FORMAL LANGUAGE & AUTOMATA THEORY
(CSBS 3103)

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) Which string can be generated by A → abA/bcB, B → cd /ccbB?
(a) aabccd (b) adabcca (c) abbccd (d) abababd.

(ii) A regular expression representing the language {ϵ, a, b} is
(a) a + b (b) ab (c) ϵ + a + b (d) ϵab.

(iii) The language accepted by PDA is
(a) type 0 (b) type 1 (c) type 2 (d) type 3.

(iv) Which of the following is true?
(a) (01)*0 = 0(10)* (b) (0+1)*0(0+1)*1(0+1) = (0+1)*01(0+1)*
(c) (0+1)*01(0+1)*+1*0* = (0+1)* (d) All of the mentioned.

(v) The finite state machine can recognize
(a) any grammar (b) only context-free grammar
(c) Both (a) and (b) (d) only regular grammar.

(vi) A set of regular languages over a given alphabet set is closed under
(a) union (b) complementation (c) intersection (d) all of these.

(vii) A pumping lemma is used for proving that
(a) a language is context free (b) a language is not context free
(c) two CFLs are same (d) two CFLs are different.

(viii) A Moore machine accepts a string w of length k. The length of the output string is
(a) k+1 (b) k-1 (c) k (d) k^2.

(ix) Turing machine (TM) is more powerful than Finite State Machine because
(a) tape movement is confined to one direction
(b) it has no finite state
(c) it has the capability to remember arbitrarily long sequences of input symbols
(d) none of these.

(x) A PDA can behave like Turing Machine when
(a) it has no stack (b) it has two or more stacks
(c) it has a stack of infinite size (d) all of these.

Group- B

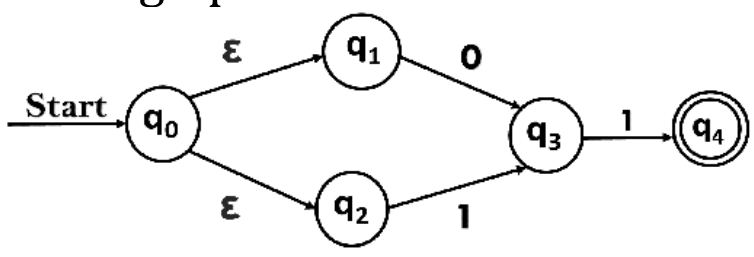
2. (a) Design a DFA that will accept a string over $\sum$ ={a,b} ending with a substring w=bab. [(CO1)(Apply/IOCQ)]

(b) Convert the following NFA into equivalent DFA where q_0 is the initial state and q_3 is the final state.

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

[(CO1)(Apply/IOCQ)]
5 + 7 = 12

3. (a) Convert the following Epsilon-NFA into NFA using Epsilon closure.



[(CO1)(Apply/IOCQ)]

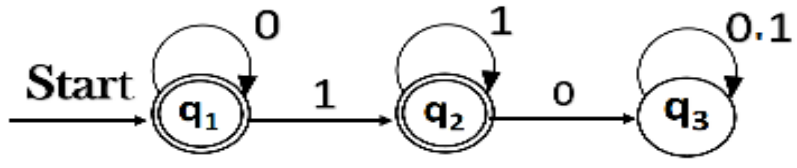
(b) Consider the following Mealy machine as shown below. Convert it to equivalent Moore machine.

PS	Next State,O/P	
	x=a	x=b
q_1	q_1,0	q_2,0
q_2	q_2,1	q_3,0
q_3	q_2,0	q_3,1

[(CO1)(Apply/IOCQ)]
6 + 6 = 12

Group - C

4. (a) Find the regular expression for the following DFA:



[(CO3)(Apply/IOCQ)]

(b) Define pumping lemma for regular language. Show that the language L={a^p|p=prime number} is not regular. [(CO2)(Understand/LOCQ)]

(c) Draw finite automata transition diagram of the following regular expression:
$(ab)^* + (a+ab)^*b^*(a+b)^*$ [(CO3)(Apply/IOCQ)]
3 + (2 + 3) + 4 = 12

5. (a) Convert the following regular grammar to finite automata:

S→S10|01

S→01S|10. [(CO3)(Apply/IOCQ)]

(b) Convert the following regular grammar to regular expression:

S→ 01A|B11

A→ 011A|01

B→ 101B|11 [(CO3)(Apply/IOCQ)]

(c) Write short notes on Chomsky classification. [(CO3)(Understand/LOCQ)]

(d) Find the regular expression over $\sum$ ={a,b} such that $|w_b| = 0 \pmod 2$. [(CO3)(Apply/IOCQ)]

3 + 3 + 3 + 3 = 12

Group - D

6. (a) Define Left Recursive Grammar (CFG) with example . [(CO4)(Understand/LOCQ)]

(b) Show that the following grammar is ambiguous:

S→aB|ab

A → aAB| a

B → ABb| b [(CO4)(Apply/IOCQ)]

(c) Write context free grammar that generates odd and even palindrome strings with 0 and 1. [(CO4)(Apply/IOCQ)]

3 + 5 + 4 = 12

7. (a) Convert the following Context Free Grammar (CFG) to Chomsky's Normal Form (CNF):

S → aAbB

A → aA|a

B →bB |b. [(CO4)(Apply/IOCQ)]

(b) Design a PDA to accept the language L = $\{a^n b^{2n} \mid n \geq 1\}$. [(CO5)(Analyse/IOCQ)]

4 + 8 = 12

Group - E

8. (a) Design a Turing Machine that accepts the language L = $\{0^n 1^n \mid n>=1\}$. [CO6)(Analyse/IOCQ)]

(b) Write a short note on Multi-tape Turing Machine (TM). [(CO6)(Understand/LOCQ)]

8 + 4 = 12

9. (a) Write short notes on a Non-deterministic Turing Machine. [(CO6)(Understand/LOCQ)]

(b) Construct a Turing machine (TM) to accept all strings ending with 010 over {0,1}. [(CO6)(Analyse/IOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	21.87	78.13	0

Course Outcome (CO):

After the completion of the course students will be able to

1. Demonstrate basic concepts of formal languages of finite automata techniques
2. Identify different formal language classes and their relationships
3. Design finite automata for different regular expressions and languages
4. Construct context free grammar for various languages
5. Design push down automata as a recognizer of languages
6. Interpret Turing machines as a language acceptor.

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