Q. P. Code: 40017

Duration: 3 Hours Marks :80

K. G. C. E. EXAM KARJAT, RAIGAD

N.B. (1) Question No. 1 is compulsory.
(2) Solve any three questions from remaining questions.
(3) Draw suitable diagrams wherever necessary.
(4) Assume suitable data, if necessary.

Q.1 Attempt any four sub-questions.

a) State and explain advantages and limitation of regular and context free grammar. 05

b) Design a Mealy machine for a binary adder. 05

c) Give formal definition of PDA. 05

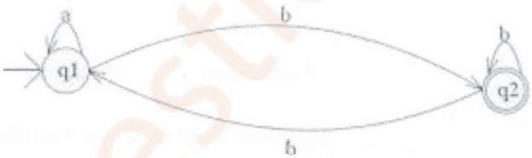
d) Construct the DFA that accept set of all strings over the alphabet $\sum = \{a, b\}$ containing either the substring 'aaa' or 'bbb'. 05

e) Find the CNF equivalent to
$S \rightarrow aAbB$, $A \rightarrow aA \mid a$, $B \rightarrow bB \mid b$. 05

Q2. a) What is NFA? Design a NFA for a binary number where the first and last digit is same. 10

b) Write a necessary function for the given automata. 10

Q3.a) i) Find a regular expression RE corresponding to the following FA 10



ii) Give a regular expression for a language over the alphabet $\sum = \{a, b\}$ containing at most two a's

b) Construct a Mealy machine that accepts strings ending in '00' and '11'. Convert the same to Moore machine. 10

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Q4.a) Design a PDA for CFL that checks the well formedness of parenthesis i.e the language L of all balanced string of two types of paranthesis "( )" and "[ ]". Trace the sequence of moves made corresponding to input string (([ ]) [ ]). 10

b) Construct a TM accepting palindromes over $\sum = \{a,b\}$. 10

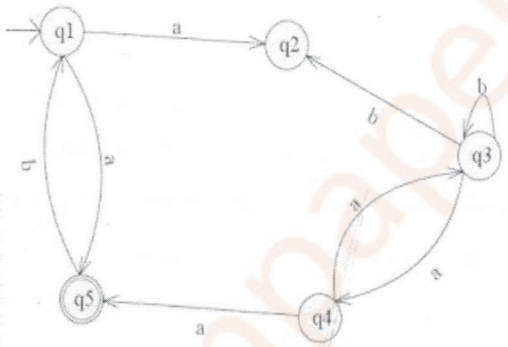
Q5. a) Let G be the grammar. Find the leftmost derivation, rightmost derivation and parse tree for the string 001222. 10

G: $S \rightarrow 0S \mid 1A \mid 2B \mid \varepsilon$

$A \rightarrow 1A \mid 2B \mid \varepsilon$

$B \rightarrow 2B \mid \varepsilon$

b) Design a NFA for accepting input strings that contain either the keyword 000 or the keyword 010 and convert it into an equivalent DFA. 10



Q6. Write short notes on (any four) 20

a) Variants of Turing Machines
b) Algorithm for CFG to CNF Conversion
c) Chomsky Hierarchy
d) Limitation of Finite Automata
e) Halting Problem.

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Q. P. Code: 40016

Duration: 3 Hours Marks :80

Note :

1. Question No.1 is compulsory.
2. Attempt any three question form remaining question.
3. Draw suitable diagram whenever necessary.
4. Assume suitable data if, necessary.

Q.1:

a) Design FA for decimal number divisible by 4 (05)

b) Write a regular expression for $a^n b^m c^k$ where n+m is odd and k is even (05)

c) Design NFA for binary number divisible by 4 or 6 (05)

d) Design Moore machine for binary adder. (05)

Q.2:

a) Convert the following Regular Expression to NFA with Null moves , then convert it to DFA (10)

$(0+1)^* 011 (0+1)^*$

b) Give the Regular expression and corresponding DFA for all the words that begin and end with double letter (10)

Q.3:

a) Design the Turing machine for $a^n b^n c^n$ **where n ≥ 1.** (10)

b) Write a Right linear grammar and left linear grammar for RE $(0+1)^*0$ and show derivation tree for 1010110. (10)

Q.4:

a) Construct CFG for the following

i. Alternate sequences of 0 and 1. (03)

ii. Do not contain 3 consecutive b's (04)

iii. $a^n b^m c^k$ where k=n+m (03)

b) Design CFG for $a^n b^n$ **where n ≥ 1**and convert it to Chomsky's Normal form (10)

Q.5:

a) What is Ambiguous Grammar, find if the following grammar is ambiguous or not? (10)

S--> S+S

S-->S*S

S-->a

S-->b

b) Design PDA for odd length palindrome, **let $\sum$ ={ 0,1} ,L= { W X W^R where W $\in \sum^*$}** (10)

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Q.6:

a) Design Turing machine which adds 2 unary numbers and convert the Turing machine design to a Program (12)

b) Explain the Applications of Automata (FM,PDA,TM) in detail with example (08)

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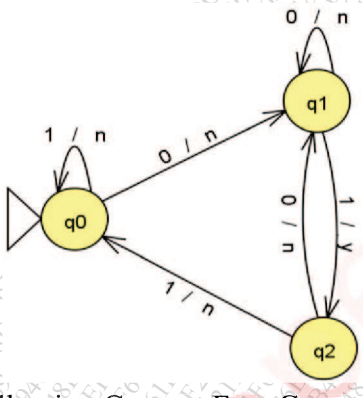
(3 Hours) **[Total Marks: 80]**

1. Question No. **1** is **compulsory**.
2. Out of remaining questions, attempt any **three** questions.
3. Assume **suitable** data wherever required but **justify** the same.
4. **All** questions carry **equal** marks.
5. Answer to each new question to be started on a fresh page.
6. **Figure** to the **right** in brackets indicate **full** marks.

1. Solve any four from the followings.

(a) Construct Moore machine equivalent to following Mealy machine. **[05]**



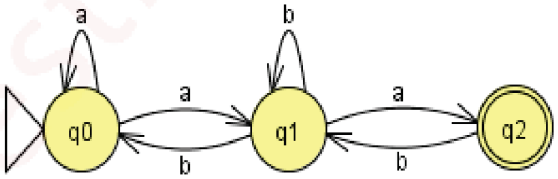
(b) Construct a PDA for the following Context Free Grammar (CFG). **[05]**

$S \rightarrow CBAA$ $A \rightarrow 0A0 \mid 0$ $B \rightarrow 0B \mid 0$ $C \rightarrow 0C1 \mid 1C0 \mid \varepsilon$

(c) Construct right linear grammar and left linear grammar for the regular expression 1(01)*0(0 + 1)*. **[05]**

(d) Explain the concepts, acceptance by final state and acceptance by empty stack of a Pushdown automata with suitable example. **[05]**

(e) Construct regular expression for the following FA using state elimination method. **[05]**

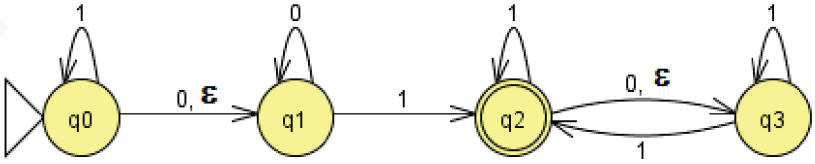


2. (a) Write down the regular expressions for the following language. **[04]**

i. L is the language of all strings over {0, 1} having odd number of 0's and any number of 1's.

ii. L is the language of all strings over {0, 1} having number of 1's multiple of three.

(b) Construct DFA for the following NFA with ε-moves. **[10]**



(c) Construct NFA with ε-moves for the regular expression ab*(a + b)* + ba* **[06]**

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3. (a) Covert the following context free grammar into Chomsky normal form. **[10]**

$S \rightarrow A \mid C \qquad A \rightarrow aA \mid a \mid B \qquad B \rightarrow bB \mid b \mid \varepsilon \qquad C \rightarrow cC \mid c \mid B$

(b) Construct a Context Free Grammar (CFG) for the following PDA. **[10]**

$M = (\{q_0, q_1\}, \{(,), [,]\}, \{(, [, Z_0\}, \delta, q_0, Z_0, \Phi)$ and δ is given by:

$\delta(q_0, (, Z_0) = (q_0, (Z_0)$

$\delta(q_0, [, Z_0) = (q_0, [Z_0)$

$\delta(q_0, (, ( ) = (q_0, (( )$

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$\delta(q_0,), ( ) = (q_0, \varepsilon)$

$\delta(q_0,], [ ) = (q_0, \varepsilon)$

$\delta(q_0, \varepsilon, Z_0) = (q_1, \varepsilon)$

4. (a) Construct a PDA for $L = \{a^n b c^m \mid n, m \geq 1 \text{ and } n < m\}$. **[10]**

(b) Design a DFA over {0, 1} which accepts all strings that contain substring '11' and do not contain the substring '00'. **[06]**

(c) Give context free grammar for the following languages. **[04]**

i. $L = \{0^n 1^m 0^k \mid m > n + k \text{ and } n, m, k \geq 0\}$

ii. $L = \{a^{2n} b^{3m} c^m d^n \mid n, m \geq 1\}$

5. (a) Construct Turing Machine to accept language $L = \{a^n b^{2n+1} \mid n \geq 1\}$. **[10]**

(b) Find the equivalent NFA with ϵ-moves accepting the regular language defined by the following grammar. **[05]**

$S \rightarrow 01S \mid 0A \qquad A \rightarrow 10 \mid 1B \mid 00A \qquad B \rightarrow 1S \mid 1B \mid \epsilon$

(c) Let G be the grammar having following set of production. **[05]**

$S \rightarrow ABA \qquad A \rightarrow aA \mid bA \mid \epsilon \qquad B \rightarrow bbb$

For the string "ababbbba", find a leftmost derivation and rightmost derivation.

6. (a) Minimize the following DFA $M = (\{q_0, q_1, q_2, q_3, q_4, q_5\}, \{0, 1\}, \delta, q_0, \{q_3, q_5\})$, where δ is given in the following table. **[06]**

	$\rightarrow q_0$	q_1	q_2	$*q_3$	q_4	$*q_5$
0	q_1	q_3	q_5	q_3	q_5	q_3
1	q_2	q_4	q_1	q_4	q_1	q_4

(b) Construct Turing Machine wherein given an input 1^n leaves 1^{3n+1} on the tape. Covert the TM design into equivalent function. **[10]**

(c) What do you understand by closure property? State the various set theoretic operations under which regular languages are closed. Give suitable example. **[04]**

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(3 Hours) **Marks:80**

Note: Question **No. 1** is **Compulsory**
Attempt **any three** out of the remaining **five** questions
Assumptions made should be clearly stated

Q.1 Attempt any four sub-questions.

a) Construct the Finite Automata for binary umber divisible by 2 **(05)**

b) Design FA for decimal number divisible by 5 **(05)**

c) Give formal definition of Turing Machine **(05)**

d) State and explain closure properties of regular languages **(05)**

e) Construct DFA accepting all the strings corresponding to the Regular expression
1* 0 1 (0 + 11) * **(05)**

Q2. a) Construct the following grammar to CNF **(10)**

S→ Ba / aB
A→bAA / aS / a
B→aBB / bS / b

b) Design Moore machine for binary adder. **(10)**

Q3.a) Design a DFA corresponding to the regular expression (a+b)* aba (a+b)* **(10)**

b) Define CFG, obtain CGF for the following grammar **(10)**
(110+11)* (10)*

Q4.a) Design a PDA for CFL that checks the well formedness of parenthesis i.e. the language L of all balanced string of two types of parenthesis "( )" and "[ ]".Trace the sequence of moves made corresponding to input string [( ) (( ))]. **(10)**

b) Construct a TM for 2's complement of a binary number. Simulate it for 1 0 1 0 **(10)**

Q5. a) Let G be the grammar. Find the leftmost derivation, rightmost derivation and parse tree for the string 001222. **(10)**

G: S → 0S | 1A | 2B | ε
A → 1A | 2B | ε
B → 2B | ε

b) Consider the CFG S→aSb | bSa | SS | ε , consider the string ***babbabaaaababb*** .prove that given grammar is ambiguous by generating more than one parse tree for a given string **(10)**

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Q6. Write short notes on (**20**)

a) Applications of Automata Theory
b) Chomsky Hierarchy
c) Power and limitations of PDA
d) Halting Problem.

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