SWITCHING THEORY & AUTOMATA
(INFO 2201)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> 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)   A language is regular if and only if
          (a) accepted by DFA   (b) accepted by PDA
          (c) accepted by LBA   (d) accepted by turing machine.

    (ii) Which of the following regular expressions over {a, b} denotes all words begin
          and end with 'a' and in between any word using 'b'
          (a) ab^*a (b) $a + ab^*a$ (c) $(a +b)^*a$ (d) $a(a+b)^*a$.

    (iii) L= { $a^n b^{2n}$ | n>=1} is accepted by
          (a) a DFA   (b) a NFA   (c) a PDA   (d) none of these.

    (iv) Input sequence of an information lossless machine can be determined from the
          knowledge of
          (a) only output sequence
          (b) output sequence and initial state
          (c) output sequence, initial state and final state
          (d) initial state.

    (v)   Which of the following regular expressions over {a, b} denotes all words contain
          exactly one 'a'
          (a) $(a + b)^*$ (b) $(ab)^*$ (c) b^*ab^* (d) ab^*.

    (vi) If a machine of n states is μ definite, then
          (a) $\mu \le n – 1$ (b) $\mu \ge n – 1$ (c) $\mu = n – 1$ (d) none of these.

    (vii) Consider the following grammar
          $S \to aABC \mid a$
          $A \to aA \mid B$
          $B \to aBA \mid C$
          $C \to \lambda \mid aC$

The null-able variables for the above grammar are
(a) S, A, B, C   (b) S, A, C   (c) A, B   (d) A, B, C.

(viii) Which of the following sets is regular?
(a) $\{ a^n | n$ is a prime$\}$ (b) $\{ a^{2n} | n>=1\}$
(c) $\{ a^n b^n c^n | n>=1\}$ (d) $\{ ww | w$ is in $(a, b)^+\}$.

(ix) Which is true of the following?
(a) Merger graph is directed graph   (b) Compatible graph is directed graph
(c) Both are directed   (d) None of these.

(x) Difference between Turing machine and Two-way FA is in
(a) Input Tape   (b) Read Write head
(c) Finite Control   (d) All of these.

Group - B

2. 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 0101 occurs. Overlapping sequences are accepted; for example, if the input is 01011011010101........., the required O/P is 00010100100101..........
(i)   Draw a state diagram.
(ii) Select an assignment and show the excitation and O/P tables.
(iii) Draw a Logic Diagram of the sequence (0101) detector.   [(CO1)(Evaluate/HOCQ)]

(3 + 4 + 5) = 12

3. (a)   Consider the following machine:

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

(i)   Draw the merger graph.
(ii)   Draw the compatibility graph.
(iii) Find the minimal closed covering with justification
[(CO1)(Understand/LOCQ)]
(b)   Explain with an example when two states of a machine are distinguishable.
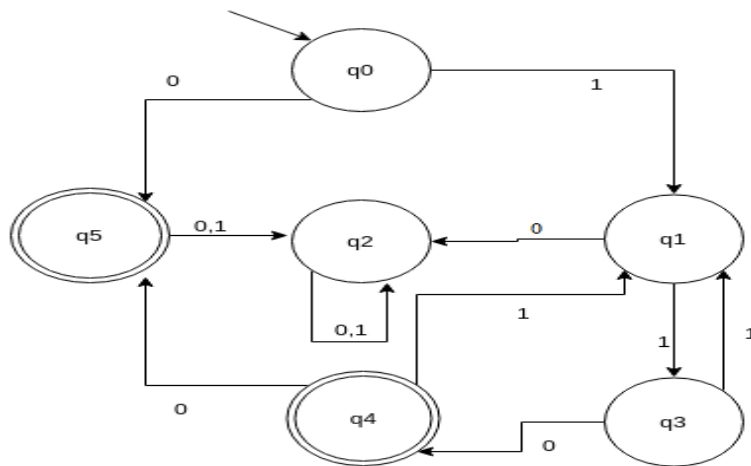[(CO1)(Understand/LOCQ)]
(4 + 3 + 2) + 3 = 12

Group - C

4. (a) Using Thompson's Construction rules design a NFA with ∈-transition for $r=$ $(0+1)^*10(0+1)$ and converts its equivalent DFA. [(CO2)(Create/HOCQ)]

   (b) Design a DFA that will accepts those words from $\sum=\{a, b\}$ where the numbers of 'b' is divisible by two. [(CO2)(Create/HOCQ)]

   (3 + 6) + 3 = 12

5. (a) Construct a Moore machine equivalent to the following Mealy machine:

PS	Input Symbol			
	a=0		a=1	
	NS	o/p	NS	o/p
q1	q3	0	q2	0
q2	q1	1	q4	0
q3	q2	1	q1	1
q4	q4	1	q3	0

[(CO2)(Apply/IOCQ)]

   (b) Using Ardens' theorem find out the regular expression for the following FA:

[(CO2)(Understand/LOCQ)]

   4 + 8 = 12

Group - D

6. (a) Let G be the grammar
   S->aB|bA, A->a|aS|bAA, B->b|bS|aBB
   For the string aaabbabbba, find
   (i) Leftmost derivation
   (ii) Rightmost derivation
   (iii) Parse tree
   Where S is the Start symbol. [(CO3)(Understand/LOCQ)]

   (b) Show that the following grammar is ambiguous
   S→ a | abSb | aAb,
   A→bS | aAAb. [(CO3)(Understand/LOCQ)]

    (c)   Prove that L= $\{a^n b^n c^n \mid n>=1\}$ is not Context Free Language.

                                                    [(CO3)(Apply/IOCQ)]
                                                    (3 × 2) + 3 + 3 = 12

7.   (a)   Remove all unit productions, all useless productions for the Grammar $S \rightarrow aA/aBB$, $A \rightarrow aaA/e$, $B \rightarrow bB/bbC$, $C \rightarrow B$.

              Where S is the Start Symbol.   **[(CO3)(Understand/LOCQ)]**

    (b)   Construct a DFA corresponding to the following regular grammar

              $S \rightarrow aS \mid bS \mid aA$

              $A \rightarrow bB$

              $B \rightarrow aC$

              $C \rightarrow \epsilon$.   **[(CO3)(Apply/IOCQ)]**
                                                    5 + 7 = 12

Group - E

8.   (a)   Define Push Down Automata.   **[(CO3)(Remembering/LOCQ)]**

    (b)   Design a PDA to accept the following language

             $L=\{a^n b^m a^n \mid m,n>=1\}$.   **[(CO3)(Create/HOCQ)]**

    (c)   Construct a PDA for the following language

             $L=\{a^n b^{2n} \mid n>0\}$.   **[(CO3)(Apply/IOCQ)]**
                                                    2 + 5 + 5 = 12

9.   (a)   Design a Turing Machine for acceptance string $0^n 1^n$.   **[(CO4)(Create/HOCQ)]**

    (b)   Differentiate between Multitape Turing Machine and Nondeterministic Turing Machine.   **[(CO4)(Analyze/IOCQ)]**
                                                        9 + 3 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	37.50	22.92	39.58

Course Outcome (CO):

After the completion of the course students will be able to

1. Define a system and recognize the behavior of a system as well as will be able to minimize a system and compare different systems.
2. Convert Finite Automata to regular expression and check equivalence between regular linear grammar and FA.
3. Minimize context free grammar and to check equivalence of CFL and PDA.
4. Design Turing Machine.

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