B.TECH/IT/4TH SEM/INFO 2201 (Backlog)/2023

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 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) 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) A grammar in CNF may contain productions like
(a) A -> B (b) A -> BC (c) A ->aB (d) A ->Abcd.

(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) Using Pumping Lemma if we select a string w such that w∈L, and w=xyz. Which of the following cannot be an empty string?
(a) x (b) y (c) z (d) All of the mentioned.

(vi) 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.

(vii) 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.

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

(x) A FSM can be considered, having finite tape length without rewinding capability and unidirectional tape movement
(a) Turing machine (b) Pushdown automata
(c) Context free languages (d) Regular languages.

Group – B

2. (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

Can the machine produce the output sequence 11011000 when both its initial and final states are A? *[(CO1,CO4)(Evaluate/HOCQ)]*

(b) 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 0101101101001……., the required O/P is 0000100100000…….
(i) Draw a state diagram.
(ii) Select an assignment and show the excitation and O/P tables.
[(CO1,CO4)(Evaluate/HOCQ)]

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

3. Write a short note of the following: **(3 × 4) = 12**
(i) Finite State Machine (FSM)
(ii) Merger Graph
(iii) Information Lossless Machine.

Group - C

4. (a) Using Thompson's Construction rules design a NFA with ∈-transition for r=10(0+1)*01 and converts it's equivalent DFA. *[(CO3)(Create/HOCQ)]*

(b) Design a DFA that will accepts those words from ∑={ a, b} where the numbers of 'a' is divisible by two. *[(CO3)(Create/HOCQ)]*

(3 + 6) + 3 =12

5. (a) Consider the following Non-deterministic Finite Automata (NFA).

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

Where q_0 is the initial state and q_3 is the final state.
(i) Converts to it's equivalent DFA
(ii) Generate regular expression using Arden's theorem. *[(CO3)(Apply/IOCQ)]*

(5 + 7) = 12

Group - D

6. (a) Construct regular grammar G for the following Deterministic Finite Automata (DFA):
$\partial(q_0, a) = q_0, \partial(q_1, a) = q_f, \partial(q_f, a) = q_f$
$\partial(q_0, b) = q_1, \partial(q_1, b) = q_f, \partial(q_f, b) = q_0$
Where q_0 is the initial state and q_f is the final state. *[(CO2)(Apply/IOCQ)]*

(b) Show that the following grammar is ambiguous
$S \rightarrow a \mid abSb \mid aAb,$
$A \rightarrow bS \mid aAAb.$ *[(CO2)(Understand/LOCQ)]*

(c) Convert the following productions into Chomsky's Normal Form (CNF):-
$B \rightarrow aBB \mid C \mid abA$
$C \rightarrow aCC \mid aa \mid D \mid a$
$D \rightarrow \lambda \mid dd.$ *[(CO3)(Apply/IOCQ)]*

4 + 3 + 5 = 12

7. Write a short notes of the following: **(3 × 4) = 12**
(i) Regular grammar
(ii) Pumping Lemma for Context Free Language
(iii) Chomsky Normal Form (CNF). *[(CO2)(Understand/LOCQ)]*

Group – E

8. Construct a PDA for the following language: **(3 × 4) = 12**
(i) $L=\{a^n b^{n+2} \mid n>0\}$
(ii) $L=\{wcw^R \mid w \in \{a,b\}^*\}$
(iii) $L=\{a^n b^m a^n \mid m,n>=1\}$. *[(CO5,CO6)(Apply/IOCQ)]*

9. Write a short notes of the following: **(3 × 4) = 12**
(i) Universal Turing Machine
(ii) Push Down Automata
(iii) Multi-tape Turing Machine. *[(CO5,CO6)(Understand/LOCQ)]*

Cognition Level	*LOCQ*	*IOCQ*	*HOCQ*
Percentage distribution	*40.6*	*34.4*	*25.0*

Course Outcome (CO):

After the completion of the course students will be able to

1. Recall Knowledge of elementary discrete mathematics including the notion of set, function, relation, product, partial order, equivalence relation, graph & tree.
2. Classify, describe and discuss different types of Grammar (Chomsky's classification: Type 0. Type1, Type 2 and Type 3) and its corresponding Machines like (TM, LBA, PDA, FA).
3. Describe, Evaluate and express the different concepts in automata theory and formal languages such as formal proofs, (non-) deterministic automata, regular expressions, regular languages, context-free grammars, context-free languages, different Machines (LBA, Turing, DFA, NFA, nPDA, dPDA).
4. Apply powerful model of computation since they help computer scientists understand the limits of mechanical computation by providing a precise definition of an 'algorithm' or 'mechanical procedure'.
5. Construct different languages (type0-unresticted language, type1-context sensitive language, type2- context free language, type 3: regular language) and Turing machines.
6. Develop and Evaluate different Machines corresponding different types of language like Unrestricted language: Turing Machine (TM), context sensitive language: Linear Bounded Automata, Context free language: Push Down Automata, Regular language: Finite Automata.

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