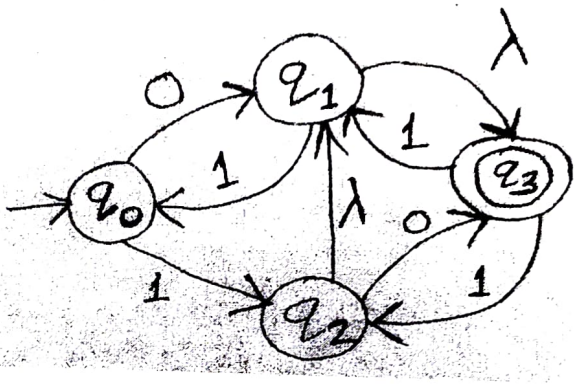
NOV-DEC-2023 EXAM
III YEAR B.TECH.
CO34002: THEORY OF COMPUTATION

Time: 3 Hours] [Max. Marks: 70

TOTAL NO. OF QUESTIONS IN THIS PAPEP: 5

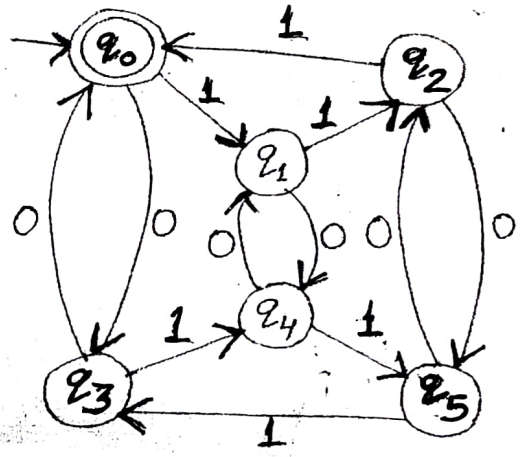
NOTE: Part (a), (b) and (c) of each question is compulsory. Attempt any one part from (d) and (e). Make assumptions wherever required.

Question No.	Question	Marks	CO	P	PI
Q.1 (a)	Are the following questions about regular language decidable? Justify your answer. 1. Is a given regular language empty? 2. Is a given regular language finite or infinite?	[02]	4	4	1.6.1
(b)	Write closure properties of Regular Languages and Context Free Languages.	[02]	1	1	1.6.1
(c)	Answer the following questions: 1. Find the string of minimum length over {a, b}, which does not correspond to the regular expression: r = a*b*. 2. Write regular expression generating set of all strings over {0, 1} containing at most one 0.	[03]	2	3	1.7.1
(d)	Convert the following Non-deterministic Finite Automata (NFA) into an equivalent Deterministic Finite Automata (DFA):	[07]	2	3	1.7.1



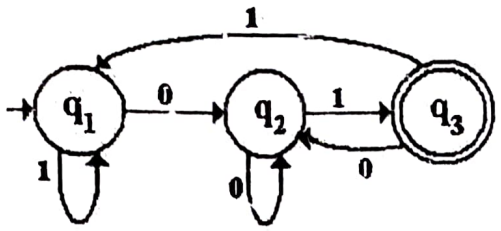
OR

(e)	Minimize the following Deterministic Finite Automata:	[07]	2	3	1.7.1



Q.2 (a) Write applications of Finite Automata and Context Free Grammar. [02] 1 1 1.6.1

(b) Find the regular expression corresponding to the following automata using Arden's Theorem: [02] 2 3 2.6.3



(c) Design a regular grammar for the following language: [03] 2 3 2.6.3
$L = \{ a^n b \mid n \geq 0 \} \cup \{ a^n bc \mid n \geq 0 \}$.

(d) Design a Moore Machine that scans binary strings over {0, 1}, and produces output X for each occurrence of substring 101, produces output Y for each occurrence of substring 110, otherwise produces output Z. [07] 2 3 2.6.3

OR

(e) Design a finite automata to accept the language L over {a, b} such that $L = \{ a^n b^m \mid n, m \geq 1$ and $n + m$ is even $\}$. [07] 2 3 2.6.3

Q.3 (a) Debug and correct the following grammar to accept binary strings containing b's in odd numbers: [02] 1 4 1.7.1
$S \rightarrow aS \mid bA \mid \lambda$, $A \rightarrow bA \mid aA \mid \lambda$

(b) Prove that the following language is not context-free using pumping lemma: $L = \{a^n b^n c^m \mid n \neq m\}$. [02] 3 3 1.7.1

(c) Convert the following Context Free Grammar into CNF Form: [03] 1 3 1.7.1
$S \rightarrow aAa \mid bBb \mid BB$, $A \rightarrow C$, $B \rightarrow S \mid Aa$, $C \rightarrow S \mid \lambda$

(d) Consider the following production rules of the grammar: [07] 1 3 1.7.1
$S \rightarrow AB \mid BC$, $A \rightarrow BA \mid a$, $B \rightarrow CC \mid b$, $C \rightarrow AB \mid a$.
Test the membership of the string baaba and babba in L(G) using CYK algorithm.

OR

(e) Design a push down automata for the following language: [07] 2 3 2.6.3
$L = \{ w : n_a(w) + n_b(w) = n_c(w) \}$.

Q.4 (a) Give example of following: [02] 3 2 1.6.1
1. A language which is context sensitive but not context free.
2. A language which is regular, context free but not context sensitive.
3. Deterministic context free language.
4. A grammar which is Linear but not regular.

(b) Give formal description of a Linear Bounded Automata and Multi-tape Turing Machine. [02] 1 1 1.6.1

(c) Consider the PDA $M = (\{q_0, q_1\}, \{a, b\}, \{z\}, q_0, \{q_1\})$, with following transitions [03] 1 4 1.7.1
$(q_0, a, z) = (q_1, z)$
$(q_0, b, z) = (q_0, z)$
$(q_1, a, z) = (q_1, z)$
$(q_1, b, z) = (q_0, z)$
Is it possible to find a DFA that accepts the same language as the PDA? Justify your answer.

(d) Design a Linear Bounded Automata for accepting all the strings of the language $L = \{ a^n b^{n+m} c^m : n, m \geq 1 \}$. (Draw Transition Diagram) [07] 2 3 2.6.3

OR

(e) Design a Linear Bounded Automata for accepting all the strings of the language $L = \{ ww^R : w \in \{a, b\}^* \}$. (Draw Transition Diagram) [07] 2 3 2.6.3

Q.5 (a) What is Halting Problem of Turing Machine? [02] 4 1 1.6.1

(b) Differentiate between Recursive Language and Recursively Enumerable Language. [02] 4 2 1.6.1

(c) Given a Turing Machine M, find L(M): [03] 1 3 1.7.1
M = ({q0, q1, q2}, $\sum$ = {a, b}, Γ = {a, b, □},δ, q0, □, {q2}), δ:
δ (q0, a) = (q1, □, R)
δ (q0, b) = (q1, □, R)
δ (q1, a) = (q0, □, R)
δ (q1, b) = (q0, □, R)
δ (q1, □) = (q2, □, L)

(d) Construct a Turing Machine to accept all odd length palindromes on {a, b}*. Show an accepting sequence of configurations for the input baaab. [07] 2 3 2.6.3

OR

(e) Construct a Turing Machine that will accept input on {a, b}* and copy all the input at the end after □. Show sequence of configurations for the input abab. [07] 2 3 2.6.3

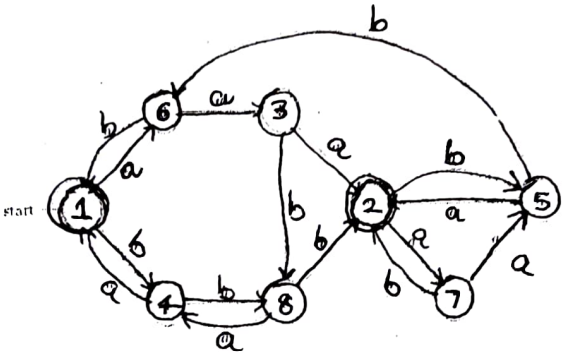
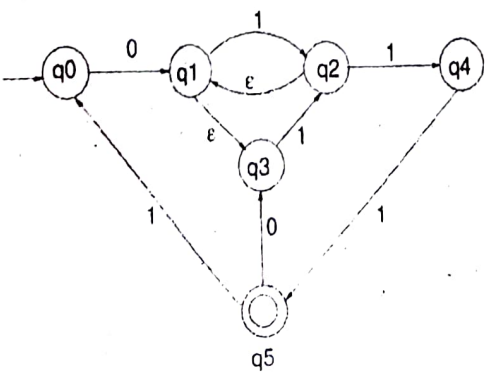
****

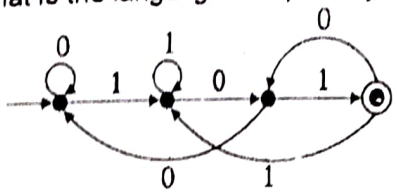
Exam Code:331

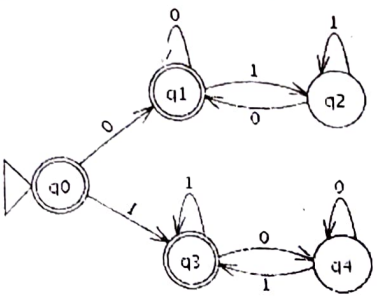
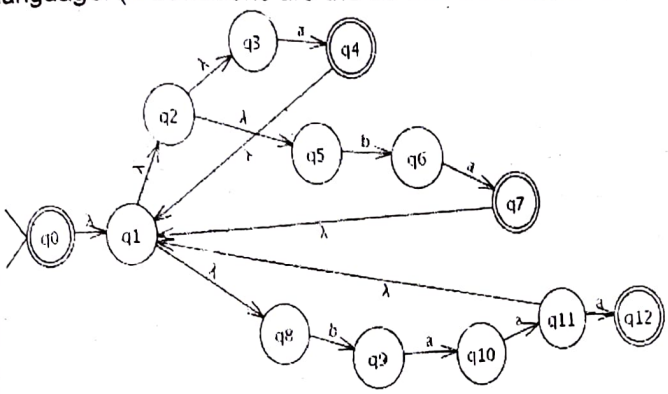
Shri G.S. Institute Of Technology And Science, Indore
CO 34002/3402
III Year B.E/B.Tech Examination
Theory of Computation
B.E/B.Tech Examination

Nov - Dec 2022

Max:70 marks

			CO	BL	PI
Q1 a	Draw a Deterministic Finite Automata for the language contains an even number of a's.	2	1,2	3	1.2.1,2.5.2
b	Prove given language is regular or not:- $L=\{0^i1^j \mid gcd(i,j)=1\}$	2	2,3	4	1.4.3
c	Apply optimization technique on the given DFA and convert it into the minimized one. 	3	3	4	1.2.1,2.5.2
d	Let Σ={a,b} and L = {string start with aa but does not end with aa} (a)Write regular expression for the given language L. (b)Design DFA for given language.	7(2+5)	1,2	3	3.4.1
	OR				
e	Convert the given NFA to DFA and write the regular expression accepted by it:- 	7	1,2	3	1.4.2

Q2 a	Generate parse tree for the given grammar if possible for the following string:- S1 =aaabbbccc S → ASB | A → aAS | a Ɛ → SbS | A | bb	2	2,3	4	1.2.1 5.2
b	What is the language accepted by the given DFA?  	2	1,2	4	1.4.3
c	Write the language generated by the given grammar (i)S → UT U→ε | aUbC C→ bC C→ Tc T →ε	3	1,2	4	1.2.1 5.2
d	Consider the language L ={wc^{m}d^n | w ∈ {a, b}*, m = the number of a's in w, and n = the number of b's in w} (a) Design a Turing machine that accepts L.	7	4	5	3.4.1
	OR				
c	Give a PDA to accept the following language:- L={set of strings having 0's twice of no. Of 1}	7	2,3	5	1.2.1
Q3 a	Prove that the language L1 ={a^{l}b^{m}c^n | l < m and l < n} is not context-free.	2	1,3	3	1.2.1
b	What type of Language L is representing with justification? L ={M # N # x | M, N are Turing machines over Σ, x ∈ Σ*, and both M and N accept x}	2	3	3	1.4.3
c	Create a pushdown automaton that accepts the language {0^{n}1^n | n > 0}. Show that your PDA accepts 000011 and that it rejects 0001.	3	1,2	4	2.5.2

d	Find a regular expression that generates exactly the same language as is accepted by the DFA shown below.  	7	1,2	3	3.4.1
	OR				
e	Convert the following NFA to a DFA that accepts the same language. (λ-transitions are the same as ε-transitions.)  	7	2,3	4	1.2.1,2. 5.2
q4	Justify the given statement:- The intersection of two context-free languages is never context-free.	2	1,2	3	4.2.1
b	Define:- (i)Turing recognizable language (ii)Turing decidable language	2	2	3	1.4.3
c	Proof by contradiction:- If a, b ∈ Z, then $a^2 - 4b - 3 \neq 0$.	3	3	4	1.2.1
	For all integers n, prove the following: (a) $2n^3 + 3n^2 + n$ is an integral multiple of 6. (b) $n^5 - 5n^3 + 4n$ is an integral multiple of 120.	7	3	3	3.4.2
	OR				
e	(i)Prove by diagonalization:- The Halting Problem in the Turing machine is Recursive Enumerable. (ii)Prove by mathematical induction :- $(1^3+2^3+3^3.....+n^3)+3(1^5+2^5+3^5....+n^5) =$ $4(1+2+3....+n)^3$	7(3.5+3.5)	4	4	1.4.3
Q5 a	Define Linear Bounded Automata and its model.	2	1,2	1	1.2.1,2. 5.2

b	State Computability and Complexity according to **The Church-Turing Thesis.**	2	2,4	3	1.4.3
c	If a Language and its Complement is Recursive enumerable then the language is _____. Justify	3	4	4	1.2.1, 5.2
d	C = $\{0^{2^n} \mid n \geq 0\}$, i.e. all strings of 0's whose length is a power of 2. I) Give a high level description of a TM that accepts C . II) Give the formal TM construction and state-diagram	7	4	3	3.4.1
	OR				
e	Give an algorithm to show:- (a) Running Time Complexity of a one tape turing machine for the given problem is A = $\{0^k 1^k \mid k \geq 0\}$ is $O(n^2)$ (b)Explain the improvement in Running Time Complexity achieved if two tape turing machine is used.	7	1,4	4	1.4.2

Code : 422

November, 2018 Examination
III B.E. Computer Engineering
CO34002/ CO3402 : Theory of Computation

Max. Marks : 70

Time : 3 Hour

TOTAL NO. OF QUESTIONS IN THIS PAPER : 5

Note: Question number ONE is COMPULSORY. Solve any one part out of (a) and (b) and any one part out of (c) and (d) from question number TWO to FIVE.

Q.1 (a) Define Finite Automata? Write any two applications of FA. (2)

(b) Show by induction that $n^4 - 4n^2$ is divisible by 3 for all n>=0. (3)

(c) Define functions and its types with suitable examples. (3)

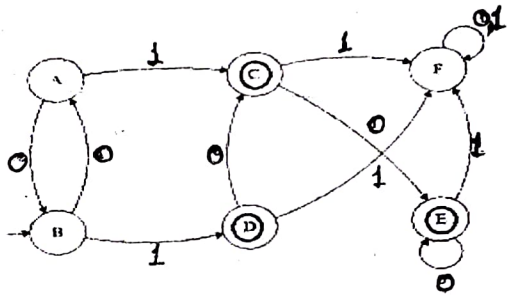
(d) Give necessary and sufficient condition on sets E1 and E2 to ensure that (3)
E1 = (E1 U E2) - E2

(e) Define relation. Find the transitive closure and the symmetric closure of the relation: (3)
{ (1,2), (2,3), (3,4), (5,4) }

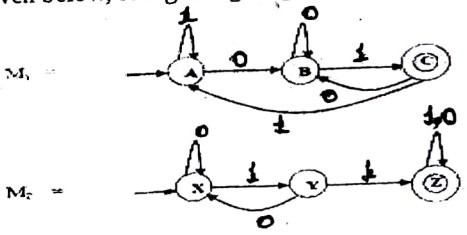
Q.2 (a) Draw Deterministic Finite Automata for the following languages (7)
i) L1 = { x ε (0,1)* | x contains101}
ii) L2 = { x ε (0,1)* | x contains odd number of zero and ends with 00}
iii) L3 = { x ε (0,1)* | x ends with 11}

OR

(b) Minimize the following FA. (7)



(c) Let M1 and M2 be the FA as given below, recognizing languages L1 and L2 Respectively:



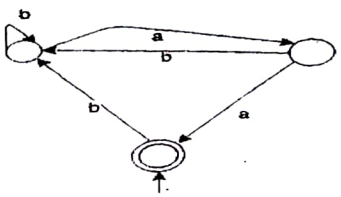
Draw the FAs recognizing the following languages:

(i) L1 ∩ L2 (4)

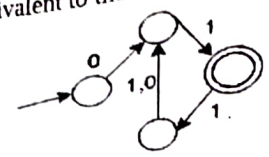
(ii) L2 – L1 (3)

OR

(d) (i) Convert the given FA to its equivalent Regular Expression. (4)



(ii) Write a regular expression equivalent to the following NFA.



Q.3 (a) Consider the context-free grammar G over {a, b}, with start symbol S, and with the following productions.

$S \rightarrow aaB \mid Abb$, $A \rightarrow a \mid aA$, $B \rightarrow b \mid bB$

(i) What is L(G)?

(ii) Is this grammer ambiguous. Justifs your answer?

OR

(b) (i) Construct Pushdown automata for the following language: L = {the set of strings over alphabet {a, b} with exactly twice as many a's and b's } Trace string "abaabbaaa".

(c) (i) Find an equivalent grammar in CNF for the grammar given below:

$S \rightarrow bB \mid aB$, $A \rightarrow bAA \mid aS \mid a$, $B \rightarrow aBB \mid bS \mid b$

(ii) Eliminate the unit production in the following grammar given below:

$S \rightarrow Aa \mid B$, $A \rightarrow A \mid bb$, $B \rightarrow a \mid bc \mid B$

OR

(d) (i) Consider following PDA machine M = ({p, q}, {0,1}, (x, z}, δ, q, Z) where δ is given by

$\delta(q, 1, z) = (q, xz)$
$\delta(q, 1, x) = (q, xx)$
$\delta(q, ^, x) = (q, ^)$
$\delta(q, 0, x) = (p, x)$
$\delta(p, 1, x) = (p, \varepsilon)$
$\delta(p, 0, z) = (q, z)$

Construct Equivalent CFG.

(ii) Prove that $L = \{a^n b^n c^n \mid n \geq 0\}$ is not a CFL using pumping lemma.

Q.4 (a) Design a Turing Machine which recognizes words of the form $a^n b^n c^n \mid n \geq 1$, Trace string "aabbcc".

OR

(b) Define Linear Bounded Automata. Find Linear Bounded Automata for the language L= {w :|w| is a multiple of 3} on Σ ={a, b}

(c) (i) Write Short note on Universal Turing Machine.

(ii) Differentiate between Recursive language and Recursively Enumerable language.

OR

(d) (i) Construct Turing machine that will accept the language L = {w :|w| is even} on Σ ={a, b}

(ii) Prove that following function on add(x,y) = x+y is primitive recursive function.

Q.5 (a) What do you mean by Solvability and Unsolvability ? Explain with suitable Example.

OR

(b) What are different complexity classes ? Define each and show the relationship between them.

(c) (i) What do you mean by Chomsky Hierarchy?

(ii) Show that halting problem is undecidable.

OR

(d) (i) Prove that the recursiveness problem of type 0 grammar is unsolvable.

(ii) Define Petri Nets and explain it with the help of suitable Example.

-----***-----

October-November 2017 Examination
III B.E. Computer Sc. & Engineering
CO-3402/CO34002 : Theory of Computation

Time : 3 Hour

Max. Marks : 70

TOTAL NO. OF QUESTIONS IN THIS PAPER : 5

Note: Question number ONE is COMPULSORY. Solve any one part out of (a) and (b) and any one part out of (c) and (d) from questions TWO to FIVE.

Q.1 (a) Define function. Define (i) One-to-One (ii) Onto (iii) One-to-One Onto functions. Give one example for each. (3)

(b) Determine whether the relation R defined on the sets of integer as R= {(a, b) | a + b = even number} is equivalence relation or not. (3)

(c) Show for any n>=0 (3)
$1^2+2^2+.....+n^2 = (n^2 + n)(2n+1)/6$

(d) What is Tautology? Find whether following are Tautology or not. (3)

(i) $\sim(P \vee Q) \vee R \equiv (\sim P \vee R) \wedge (\sim Q \vee R)$

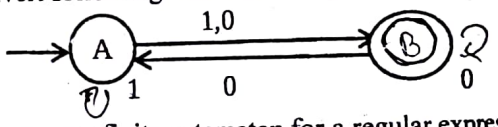
(ii) $(P \wedge Q) \rightarrow R \equiv (P \rightarrow R) \vee (Q \rightarrow R)$

(e) Convert following into predicate logic. (2)

(i) Not everybody is rich.

(ii) Some days are cloudy, some days are sunny.

Q.2 (a) (i) Convert following NFA into an equivalent deterministic machine. (4)



(ii) Construct a finite automaton for a regular expression (a+b)*(aa+bb)(a+b*). (3)

OR

(b) (i) Construct a DFA to accept the language where Σ ={a, b} (4)
$n_a(w)$ mod 2=0 {a's divisible by 2}
$n_b(w)$ mod 3=0 {b's divisible by 3}

(ii) Define Mealy machine and Moore machine. How are they different from each other. (3)

(c) (i) Construct a DFA, the language of all the string over (0,1) such that every block of five consecutive symbols contains atleast two 0's. (4)

(ii) Prove that the language L = {w : $n_a(w) \neq n_b(w)$} is not regular. (3)

OR

(d) Construct a DFA with minimum states equivalent to the regular expression 10+(0+11)0*1 (7)

.....2

Q.3 (a) (i) Construct a PDA which accepts $L=\{a^{2n}\, b^m\, a^n \mid n,m>=1\}$ on $\Sigma=\{a, b\}$

(ii) Use the CYK algorithm to determine whether the string aabba ϵ L is generated by the grammar {S → AB, A → BB/a, B → AB/b}

OR

(b) (i) Construct a NPDA which accepts $L=\{a^n\, b^m\, c^{n+m} \mid n>=0,m>=0\}$ on $\Sigma=\{a, b, c\}$

(ii) Prove that Context free language are closed under Union.

(c) (i) Transform the grammar with production {S → abAB, B → Baa/ϵ, A → bAB/ϵ} into Chomsky Normal Form.

(ii) Remove all the Unit productions from the grammar {S → ASA/bA, A → B/S, B → c}

OR

(d) (i) Transform the grammar with production {S → ABb/a, A → aaA, B → bAb} into Greibach Normal Form.

(ii) Show that the following grammar is ambiguous {S → a/abSb/aAb, A → bS/aAAb}

Q.4 (a) (i) Show that $L=\{a^n\, b^n\, c^n \mid n>=1\}$ on $\Sigma=\{a, b, c\}$ is not context free but context-sensitive.

(ii) Write the key features of Turing Machine?

OR

(b) (i) Construct a Turing machine that can accept the set of all even palindromes over {0,1}

(ii) Define Universal Turing Machine and explain it with its diagram?

(c) (i) Prove that the recursiveness problem of type 0 grammar is unsolvable.

(ii) What do you mean by Linear Bounded Automata?

OR

(i) Construct a Linear Bounded Automaton that accepts the language $L=\{ a^{n!} \mid n>=0 \}$

(ii) Differentiate between Recursive language and Recursively Enumerable language.

Q.5 (a) (i) Explain Chomsky Hierarchy with the help of its diagrammatic representation.

(ii) Write a grammar G to recognize all expressions involving all binary arithmetic operators. Construct a parse tree for sentence "-*+abc/de" using G.

OR

(b) (i) What do you mean by Turing Machine's Halting Problem? Explain.

(ii) Define Petri Nets and explain it with the help of an Example.

(c) (i) What are different Complexity classes?

(ii) Define relationship between Complexity classes?

OR

(d) (i) What do you mean by Solvability and Unsolvability concept of Turing Machine? Explain with an Example.

(ii) Write short note on Church's thesis.

-----*-----

November-December 2016 Examination
III Year BE Computer Engineering
CO3402 Theory of Computation

Time: 3 Hours

Max. Marks: 70
Min Marks: 21

Note: Attempt all the five questions. All questions carry equal marks. Attempt any one part from section 'a' and 'b', similarly any one from 'c' and 'd'.

Q.1. (a) (i) Prove by the principle of Induction: $\sum_{i=1}^{n} i^2 = \frac{n(n+1)(2n+1)}{6}$ 3

(ii) Discuss the validity of the following argument: 2
All educated persons are well behaved. Ram is educated. No well-behaved person is quarrelsome. Therefore, Ram is not quarrelsome.

(iii) Define Power set of a set. If cardinality of a set is n, then what is cardinality of its Power set? 2

OR

(b) (i) Prove by the principle of Induction: 1+4+7+.....+(3n-2)=n(3n-1)/2 3

(ii) Let Σ be a set of alphabets. If $|\Sigma|$ is finite then what will be $|\Sigma^*|$ and $|\Sigma^+|$? 2

(iii) Check the validity of the following argument:
"If Ram has completed B.E. (Computer Science) or MBA, then he is assured of a good job. If Ram is assured of a good job, he is happy. Ram is not happy. So Ram has not competed MBA."

(c) (i) Show that: $(\sim p \wedge (\sim Q \wedge R)) \vee (Q \wedge R) \vee (P \wedge R) \Leftrightarrow R$ 3

(ii) Let R={(1,2),(2,3),(1,4),(4,2),(3,4)}. Find R^+, R^*. 2

(iii) Define a graph. When do we call a graph to be a tree? 2

OR

(d) (i) Define Automata. How the power of different automata is governed? 3

(ii) Prove that $Q \vee (P \wedge \sim Q) \vee (\sim P \wedge \sim Q)$ is tautology. 2

(iii) Let P represents 'It is cloudy.' and Q represents 'It is raining.' Convert the following into predicates in symbolic form: 2

1. It is neither cloudy nor raining.
2. It is raining but not cloudy.
3. It is either raining or cloudy.
4. It is cloudy but not raining.

Q.2. (a) (i) Construct Deterministic Finite Automata equivalent to the following Nondeterministic Finite Automata 4

M=({p,q,r},{0,1},δ,p,{q,s})

Where δ is defined in the following table:

δ	0	1
p	{q,s}	{q}
q	{r}	{q,r}
r	{s}	{p}
s	-	{p}

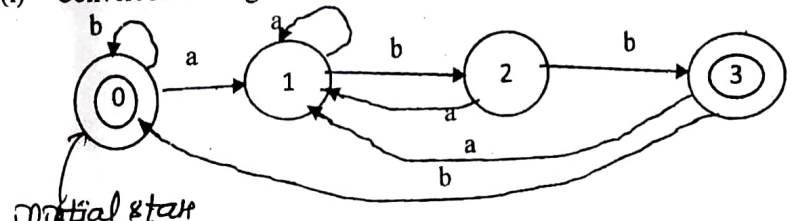
(ii) Give Mealy and Moore machines for the input from (0+1)*, if the input ends in '000', output is A; if the input ends in '111', output is B; otherwise output is C. 3

OR

(b) (i) Draw a DFA that accepts a language which contains all strings ending with 'ed'. Write a regular expression for such a language. 4

(ii) Write applications of regular expressions. 3

(c) (i) Convert following NFA to regular expression: 4



(ii) Fill in the blanks: In a Regular expression:

(i) $R + \_\_\_\_\_ = R$

(ii) $\lambda R = R \lambda = \_\_\_\_\_$

(iii) $R+R = \_\_\_\_\_$

(iv) $(R^*)^* = \_\_\_\_\_$

(v) $(P+Q)^* = P^*Q^* \_\_\_\_\_$

(vi) $(PQ)^*P = P \_\_\_\_\_$

OR

(d) (i) Draw a NFA that accepts r= (a+bb)* (ba* +λ).

(ii) Write in set notation the language represented by the regular expression (a+(b.c))*.

Q.3. (a) (i) Design PDA for the language : $L=\{w \mid w \in (a+b)^* \text{ and } n_a(w)>n_b(w)\}$

(ii) I. What is the form in which grammar of a programming language is written?

II. How can we represent optional elements in BANF notation? Give an example.

OR

(b) (i) Construct CFG equivalent to the following PDA:

$M=(\{p,q\},\{0,1\},\{z,x\},\delta,p,z,\varphi)$

Where δ is given by:

$\delta(p,1,z)=(p,xz)$; $\delta(p,\varepsilon,z)=(p,\varepsilon)$; $\delta(p,1,x)=(p,xx)$;

$\delta(p,0,x)=(q,x)$; $\delta(q,1,x)=(q,\varepsilon)$; $\delta(p,0,z)=(p,z)$

(ii) Define Context Free Grammar.

(c) (i) Given grammar with productions S-> aAB, A->bBb, B-> A|λ

Give (i) leftmost and (2) right most derivation of string "abbbb"

(ii) Is exhaustive search method to find membership of a string in a Context free grammar practically useful? Justify your answer/.

OR

(d) (i) What is meant by ambiguous grammar? Show that the grammar S-> SS|(S)|() is ambiguous.

(ii) Reduce following Context free grammar into Chomsky Normal Form given by following productions:

S-> aAC, A->aB|bAR, B->b, C->c

Q.4. (a) Build a Turing Machine that accepts the language: $L=a^nb^{2n} \mid n>=1$

OR

(b) Design a Turing Machine to compute the function f(m,n)=m+n where m and n are two non-negative integers.

(c) (i) What is linear bounded automata? Is it more powerful than Pushdown automata? Justify your answer.

(ii) What is a Universal Turing Machine?

OR

(d) Define Recursive Languages and Recursively Enumerable Language. Distinguish between the two. What is their relationship with the set of languages that can be generated over a set of alphabets.

Q.5. (a) What is Halting Problem? Explain why Halting problem is undecidable?

OR

(b) (i) Differentiate between solvable and unsolvable problems.

(ii) Define following classes of problems: 1. P-class 2. NP-Class 3. NP-Hard 4. NP-Complete

(c) (i) State Turing's thesis. What is its significance?

(ii) What is Chomsky's Hierarchy?

OR

(d) Write a short note on Pertinets. Draw a Petrinet model for a vending machine which can accept coins of Rs. 5 and Rs. 10 and gives a candy when an amount of Rs. 20 has been deposited.

****

OCTOBER –NOVEMBER' 2015 EXAMINATION 337
III B.E. COMPUTER ENGINEERING
CO-3402: THEORY OF COMPUTATION

Time: 3 Hours

Max. Marks: 70
Min. Pass Marks: 28

Note: Question number ONE is COMPULSORY. Solve any one part out of parts a and b and any one part out of parts c and d from question number TWO to SIX.

Q.1 (a) Give necessary and sufficient conditions on sets S1 and S2 to ensure that
$S1 = (S1 \cup S2) - S2$ (02)

(b) If Σ be a set of alphabets then if $|\Sigma|$ is finite then what will be $|\Sigma^*|$ and $|\Sigma^+|$? (02)

(c) If we select 11 natural numbers between 1 and 380, show that there exist at least two among these 11 numbers whose difference is 38 or less. (02)

(d) Is a Non-deterministic Finite Automata more powerful than a Deterministic Finite Automata? Justify your answer. (02)

(e) Exhibit the language L in set notation for regular expression r = (a+b)* (a+bb) (02)

(f) Let S = {+,-, λ } and d= { 0,1,2,3...9}. Write a regular expression to represent an integer. (02)

(g) State True or False (i) Regular and linear grammars are context-free, but a context-free grammar is not necessarily linear.
(ii) A multi-tape TM is more powerful than a single tape TM. (02)

(h) Let S→ aB | bA
A→aS | bAA|a
B→ bS | aBB|b
Derive the string **aaabbabba** as left-most derivation. (02)

(i) Use the CYK algorithm to determine whether the string **aabba** ∈ L generated by the grammar. { S→ AB, A→ BB| a, B→AB | b} (02)

(j) (i) Write the key features of Turing Machine.
(ii) What are the applications of automata? (02)

Q.2 (a) Define functions. Define (i) One-to-One (injection) (ii) Onto(Surjection) (iii) One-to-one Onto (Bijection) functions. Give one example for each. (05)

OR

(b) Define Relations. What are different properties of relations? Give one example of each. (05)

(c) (i) Explain the methods of proof (1) By induction (2) By contradiction. In which situations these are useful? (03)
(ii) Prove $\sum_{i=1}^{n} \frac{1}{i(i+1)} = \frac{n}{n+1}$ using principle of mathematical induction. (02)

OR

(d) What is tautology? Find whether following are tautology- (01)
(1) $((P \Rightarrow (Q \vee R)) \wedge (\neg Q)) \Rightarrow (P \Rightarrow R)$ (02)
(2) $Q \vee (P \wedge \neg Q) \vee (\neg p \wedge \neg Q)$ (02)

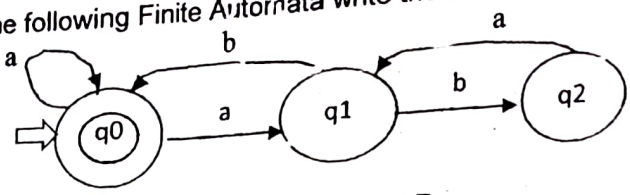
Q.3 (a) (i) Define Mealy machine and Moore Machine. How are they different from each other? (02)
(ii) Construct a Mealy machine for the following Moore Machine (03)

Present State	Next State a=0	Next State a=1	Output
→q0	q3	q1	0
q1	q1	q2	1
q2	q2	q3	0
q3	q3	q0	0

OR

(b) Create a DFA in which two 1's are followed by two 0's over $\Sigma = \{0,1\}$ (05)

(c) For the following Finite Automata write the corresponding regular expression.



OR

(d) Prove that regular languages are closed under (i) Intersection (ii) Reversal

Q.4 (a) Design a PDA which accepts the language
L= { ω | ω ϵ (a+b)* and number of a's in ω are equal to number of b's in ω}

OR

(b) Construct a PDA which accepts { $a^n b^m a^n$| m,n ≥ 1}.

(c) Define ambiguity. Show that the following grammar is ambiguous.
S → a | abSb | aAb
A→ bS | aAAb

OR

(d) Convert the grammar with productions { S→ ABa, A→ aab, B→ Ac } to Chomsky Normal Form.

Q.5 (a) Construct a Turing Machine for performing subtraction of two unary numbers such that f(a-b) =c where a is always greater than b.

OR

(b) Construct a TM for performing logarithmic operations of a given binary number i.e. compute log (n) function, where n is a binary number which has to be in powers of 2 e.g. log (100) = 4

(c) (i) What are (1) Recursive Languages? (2) Recursively Enumerable Languages?
(ii) What is a Universal Turing Machine?

OR

(d) What is a linear bounded automata? Is it more powerful than Pushdown Automata? Justify.

Q.6 (a) Write Turing's Thesis. What is meant by decidable and undecidable problems?

OR

(b) Write Chomsky's Hierarchy.

(c) What are different complexity classes? Define each and show the relationship between them.

OR

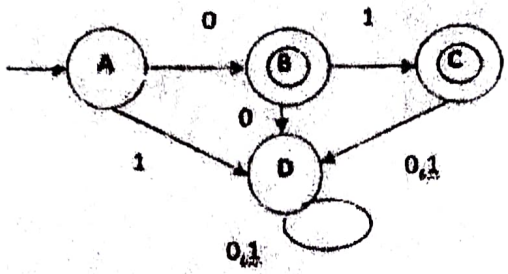
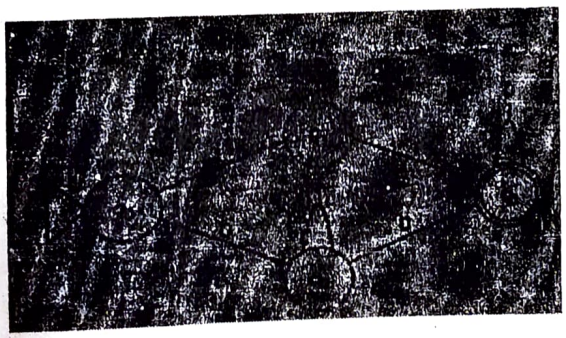
(d) Draw a Petrinet model for a vending machine which can accept coins of Rs. 5 or Rs. 10 and gives a 15 Rs. candy when the amount has been deposited.

*****

Shri G. S. Institute of Technology and Science, Indore
Department of Computer Engineering
CO34002: Theory of Computation
Mid Term Test – 1 Session July-December 2023

Time: 1 Hour **Max. Marks: 20**

Note: Clearly draw automata wherever required. Make assumptions if required.

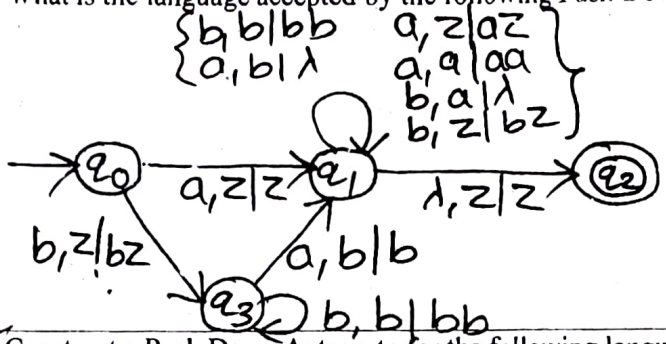
		Marks	CO	BL
Q.1	Answer the following questions (to the point): 1. Given two languages L1 and L2, the automata's corresponding to these languages contains 3 states and 5 states respectively. How many number of states will be there in the automata for the language L1 ∩ L2. 2. What happens if we apply the method of subset construction to a DFA instead of NFA? 3. Give formal description of Moore Machine. 4. Give an equivalent NFA for the regular expression r = a*b (a + ba)*. 5. Write the formal description of language L(G) generated by regular grammar G.	[5]	1	1,2
Q.2	Construct a regular expression for the language on {a, b} containing set of strings of the form $a^{2n}b^{3m}$ where n and m are positive integers.	[3]	2	3
Q.3	Construct a Mealy Machine on {0, 1} which detects number of times 100 sequence is present in the given input string.	[3]	2	3
Q.4	Construct reverse of the given finite automata. 	[3]	2	3
Q.5	Debug and fix the following defective finite automata for accepting all binary strings with alternate 0's and 1's: 	[3]	2	3
Q.6	Design a right linear grammar for the language on {a, b} generating strings that do not contain the substring baa.	[3]	2	3

****

Shri G. S. Institute of Technology and Science, Indore
Department of Computer Engineering
CO34002: Theory of Computation
Mid Term Test – 2 Session July-December 2023

(24) Aryansh

Time: 1 Hour **Max. Marks: 20**

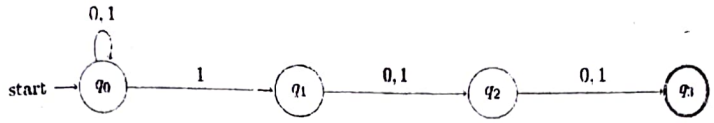
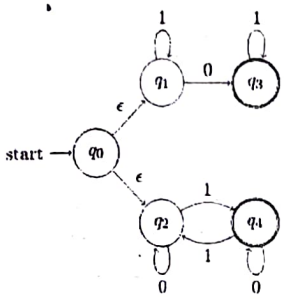
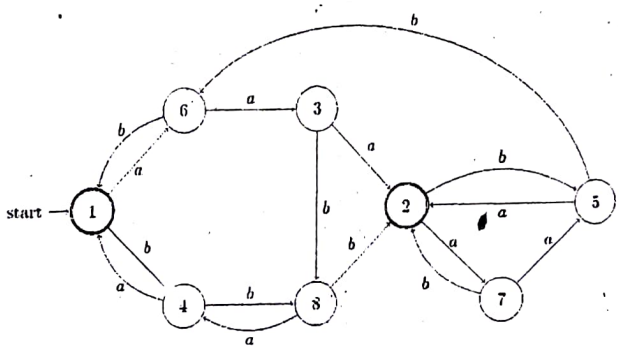
		Marks	CO	RL
Q.1	Apply the CYK algorithm to verify if the string w = aabba can be derived by the grammar S → AB, A → BB | a, B → AB | b.	[3]	1	3
Q.2	Consider the following grammar: S → aaS | aaaS | λ. Is the grammar ambiguous? Prove with a suitable example.	[3]	1	2
Q.3	What is the language accepted by the following Push Down Automata? 	[3]	2	2
Q.4	Construct a Push Down Automata for the following language: L = {$a^n b^m c^k$: 2n = m and k ≥ 2}.	[3]	2	3
Q.5	Write closure properties of Context Free Languages. Prove that the complement of a Context Free Language is not a Context Free Language.	[3]	3	2
Q.6	Convert the following grammar to Chomsky Normal Form: S → Aa | B | Ca, B → aB | b, C → Db | D, D → E | d, E → ab.	[3]	1	3
Q.7	Differentiate between Non-deterministic PDA and Deterministic PDA.	[2]	1	2

July-Dec-22

Shri G S Institute of Technology and Science
Department of Computer Engineering
CO34002:Theory of Computation

Mid Sem-1

Time:1 hr | Max Marks:20

Q1)	Write the regular expression for the given automaton. 	2	CO1
Q2)	Write the regular expression for the given automaton. 	3	CO1
Q3)	Convert the epsilon move NFA in question 2 to DFA.	3	CO1,CO2
Q4)	Apply optimization technique on the given DFA and convert it into the minimized one. 	3	CO1,CO2
Q5	Proof by contadiction:- if a,b∈ Z, then $a^2 - 4b - 3 \neq 0$	3	CO1
Q6	Proof by induction that n^5 – n is an integral multiple of 30 for all integers n.	3	CO1
Q7)	Draw the DFA for all languages which are not accepted by the DFA designed in question 3.	3	CO1,CO2

u v' x y' z

Shri G S Institute of Technology and Science
Department of Computer Engineering
CO34002:Theory of Computation

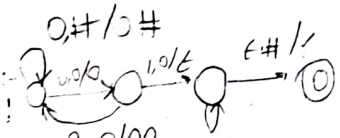
Mid Sem-2

Time:1 hr | Max Marks:20

Q1) Give a context-free grammar(CFG) if possiblefor the following languages:- 3 CO2
$\{a^m b^n \mid m \neq n\}$ $S \to aS \mid bS \mid \epsilon$

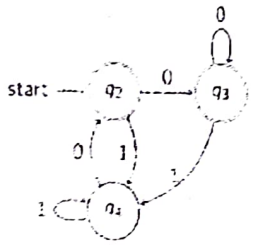
Q2) Convert the following grammars into Chomsky normal form(CNF) 3 CO2
S → ASB | ε
A → aAS | a
B → SbS | A | bb

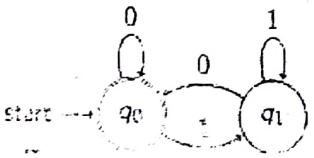
Q3) Give a PDA to accept the following language:- 3 CO2,CO
L={set of strings having 0's twice of no. Of 1}



Q4) Prove by pumping lemma for the given language:- 3 CO2,CO
L={1^p | p is a prime number}

Q5) Proof the given DFA are equivalent by construction:- 3 CO3

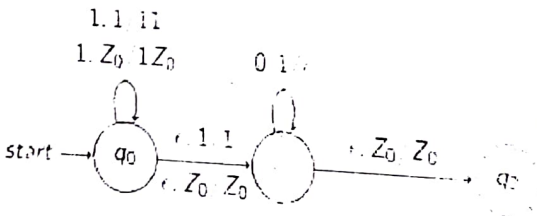




Q6) Identify the given grammer is ambiguous or not:- 3 CO3
E --> E+E|E*E|B
B -->B0|B1
B -->0|1

Q7) Identify the language given PDA will accept for the given model:- 2 CO2,CO
M= ({q0, q1, q2}, {0, 1}, {Z0, 1}, δ, q0, Z0, {q2})

aaabb

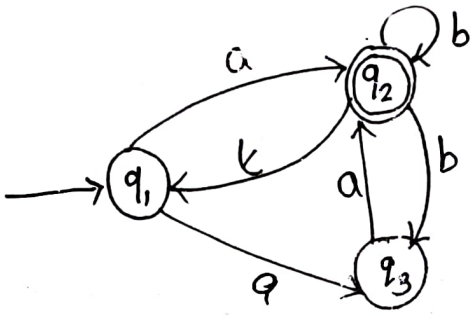


307

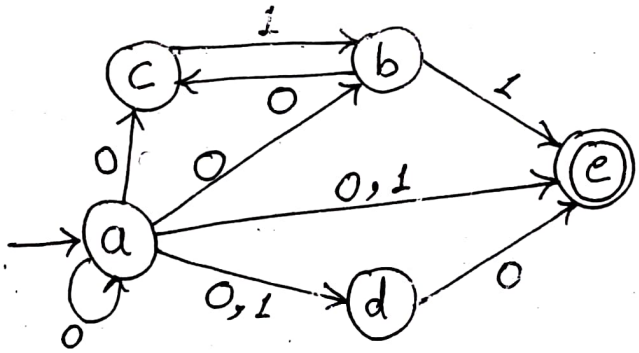
Shri G. S. Institute of Technology and Science, Indore
Department of Computer Engineering
CO34002: Theory of Computation
Mid Sem – 1(Sem A 2019)

Time : 1 Hour **Max Marks : 25**
Note : Attempt all questions.

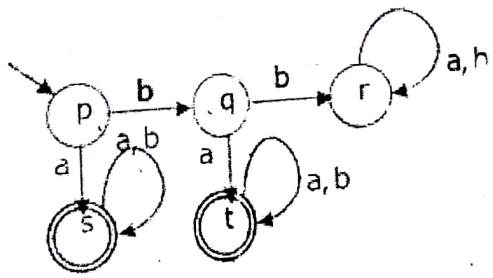
1. Write a Definition of a Finite Automaton. **(2)**
2. Construct a DFA with ∑ = {0, 1} that ccepts all strings ending with 01 and start with 00. **(3)**
3. Construct a DFA, the language of all string containing both 101 and 010 as substring. **(3)**
4. Construct a finite automata M accepting L = 10 + (0 + 11) 0*1 **(3)**
5. Convert the following ϵ-NFA to NFA without ϵ. **(3)**



6. Covert the given NFA to its equivalent DFA. **(3)**



7. Construct a minimum state automaton equivalent to the DFA described by fig. **(4)**



8. Construct a DFA to accept the language where Σ ={ a ,b } **(4)**
   $n_a(w) \bmod 2 = 1$, (a's divisible by 2)
   $n_b(w) \bmod 2 = 1$, (b's divisible by 2)

Shri G. S. Institute of Technology and Science, Indore
Department of Computer Engineering
CO34002: Theory of Computation
Mid Sem – II(SEM A 2019-2020)

Time : 1 Hour **Max Marks : 25**

Note : Attempt all questions.

1. What is the CFG, write any two application of CFG. (2)
2. Construct a deterministic finite automaton equivalent to the grammar, (3)

   $S \rightarrow aS / bS / aA, \quad A \rightarrow bB, \quad B \rightarrow aC, \quad C \rightarrow \epsilon$
3. A context free grammar G has the following production: (4)

   $S \rightarrow 0S0 / 1S1 / A, \quad A \rightarrow 2B3, \quad B \rightarrow 2B3 / 3$
4. What is Ambiguous Grammar, show that the grammar is Ambiguous. (4)

   $S \rightarrow a / abSb / aAb$

   $A \rightarrow bS / aAAb$
5. Convert the grammar into Chomsky normal form. (4)

   $S \rightarrow 1A / 0B$

   $A \rightarrow 1AA / 0S / 0$

   $B \rightarrow 0BB / 1S / 1$
6. Convert the grammar into Greibach normal form. (4)

   $S \rightarrow ABb / a$

   $A \rightarrow aa\,A$

   $B \rightarrow b\,A\,b$
7. Construct a PDA for that CFL. (4)

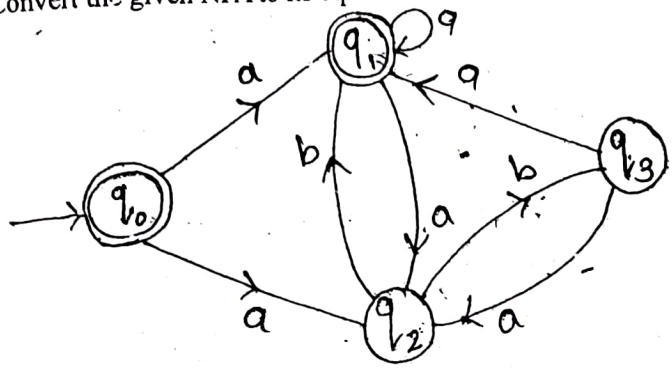
   $L = \{ a^{2m}b^{n}c^{m} \ / \ m,n>=1 \}$

2018

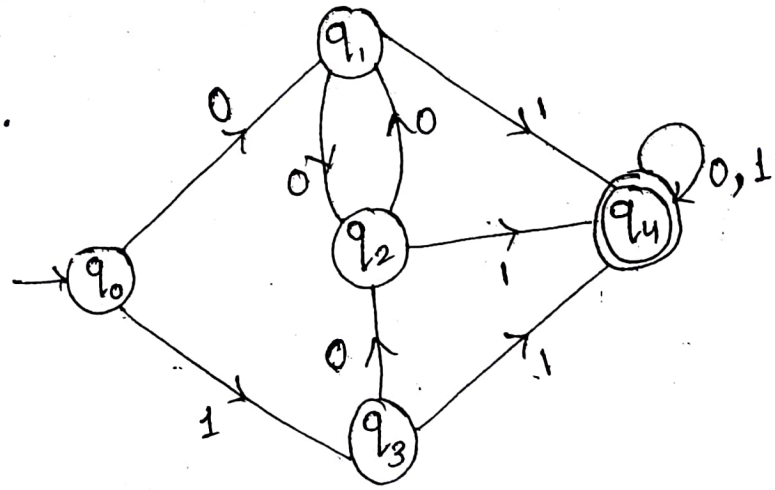
Shri G. S. Institute of Technology and Science, Indore
Department of Computer Engineering
CO34002: Theory of Computation
Mid Sem – 1

Time : 1 Hour **Max Marks : 25**
Note : Attempt all questions.

1. What are the applications of Automaton. (2)
2. Define functions and its types also. (2)
3. Construct a DFA, start congaing 11 and end with 00 over $\Sigma = \{0, 1\}$ (3)
4. Construct a finite automaton M accepting $L = 0 + 10^* + 01^*0$ (4)
5. Convert the given NFA to its equivalent DFA. (4)



6. Construct a minimum state automaton equivalent to the DFA. (5)



7. Construct a DFA to accept the language where, (5)

   $L = \{ X / X \text{ is a binary string divisible by 4} \}$

2018

Shri G. S. Institute of Technology and Science, Indore
Department of Computer Engineering
CO34002: Theory of Computation
Mid Sem – II

Time : 1 Hour **Max Marks : 25**
Note : Attempt all questions.

1. What is the CFG . (2)
2. Remove the useless symbol from the given C.F.G. (3)

$$A \rightarrow 012 / X122$$
$$X \rightarrow X2 / 0Y2$$
$$Y \rightarrow 1Y1 / X2$$
$$Z \rightarrow Z1 / 2 \ , \ A \rightarrow 012$$

3. What is Ambiguous Grammar, show that the grammar is Ambiguous. (3)

$$S \rightarrow aB / ab$$
$$A \rightarrow a\,AB / a$$
$$B \rightarrow AB\ b / b$$

4. Remove all the null production from the grammar. (3)

$$S \rightarrow aAbB$$
$$A \rightarrow aA/\epsilon$$
$$B \rightarrow bB/\epsilon$$

5. Remove all the unit production from the grammar. (3)

$$S \rightarrow Aa / B$$
$$A \rightarrow A / bb$$
$$B \rightarrow a / bc / B$$

6. Convert the grammar into Chomsky normal form. (4)

$$S \rightarrow b\,A / aB$$
$$A \rightarrow bAA / aS / a$$
$$B \rightarrow \ aBB / bS / b$$

7. Convert the grammar into Greibach normal form. (4)

$$S \rightarrow AB\ b / b$$
$$A \rightarrow aa\,A / B$$
$$B \rightarrow b\,A\,b$$

8. Construct a PDA for that CFL. (3)

$$L = \{ a^{2n}b^{n} \ / \ n>=1 \}$$

CS-5 CA Sem- 2017

Shri G. S. Institute of Technology and Science, Indore
Department of Computer Engineering
CO34002: Theory of Computation (Session 2017-18)
Mid Sem – 2

Time: 1 Hour
Note: Attempt all questions. **Max Marks: 25**

1. What is the CFG (2)
2. Define a Universal Turing Machine explain with its diagram (3)
3. What is Ambiguous Grammar, show that the grammar is Ambiguous. (3)

   $S \rightarrow aSbS/bSaS/\epsilon$

4. Remove all the null production from the grammar. (3)

   $S \rightarrow a\Lambda bB$

   $A \rightarrow a\Lambda/\epsilon$

   $B \rightarrow bB/\epsilon$

5. Remove all the unit production from the grammar. (3)

   $S \rightarrow \Lambda a/B$

   $\Lambda \rightarrow \Lambda/bb$

   $B \rightarrow a/bc/B$

6. Convert the grammar into Chomsky normal form. (4)

   $S \rightarrow AB/aB$

   $A \rightarrow aab/\epsilon$

   $B \rightarrow bbA$

7. Convert the grammar into Greibach normal form. (4)

   $S \rightarrow ab/aS/aaS$

8. Construct a PDA for that CFL. (3)

   $L = \{ a^{2n}cb^{n} \ / \ n>=1 \}$

SE I

SE PART OB ADC

Shri G S Institute of Technology and Science

Department of Computer Engineering

CO3402: Theory of Computation

Mid Sem Test-1

Time: 1Hour

Max Marks: 30

Q.1. Show that $\sum_{\substack{k=0 \\ i=0}}^{n} i^2 = n(n+1)(2n+1)/6$. 4

Q.2. Convert that following into predicate logic:

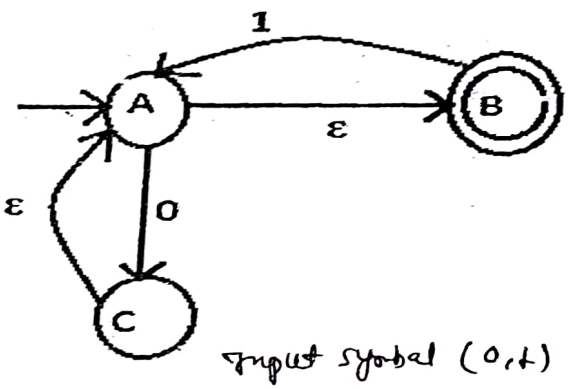
a. Everyone loves everyone. 1

b. Every student except Smith smiles. 1

c. If anyone cheats, he suffers. 1

d. Assume following predicate W(x,y):x write y, L(x,y):x longer than y, N(x): x is Novel, Convert the following into predicate logic:"Hardly(h) wrote a novel which is longer than any of Austen's(a)". 3

Q.3 Convert the following state transition diagram from NFA to DFA 5



a. Input symbol (0,1)

b. Let M=({q1, q2, q3},{0,1},δ, q1, {q3}) be an NFA where δ is given by,

δ (q1,0)={q2,q3} δ (q1, 1)={q3}

δ (q2,0)={q1,q2} δ (q2,1)= φ

δ (q3,0)={q2} δ (q3,1)={q1,q2}

Convert an equivalent DFA.

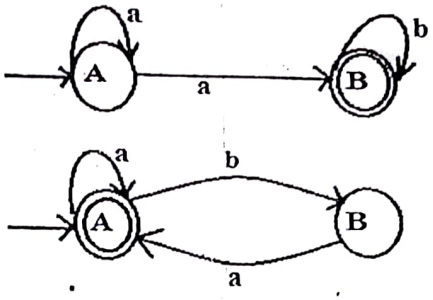
Q.4. Find a regular expression for the following language. 2

$L_1 = \{a^n b^m \mid n>=4, m<=3\}$

Q.5. Write regular expression for the following language. 2

"All strings containing even numbers of 0's"

Q.6. Find regular expression for the languages accepted by the following automata, 4



Q.7. Write True/False: 5

a. In a regular grammar at most one variable appears an RHS of any production.

b. Regular expression can be used for pattern identification.

c. Generally there are many regular expression for any given language.

d. Let L1 & L2 be two regular language then L1∩ L2 is also regular language.

e. A linear grammar is regular grammar.

Q.8. Convert following Regular expression into Finite Automata. 2

0(0+1)*

Shri G.S. Institute of Technology and Science, Indore
Department of Computer Engineering
CO 3402: Theory of Computation
Mid Semester Test - I

Time: 1 hour **Max Marks: 25**

Q.1) Let $\Sigma = \{a, b\}$ and $L = \{aa, bb\}$. Use set notation to describe $\overline{L}$. (01)

Q.2) Show that $\sqrt{8}$ is not a rational number. (03)

Q.3) Consider the set of strings on {0, 1} defined by every 00 is followed by a 1. For example, the strings 101, 0010, 0010011001 are in the language, but 0001 and 00100 are not. For this set construct an accepting DFA. (03)

Q.4) Find an NFA that accepts $\{a\}^*$ and is such that if in its transition graph a single edge is removed (without any other changes), the resulting automaton accepts {a}. (03)

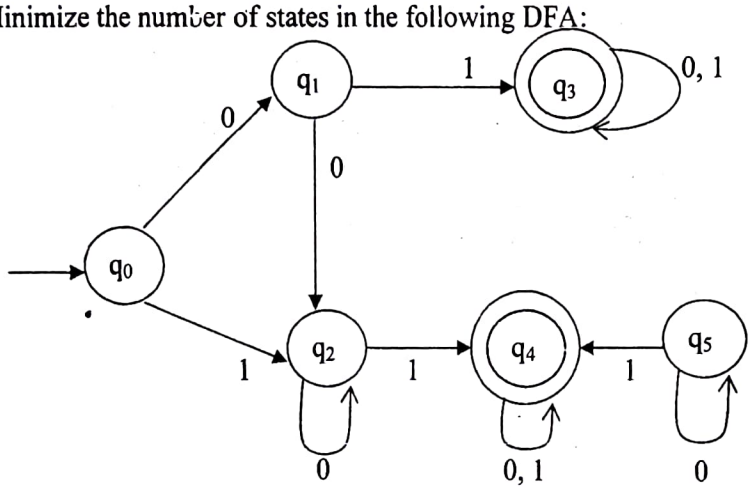
Q.5) Find an NFA without λ transitions and with a single final state that accepts the set $\{a\} \cup \{b^n : n \geq 1\}$. (03)

Q.6) Find a regular grammar for the language $L = \{a^n b^m : n + m \text{ is even}\}$. (03)

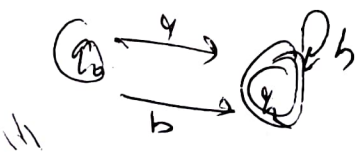
Q.7) Find a regular expression for the following language on {a, b}: (04)

$L = \{w: n_a(w) \text{ and } n_b(w) \text{ are both even}\}$.

Q.8) Minimize the number of states in the following DFA: (05)



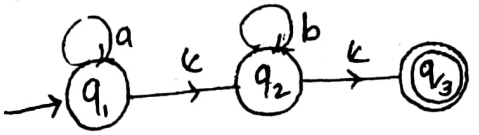
****



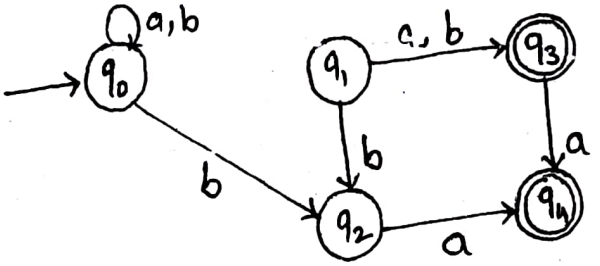
Shri G. S. Institute of Technology and Science, Indore
Department of Computer Engineering
CO34002: Theory of Computation
Mid Sem – 1

Time : 1 Hour **Max Marks : 25**
Note : Attempt all questions.

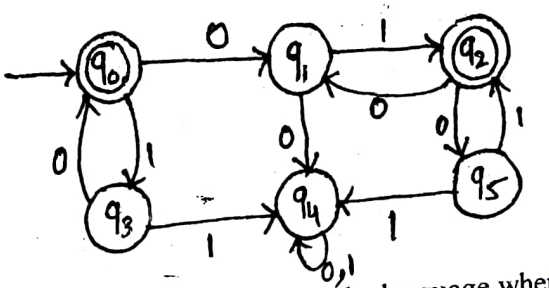
1. Write a Definition of a Finite Automaton. (2)
2. Let M be defined as (Q, Σ ,δ ,S, F). (3)
   For $Q = (q_0,q_1,q_2,q_3)$, $S=q_0$, $\Sigma = \{a, b, c\}$, $F = \{q_3\}$,
   $\delta = \{(q_0, abc) \rightarrow q_0), (q_0, ab) \rightarrow q_1, (q_1, bb) \rightarrow q_3, (q_0, b) \rightarrow q_2, (q_2, aa) \rightarrow q_3\}$.
3. Construct a DFA, the language of all string containing both 11 and 010 as substring. (3)
4. Construct a finite automata M accepting $L = 0 + 10^* + 01^*0$ (3)
5. Convert the following ϵ-NFA to NFA without ϵ. (3)



6. Covert the given NFA to its equivalent DFA. (3)



7. Construct a minimum state automaton equivalent to the DFA described by fig. (4)

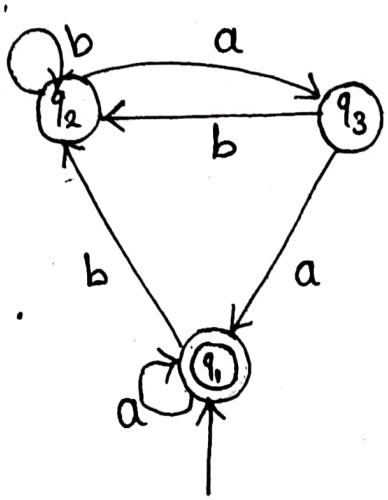


8. Construct a DFA to accept the language where Σ ={ a ,b } (4)
   $n_a(w) \bmod 2 = 0$, (a's divisible by 2)
   $n_b(w) \bmod 3 = 0$, (b's divisible by 3)

Shri G. S. Institute of Technology and Science, Indore
Department of Computer Engineering
CO34002: Theory of Computation
Mid Sem – 1

Time : 1 Hour **Max Marks : 2**
Note : Attempt all questions.

1. What are the applications of Automaton. (2)
2. Define functions and its types also. (2)
3. Construct a DFA, the language of string end with 110 (3)
4. Construct a DFA, the language of string start with 001 (3)
5. Prove that language L ={WW / W is in (0,1)*} is not regular (3)
6. Construct a minimum -state Finite Automaton M accepting L = (010)*1 + (1*0)* (4)
7. Covert the given FA to its equivalent RE. (4)



8.Construct a DFA in which two 1's are followed by two 0's where Σ ={ a ,b } (4)

Shri G.S. Institute of Technology and Science, Indore
Department of Computer Engineering
CO 3402: Theory of Computation
Mid Semester Test - II

Time: 1 hour **Max Marks: 25**

Q.1) Construct a PDA equivalent to the following grammar: (02)

$S \rightarrow aAA$

$A \rightarrow aS/bS/a.$

Q.2) Show that the grammar $S \rightarrow aSbS/bSaS/\lambda$ is ambiguous. (02)

Q.3) Is the language $L = \{a^n b^n \mid n \geq 0\}$ deterministic? (02)

Q.4) Use the CYK algorithm to find a parsing of the string aab, using the following grammar: (03)

$S \rightarrow AB,$

$A \rightarrow BB/a,$

$B \rightarrow AB/b.$

Q.5) Consider the following grammar and obtain an equivalent grammar in Greibach Normal Form (GNF): (04)

$S \rightarrow AA/0$

$A \rightarrow SS/1.$

Q.6) Construct a PDA accepting $L = \{a^{2n} c b^n \mid n \geq 1\}$. (04)

Q.7) Prove that $L = \{a^i b^i c^i \mid i \geq 1\}$ is not a Context Free Language. (04)

Q.8) Find context free grammar for the language $L = \{a^n b^m c^k : n = m \text{ or } m \neq k\}$. (04)

******** PDA

$\delta(q_0, A, Z_0) = (q_1, SZ_0)$

$\delta(q_1, a, S) = (q_1, AA)$

$\delta(q_1, a, A) = (q_1, S), (q_1, \lambda)$

$\delta(q_1, b, A) = (q_1, S)$