3 Yr. Degree/4 Yr. Honours 5th Semester Examination, 2025 (CCFUP)

Subject : Computer Application

Course : BCA5012 (MAJOR)

(Theory of Computation)

Time: 3 Hours **Full Marks: 60**

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

1. Answer *any ten* questions of the following: 2×10=20

(a) Define automation.
(b) Define a Finite State Machine (FSM).
(c) Distinguish between Moore and Mealy machines.
(d) What is state equivalence in FSM?
(e) State Pumping Lemma.
(f) What is a Derivation tree?
(g) What is meant by equivalence of DFAs?
(h) What is inverse machine?
(i) What is regular expression?
(j) Define Context-Free Grammar (CFG).
(k) Define Pushdown Automaton (PDA).
(l) Differentiate between acceptance by final state and acceptance by empty stack in PDA.
(m) What is meant by state minimization?
(n) What is Regular Grammar?
(o) What is testing graph?

2. Answer *any four* questions of the following: 5×4=20

(a) Design a Mealy machine that detects the sequence '1011' in a binary input stream. Draw the state diagram and explain its working.
(b) Prove that the language $L = \{a^n b^n | n \geq 0\}$ is not regular using the Pumping Lemma.
(c) Explain the ambiguity of a grammar with an example. How can ambiguity be removed? 3+2
(d) Prove that the class of regular languages is closed under union and intersection.
(e) Differentiate between machine equivalence and state equivalence of finite state machine.
(f) Design a deterministic finite automaton that accepts strings ending with '101'.

10×2=20

3. Answer *any two* questions of the following:

(a) Design a DFA for the language over {0, 1} consisting of all strings that do not contain three consecutive 0's. Then construct the corresponding regular expression. 6+4

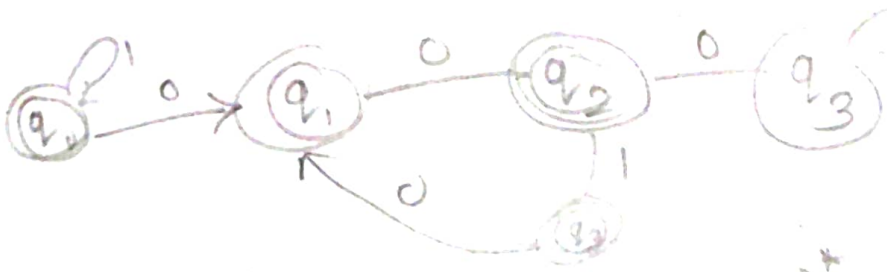
(b) Construct a PDA for the language $L = \{0^n 1^m | n >= 1, m >= 1, m > n + 2\}$.

(c) Construct an NFA for language $L = \{w \in \{a, b\} * | w$ contains substring "aba"$\}$. Convert it into an equivalent DFA. Find the corresponding regular expression. 3+4+3

(d) Design a Mealy machine to detect two consecutive 1's in a binary input sequence. The output should become 1 immediately when the second one occurs. Draw the state diagram and derive the state table. 5+5

$r = (b+a)^* aba (a+b)^*$

3a)



$r = (1+01+10)^* (0+\lambda)(1+01+10)^* (0+\lambda)(1+01+$

2021

Paper Title: Theory of Computation Paper Code: BCS1061 (Elective-I)

F.M. 80 Time: 3Hrs.

1. Answer any six questions 6*5=30

a. Differentiate between DFA and NFA.
b. Draw NFA of the regular expression r= (a|b)*abb.
c. Give the DFA of the following Language over $\sum$ = {a,b} L={w : na(w)mod 3=0}
d. Prove that if l1 and l2 are regular Languages then so is L1 INTERSECTION L2
e. State the properties of Regular Expression.
f. What is CNF? Give example.
g. Define Push Down Automata(PDA).
h. Explain that the "turing machine is language acceptor" .

2. Answer any five questions 5*10=50

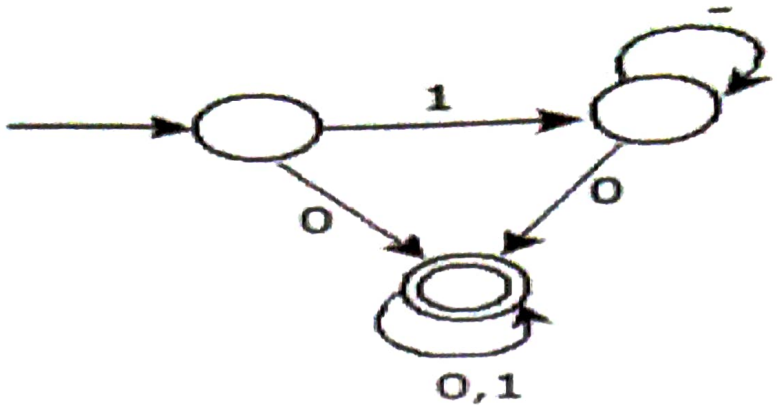
a. Differentiate between Mealy machine and Moore machine. Convert the following Mealy machine to Moore machine.

States	Input , Output	
	a	b
Q_0 (Initial)	Q_1, 1	Q_2, 0
Q_1	Q_2, 1	Q_1, 0
Q_2	Q_0, 0	Q_3, 1
Q_3 (Final)	Q_3, 1	Q_0, 0

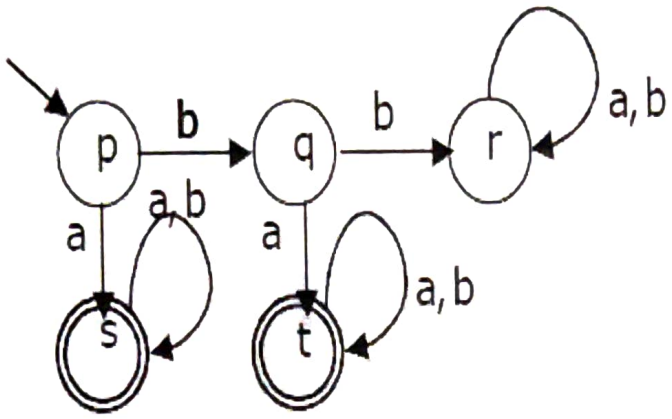
b. What is a derivation tree and what are its properties? Explain GNF with the help of suitable example.

c. Design a PDA for the following (any two)
   i. $a^{2n}b^n$: n>1
   ii. $a^nb^mc^n$: n, m > 1, n > m
   iii. a^nb^m | n,m> 1, n > m

d. Write the regular expression and draw the DFA/NDFA for the following :
   i. Strings of 1's and 0's, beginning with '1' and ending with '00' or '11'.
   ii. Strings of 1's and 0's, such that 1's are followed by 0's and ending with '1'.



f. When is a CFG said to be ambiguous, give example. Minimize the following DFA



g. Design a Turing Machine that accepts the language: $L=\{ 0^n1^n 2^n: n>=1\}$

B.C.A 6th Semester Examination, 2022

Paper Name: Theory of Computation *Paper Code: BCA 601*

Subject: Computer Application

FULL MARKS: 80 **Time: 3 Hours**

Answer question number 1 and any four from the rest.

1. Answer any eight questions . **8X2=16**

a) Define Finite Automata(FA).

b) Define state -transition diagram with a suitable example

c) Define NFA.

d) Define Regular Expressions.

e) What is context free grammar?

f) State Arden's theorem.

g)Define DFA.

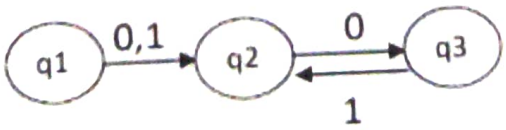
h) Draw the finite automata for the following regular expression: RE: Q=∅

i) What is parse tree?

j) Define PDA.

2. What are useful and useless symbols in grammar? Define alphabet and symbol with example. What are the different types of grammar? Construct a DFA to accept even number of 0's. Construct NFA for the regular expression a*b*. Convert the DFA to NFA, diagram is given below.

[2+2+2+3+3+4=16]



3. Define mealy machine and moore machine with example. What are the differences between mealy and moore machine? Construct a Mealy Machine which is equivalent to the Moore machine given to transition table given below. [3+3+4+6 = 16]

Present state	Next state		Output
	a =0	a=1	
q0	q3	q1	0
q1	q1	q2	1
q2	q2	q3	0
q3	q3	q0	0

4. Explain the various applications of regular expressions. Prove that $(0 * 1^*) * = (0 + 1)^*$. Prove that $(r *) * = r^*$ for a regular expression r. What is the closure property of regular set? Design a regular expression for the language containing even number of 0's followed by odd number of 1's. [3+3+3+3+4 = 16]

5. What is an ambiguous grammar? Define parse tree with an example. What are the properties of the CFL generated by CFG? What is the language generated by the grammar G = (V, T, P, S) where P={S->aSb, S->ab}. Construct the PDA accepting the language $L=\{(a^n b^{2n})|n>=1\}$. [2+2+2+4+6 = 16]

6. Write short note. I) Pumping Lemma II) Pushdown Automata (PDA) III) Derivation Tree IV) Context-Sensative Grammar . [4+4+4+4 = 16]

7. Write two notes a) Chomsky Normal Form (CNF) b) Epsilon NFA c) Turing Machine

[8+8 = 16]

BCA 6th Semester (Honours) Examination, 2023

Subject : Computer Application

Course : BCA-601 (Elective-I)

Theory of Computation

Time: 4 Hours **Full Marks : 80**

The questions are of equal value.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

Answer Question No. 1 *and* any four *from the rest questions.*

1. Answer *any eight* questions from the following: 2×8=16

(a) What is an automation?

(b) Define DFA.

(c) What is the difference between a deterministic automaton and non-deterministic automaton?

(d) How is a pushdown automaton different from a finite automaton?

(e) What is CNF (Chomosky Normal Form)?

(f) How can regular expressions be used to describe automata?

(g) What is unit production?

(h) Write an example of a context-free grammar.

(i) Explain the concept of epsilon transitions in automata.

(j) What is null production?

(k) Define Regular Expression.

(l) What do you mean by Regular Grammar?

2. Describe the process of converting a Nondeterministic Finite Automaton (NFA) to a Deterministic Finite Automation (DFA) with an example. Describe Moore Machine with example. 8+8

3. Write a regular expression for a language that accepts all strings over the alphabet {a, b} where every 'a' is immediately followed by 'b'. Convert the regular expression (a|b)*abb into an equivalent DFA. What is the regular expression for a language that accepts all strings of odd length over the alphabet {0, 1}? 4+8+4

4. State the Pumping Lemma for regular languages and explain its significance. Prove that the language $L = \{a^n b^n \mid n \geq 0\}$ is not a regular language using the Pumping Lemma. Design a DFA accepting even number of 'a' and even number of 'b' over the alphabet {a, b}. 4+8+4

370

5. What is a derivation tree in Context Free Grammar (CFG)? Describe ambiguous grammar with an example. Convert the following CFG into CNF: 4+4+4+4

   S− > AB|a

   A− > aA|ε

   B− > b

   Prove that two Regular Languages are closed under intersection.

6. Construct a parse tree for the arithmetic expression 2 + 3 * 4 – 5 using operator precedence and associativity rules. Convert the following CFG to Greibach Normal Form (GNF): 4+12

   S− > aA|Bb

   A− > Ac|ε

   B− > bB|ε

7. Write short note on Push Down Automata (PDA). Are all regular languages also context-free? Define Turning Machine. Design a turning machine that accept the language $L = \{a^n b^n c^n : n \geq 0\}$ over $\sum = \{a, b, c\}$. 2+4+2+8

BCA 6th Semester (Honours) Examination, 2024

Subject : Computer Application

Course : BCA-601 (Elective-I)

Theory of Computation

Time: 4 Hours **Full Marks : 80**

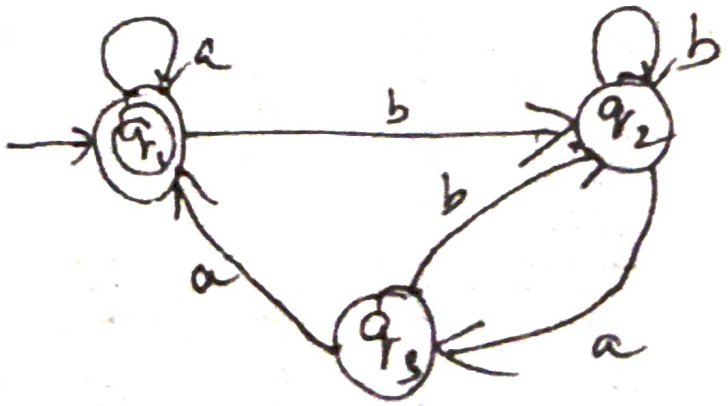
The questions are of equal value.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

Answer Question No. 1 *and* any four *from the rest questions.*

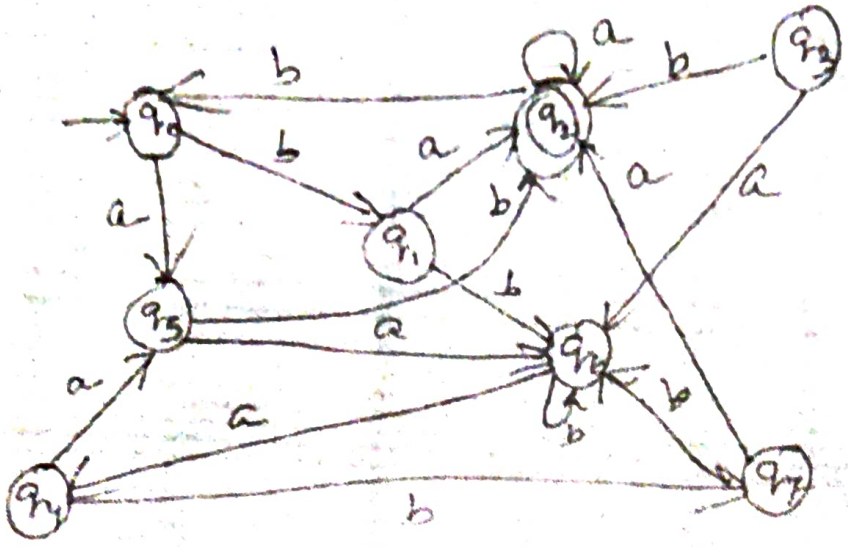
1. Answer *any eight* questions: 2×8=16

(a) Define a parse tree.
(b) Discuss the conditions under which two FSMs are considered equivalent.
(c) Describe the concept of a state table in the context of sequential circuits.
(d) Define finite automata.
(e) Explain the concept of transitions in automata.
(f) What is the significance of final states in automata?
(g) What is the role of a stack in pushdown automata?
(h) What is the concept of an empty string in automata?
(i) Explain the concept of a transition function in automata.
(j) Define the acceptance criteria for a finite automata.
(k) Define production rules in CFG.
(l) What is the significance of derivations in CFG?

2. Differentiate between Moore and Mealy Machine. State Arden's theorem. Find regular expression for the following DFA using Arden's theorem. 6+3+7



3. Describe techniques for minimizing the number of states in a sequential circuit. Minimize the following DFA. 6+



4. Show that the language $L = \{a^n b^{2n} | n \geq 0\}$ is not regular using Pumping Lemma. Write the regular expression and draw the DFA / NDFA for the following:

(a) Strings of 1's and 0's beginning with '1' and ending with '00' or '11'.

(b) Strings of 1's and 0's, such that 1's are followed by 0's and ending with '1'. 6+5+5

5. (a) Define PDA and language accepted by PDA.

(b) Draw PDA of the following languages.

(i) $L_1 = \{a^n b^n : n \geq 0\}$

(ii) $L_2 = \{a^n b^n c^m : n, m \geq 0\}$. 6+(5+5)

6. Discuss the importance of understanding formal languages and grammars in various computational tasks and applications. Define a parse tree and explain its role in representing the synthetic structure of sentences generated by a context-free grammar. 6+4+6

7. (a) Construct DFA equivalent to the Regular Expression $R = ab + (aa + bb)(a + b)^*$. Define ambiguous grammar with an example and discuss its problem in parsing. 8+8

(b) Discuss the conditions under which two FSMs are considered equivalent. Convert the following Mealy machine to Moore machine.

States	Input, Output	
	a	b
Q_0 (Initial)	Q_1, 1	Q_2, 0
Q_1	Q_2, 1	Q_1, 0
Q_2	Q_0, 0	Q_3, 1
Q_3 (final)	Q_3, 1	Q_0, 0