Group – E

8. (a) Design a PDA, M to accept the language L = $\{a^{2n}b^n | n \geq 1\}$.

   (b) Write a short note on Multi-tape Turing Machine (TM).

8 + 4 = 12

9. (a) Design a Turing Machine (TM) over $\sum$ = {a, b} to accept the following language L = $(\omega\omega^R \mid \omega \in (a, b)^+)$.

   (b) Define Non Deterministic Push Down Automata (nPDA) and Instantaneous Description (ID) of Deterministic Push Down Automata (PDA) with example.

8 + 4 = 12

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 any 5 (five) from Group B to E, taking at least one 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) Regular expression for all strings which starts with ab and ends with bba is
   (a) aba * b * bba (b) ab(ab) * bba
   (c) ab(a + b) * bba (d) all of the mentioned.

   (ii) Which of the following CFG's can't be simulated by an FSM?
   (a) S → Sa | b (b) S → aSb | ab
   (c) S → abX, X → cY, Y → d | aX (d) None of these.

   (iii) The regular sets are closed under
   (a) Union (b) Concatenation
   (c) Kleene closure (d) all of these.

   (iv) If a machine of n states is μ definite, then
   (a) μ ≤ n - 1 (b) μ ≥ n - 1
   (c) μ = n - 1 (d) none of these.

   (v) Consider the language L_1, L_2, L_3 as given below:
   L_1 = {0p1q | p, q ∈ N}
   L_2 = {0p1q| p, q ∈ N and p = q}
   L_3 = {0p1q0r | p, q, r ∈ N and p = q = r}
   Which of the following statements is NOT TRUE?

   (a) Push Down Automata (PDA) can be used to recognize L1 and L2
   (b) L1 is a regular language
   (c) All the three languages are context free
   (d) Turing machine can be used to recognize all the three languages.

(vi) Which of the following statements is true?
(a) If a language is context free it can always be accepted by a deterministic push-down automaton
(b) The union of two context free languages is context free
(c) The intersection of two context free languages is context free
(d) The complement of a context free language is context free.

(vii) Definition of a language L with alphabet {a} is given as follows.
L= $\{a^{nk} \mid k > 0$, and n is a positive integer constant$\}$
What is the minimum number of states needed in a DFA to recognize L?
(a) k + 1 (b) n + 1 (c) 2n + 1 (d) 2k + 1.

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

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

(ii) Can the machine produce the output sequence 11011000 when both its initial and final states are A?

PS	NS, z 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

(b) Define Arden's Theorem with example. Convert the following Non-deterministic Finite Automata (NFA) to Deterministic Finite Automata (DFA)

PS \ Σ	0	1
q_0	q_0, q_2	q_1
q_1	q_1	q_2
q_2	q_1, q_2	q_0, q_2, q_3
q_3	q_3	q_2

(c) Construct regular grammar G for the following Deterministic Finite Automata (DFA):
$\partial(q_0, a) = q_0, \partial(q_1, a) = q_f, \partial(q_f, a) = q_f$
$\partial(q_0, b) = q_1, \partial(q_1, b) = q_f, \partial(q_f, b) = q_0.$

4 + 5 + 3 = 12

Group – D

6. (a) Prove that L(G) = $\{a^n b^n c^n \mid n>0\}$ is non Context Free Language.

(b) Remove Null production(s) from the following productions of the given context free grammar (CFG):-
S → AaBC
A → B|aA
B → cCC|aB|a
C → aC| λ

(c) Write context free grammar that generates:
L(G) = $\{WCW^R \mid W \in (a, b)^*\}$

4 + 5 + 3 = 12

7. (a) Check, whether the following grammar is ambiguous or not?
S → aB|bA
B → bS|bBB|b
A → aS|bAA|a

(b) Convert the following productions into Chomsky's Normal Form (CNF):-
B → aBB|C|abA
C → aCC|aa|D|a
D → λ|dd

(c) Design Context Free Grammar (CFG) to
(i) produce balanced parenthesis.
(ii) generate even and odd palindrome.

4 + 5 + (2 × 1.5) = 12

(b) Consider the following machine:
(i) Draw the merger table.
(ii) Draw the compatibility graph.
(iii) Find the minimal closed covering with justification.

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

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

3. (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 1011 occurs. Overlapping sequences are accepted; for example, if the input is 01011011……., the required O/P is 00001001…….
(i) Draw a state diagram for a sequence (1011) detector.
(ii) Draw a Logic Diagram of a sequence (1011) detector.

(b) (i) Find the equivalence partition for the machine shown in following table:
(ii) Show a standard form of the corresponding reduced machine.
(iii) Find a minimum length sequence that distinguishes state A from state B.

PS	NS,Z	
	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 + 3) + (3 + 2 + 1) = 12

Group – C

4. (a) Compute Regular Expression(RE) from the following transition system:

PS \ ∑	0	1
q_0	-	q_1
q_1	q_2	q_0
q_2	-	q_1

(b) Consider the following Meally Machine's transitions and output (O/P). Convert it to Moore's Machine.

PS	Next State, O/P	
	X = 0	X = 1
q_0	q_1, 1	q_2,1
q_1	q_2,0	q_3,1
q_2	q_3,1	q_0,0
q_3	q_1,1	q_1,0

(c) Write Regular Expression (RE) over ∑ = {0, 1}:
For set of all binary strings whose 2nd bit from right end is 1 and the 4th bit from right end is 0.

4 + 6 + 2 = 12

5. (a) Generate Regular Expression (RE) from the following Finite Automata (FA), where S_0 is the initial state and S_1, S_2 are final states:

PS	Next State,O/P	
	X=a	X=b
S_0	-	S_1
S_1	-	S_2
S_2	S_3	-
S_3	S_0	S_1