

**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) If a machine of n states is μ definite, then
(a) $\mu \leq n - 1$ (b) $\mu \geq n - 1$ (c) $\mu = n - 1$ (d) none of these.
- (ii) A sequence detector is set to detect the sequence 1010. How many times the output will go high if a stream of 1010101110010101011 is sent as an input and overlapping sequence is countable?
(a) 1 (b) 2 (c) 3 (d) 4.
- (iii) Number of states require to accept string ends with 10.
(a) 3 (b) 2 (c) 1 (d) can't be represented.
- (iv) P, Q, R be regular expression over Σ , P is not ϵ , then $R=Q + RP$ has a unique solution:
(a) Q^*P (b) QP^* (c) Q^*P^* (d) $(P^*O^*)^*$
- (v) Using Pumping Lemma if we select a string w such that $w \in L$, and $w=xyz$. Which of the following portions cannot be an empty string?
(a) x (b) y (c) z (d) All of the mentioned.
- (vi) Which among the following cannot be accepted by a regular grammar?
(a) L is a set of numbers divisible by 2
(b) L is a set of binary complement
(c) L is a set of string with odd number of 0
(d) L is a set of $0^n 1^n$.
- (vii) 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) $a^m b^n$.
- (viii) Which string can be generated by $A \rightarrow abA / bcB, B \rightarrow cd / ccbB$? Where A is the start symbol.
(a) aabccd (b) adabcca (c) abbccd (d) abababd.

- (ix) Which of the following automata takes stack as auxiliary storage?
 (a) Finite automata (b) Push down automata
 (c) Turing machine (d) All of the mentioned.
- (x) $L = \{ a^n b^{2n} \mid n \geq 1 \}$ is accepted by
 (a) a DFA (b) a NFA (c) a PDA (d) none of these.

Fill in the blanks with the correct word

- (xi) A Language for which no DFA exist is a_____.
- (xii) In Moore machine, the O/P depends upon_____.
- (xiii) Context free language recognized by_____.
- (xiv) A push down automaton employs _____ data structure.
- (xv) A turing machine operates over_____.

Group - B

2. (a) In response to an unknown input sequence, the machine of the following table given below produces the output sequence 0101000, Find the input sequence to the machine if it is known that its initial state is A and its final state is E. *[[CO1](Evaluate/HOCQ)]*

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

- (b) Prove that the following sequential machine has a finite memory iff its testing graph G is loop free. *[[CO1] (Evaluate/HOCQ)]*

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

7 + 5 = 12

3. (a) Consider the following machine:

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

- (i) Draw the Testing Graph
(ii) Find the output successor table
(iii) Find the predecessor table.
- (b) When two states of a machine are compatible?

[[CO1](Evaluate/HOCQ)]

[[CO1](Understand/LOCQ)]

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

Group - C

4. (a) Convert the following Non-deterministic Finite Automata (NFA) to Deterministic Finite Automata (DFA). Where, q_0 is initial state and q_2, q_3 are final states.

PS	Next State	
	X = 0	X = 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

[[CO2] (Apply/IOCQ)]

- (b) Using Thompson's Construction rules design a NFA with ϵ -transition for $r=1(00+1)^*01$ and convert its equivalent DFA.

[[CO2] (Create/HOCQ)]

$$4 + (3 + 5) = 12$$

5. (a) Show that the language $\{a^n b^n c^n \mid n \geq 1\}$ is not a regular. [[CO3](Understand/LOCQ)]
(b) Design a DFA which accepts the language $L = \{1^m 01^n \mid m, n \text{ are positive}\}$ [[CO3](Create/HOCQ)]
(c) Write Regular Expression (RE) over $\Sigma = \{0,1\}$
(i) Words ending with either double 0's or single 1's.
(ii) Set of all strings that begin or end with '00' or '11'.

[[CO3](Understand/LOCQ)]

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

Group - D

6. (a) Remove Useless symbol and unit production of the following grammar

$S \rightarrow AB$

$A \rightarrow a$

$B \rightarrow C \mid b$

$C \rightarrow D$

$D \rightarrow E$

$E \rightarrow a.$

[[CO4](CO5) (Create/HOCQ)]

- (b) Consider the following grammar G

$S \rightarrow ABAC$

$A \rightarrow aA \mid \epsilon$

$B \rightarrow bB \mid \epsilon$

$C \rightarrow c$

Remove the ϵ – production from the above grammar.

[[CO4](CO5) (Create/HOCQ)]

$$(3 + 3) + 6 = 12$$

7. (a) Show that the following grammar is ambiguous
 $S \rightarrow a \mid abSb \mid aAb,$

$A \rightarrow bS \mid aAAb$

and remove the above ambiguity.

[[CO4,CO5](Understand/LOCQ)]

(b) Prove that $L = \{a^i b^j \mid j = i^2\}$ is not Context Free Language.

[[CO5](Apply/IOCQ)]

(c) Compare between regular grammar and context free grammar.

[[CO4)(CO5)(Apply/IOCQ)]

(3 + 4) + 3 + 2 = 12

Group - E

8. (a) Design Turing Machine over $\Sigma = \{0,1\}$ to accept the language $L = \{1^m 0^m \mid m > 0\}$.

[[CO6)(Analyse/HOCQ)]

(b) Differentiate between DPDA and NPDA.

[[CO6)(Understand/LOCQ)]

9 + 3 = 12

9. (a) Let G be a CFG with the following production rules

$S \rightarrow a B c$

$A \rightarrow a b c$

$B \rightarrow a A b$

$C \rightarrow A B$

$C \rightarrow c$

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

[[CO6)(Apply/IOCQ)]

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

[[CO6)(Understand/LOCQ)]

8 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	26	18	56