FORMAL LANGUAGE & AUTOMATA THEORY
(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)   If n is the number of states in NFA then equivalent DFA can have maximum of
          (a) n states   (b) n-1 states
          (c) 2^n states   (d) $2^n - 1$ states

   (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) What is the RE for the language set strings with atleast one 1, one 2 and one 3?
          (a) 1+2+3   (b)11*22*33*
          (c) 1*2*3*   (d) both (a) and (b)

   (iv)   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.

   (v)   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 $(a, b)^+$}

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

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

(viii) Pumping Lemma for CFL is used to show that
    (a) Language is regular   (b) Language is Context Free
    (c) Language is Context Sensitive   (d) Language is not Context Free

(ix) $S \to aABC \mid a$
      $A \to aA \mid B$
      $B \to aBA \mid C$
      $C \to \lambda \mid aC$
      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

(x)   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^*

Group – B

2. (a) Consider the following machine:

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

    (i) Draw the merger graph.
    (ii) Draw the compatibility graph.
    (iii) Find the minimal closed covering with justification.

(b) Find the equivalence partition for the machine of the following table. Also find a minimum-length sequence that distinguishes state A from state B.

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

(3 + 2 + 2) + (4 + 1) = 12

3.   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 1010 occurs. Overlapping sequences are accepted; for example, if the input is 01010110101………, the required O/P is 00001000010……… .
  (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(1010) detector.

(3 + 4 + 5) = 12

Group – C

4.   (a)   Construct a NFA with ϵ transition for $r=(00+1)^*010$

  (b)   (i)   Proof Arden's theorem.
       (ii) Compute Regular Expression(RE) from the following transition system:

Σ PS	a	b
q_0	q_0	q_1,q_2
q_1	q_2	-
q_2	q_1	-

Where q_0 initial state and q_1,q_2 both are final state.

4 + (3 + 5) = 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	1	q2	0
q2	q1	1	q4	0
q3	q2	1	q1	1
q4	q4	1	q3	0

  (b)   Show that the language $\{a^n b^n c^n | n >= 1\}$ is not a regular language.

  (c)   Design a DFA that will accepts those words from $\Sigma=\{a, b\}$ where the numbers of 'b' is divisible by three.

4 + 4 + 4 = 12

Group – D

6.   (a)   Convert the following grammar in greibach normal form
$$S \to ABb \mid a$$
$$A \to aaA \mid B$$
$$B \to bAb.$$

  (b)   Show that L= $\{a^i b^j c^k \mid i<j<k\}$ is not context free.

(c) Remove all unit productions, all useless productions for the Grammar
S→aA/aBB, A→aaA/e, B→bB/bbC, C→B.
Where S is the Start Symbol

3 + 4 + (3 + 2) = 12

7. (a) Find a Chomsky normal form equivalent to the following CFG

$S \to a\ B\ c$

$A \to a\ b\ c$

$B \to a\ A\ b$

$C \to A\ B$

$C \to c$

(b) 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

(c) Construct a CFG to generate a string containing 'a' and 'b' in any sequence.

4 + (3 × 2) + 2 = 12

Group – E

8. (a) What is Instantaneous Description(ID) in PDA? Explain with example

(b) Construct a PDA for the language L={$a^n\ b^m\ a^n$ | m,n>=1} where acceptance is by empty stack.

(c) Construct a PDA for the language L={ w € {a,b}* | w has the equal number of a's and b's}.

4 + 4 + 4 = 12

9. (a) Design a Turing machine for the regular expression 0^*11^*

(b) Let G be a CFG with the following productions.

$S \to a\ B\ c$

$A \to a\ b\ c$

$B \to a\ A\ b$

$C \to A\ B$

$C \to c$

Construct a PDA M such that the language generated by M and G are equivalent.

6 + 6 = 12

Department & Section	Submission Link
IT	https://classroom.google.com/c/MzM5NTczOTk2ODU5/a/Mzc0MjIwNTk4NjQx/details