammar T is represented as_____.

Group - B

2. (a) A long sequence of pulses enters a two I/P, two O/P synchronous sequential circuit, which is required to produce an O/P pulse z=1 whenever the sequence 1001 occurs. Overlapping sequences are accepted; for example, if the input is 01001001010101……., the required O/P is 00001001000000…….
(i) Draw a state diagram.
(ii) Select an assignment and show the excitation and O/P tables.
[(CO1,CO4)(Evaluate/HOCQ)]

(b) Consider the following machine:

PS	NS, Z			
	I1	I2	I3	I4
A	___	___	E,1	___
B	D,0	A,1	B,0	___
C	C,0	D,1	___	A,0
D	___	E,1	B,__	___
E	B,0	___	C,__	B,0
F	A,__	___	D,__	____

(i) Draw the merger graph. (ii) Draw the compatibility graph.
(iii) Find the minimal closed covering with justification. *[(CO1)(Evaluate/HOCQ)]*

(2 + 3) + (3 + 2 + 2) = 12

3. (a) In response to an unknown input sequence, the machine of the following table produces the output sequence 1110000010, Find the input sequence to the machine if it is known that its initial state is A and its final state is F.

	NS,z	
PS	x=0	x=1
A	B,1	C,0
B	D,1	B,1
C	E,1	B,0
D	A,0	E,0
E	F,0	D,1
F	D,0	A,1

[(CO1,CO4)(Evaluate/HOCQ)]

(b) Prove that the following sequential machine has a finite memory iff its testing graph G is loop free.

PS	NS, z	
	x=0	x=1
A	B,0	C,0
B	D,0	E,1
C	A,1	E,0
D	E,0	D,0
E	A,1	E,1

[(CO1)(Evaluate/HOCQ)]

6 + 6 = 12

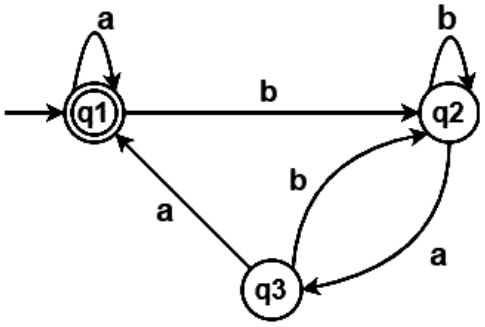
Group - C

4. (a) Design DFA of the following
   (i) Accepts strings containing exactly 1 over alphabet Σ = {0, 1}
   (ii) L = {w Є (0, 1)* | second symbol of w is '0' and fourth symbol is '1'}
   (iii) Accepts the set of strings either start with '01' or end with '01' over alphabet Σ = {0, 1} *[(CO2)(Apply/IOCQ)]*

   (b) Using Thompson's Construction rules design a NFA with ∈-transition for r=1(00+1)*01 and convert its equivalent DFA. *[(CO2)(Create/HOCQ)]*

(3 × 2) + (3 + 3) = 12

5. (a) Prove that (a* ab + ba)* a* = (a + ab + ba)*. *[(CO3)(Analyse/HOCQ)]*
   (b) Define Arden's Theorem. State one application of it. *[(CO3)(Understand/LOCQ)]*
   (c) Prove that L = { 0^n 1^m | n ≤ m } is not regular. *[(CO3)(Analyse/HOCQ)]*
   (b) Construct a regular expression corresponding to the state diagram of the following figure.



[(CO3)(Evaluate/HOCQ)]

2 + (1 + 1) + 4 + 4 = 12

Group - D

6. (a) Let G be the grammar
   S->bB|aA, A->b|bS|aAA, B->a|aS|bBB
   For the string bbaababa find (i) Leftmost derivation (ii) Rightmost derivation (iii) Parse tree where S is the Start symbol. *[(CO4)(Understand/LOCQ)]*

   (b) Consider the following grammar G
   S -> ABAC

A ->aA | Є
B ->bB | Є
C -> c

Remove the Є – production from the above grammar. *[(CO4)(Create/HOCQ)]*

(3 × 2) + 6 = 12

7. Write a short notes of the following:
   (i) Pumping Lemma for context free grammar
   (ii) Greibach Normal Form (GNF)
   (iii) Chomsky Normal Form (CNF). *[(CO4,CO5)(Understand/LOCQ)]*

(3 × 4) = 12

Group - E

8. Construct a PDA of each of the following language:
   (i) $L = \{ a^n b^{n+1} \mid n \geq 1\}$
   (ii) $L = \{ a^3 b^n c^n \mid n \geq 0\}$
   (iii) $L = \{ (ab)^n \mid n \geq 1\}$. *[(CO6)(Apply/IOCQ)]*

(3 × 4) = 12

9. (a) Design a Turing Machine that accepts the language of all strings which contain 'aba' as a substring. *[(CO6)(Analyse/HOCQ)]*
   (b) Write a short note of the following:
   (i) Context Free Language (CFL) & Push Down Automata (PDA)
   (ii) Halting Problem & Universal Turing Machine. *[(CO6)(Understand/LOCQ)]*

4 + (2 × 4) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	29.17	18.75	52.08

Course Outcome (CO):

After the completion of the course students will be able to
1. Describe and Design the Finite State Machine and the concept of Automata using sequential circuits.
2. Describe, Evaluate and express the different concepts of Finite Automata (NFA, DFA).
3. Describe and Design the Regular Language for Finite Automata (NFA, DFA).
4. Classify, describe and discuss different types of Grammar (Regular Grammar and Context Free Grammar). 5. Construct Context Free Language using Context Free Grammar.
6. Describe and Design Turing Machine and Push Down Automata for Context Free Language.

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