Course Code : CAT 207 **QVRU/RS – 22 / 1174**

Fourth Semester B. Tech. (Computer Science and Engineering / Artificial Intelligence and Machine Learning) Examination

THEORY OF COMPUTATION

Time : 3 Hours] [Max. Marks : 60

Instructions to Candidates :—

(1) All questions carry marks as indicated against them.
(2) Due credit will be given to neatness.
(3) Assume suitable data and illustrate answers with neat sketches wherever necessary.

1. (a) By mathematical induction prove that $n^2 - 3n + 4$ is even and it is true for all positive integers. 4 (CO 1)

(b) Explain the Chomsky hierarchy and classify the following grammars to identify its type and hence write the automata used to recognize the language of grammar. Chomsky :

(1) $S \rightarrow ACB$
$AC \rightarrow A11B$
$BAB \rightarrow B0101B$
$C \rightarrow 0101$

(2) $S \rightarrow 0S1 \mid 0A1$
$A \rightarrow 1A0 \mid 10$

(3) $Q \rightarrow XZaY$
$Za \rightarrow aaZ$
$ZYW \rightarrow WY$
$W \rightarrow abb$ 4 (CO 1)

(c) Provide the language generated by the following grammar :

(i) $S \rightarrow SS / \varepsilon$
$S \rightarrow aSb$
$S \rightarrow bSa$

(ii) $S \rightarrow AB$

$A \rightarrow aAb / ab$

$B \rightarrow cBd / cd$ 2 (CO 1)

2. (a) (i) Design DFA that accepts the language over $\Sigma = \{0, 1\}$, $L = \{w \mid w$ does not contain 011 as a substring$\}$.

(ii) Design DFA for the languages $L = \{ab^3wb^2 \mid w$ belongs to $(a, b)^*\}$.

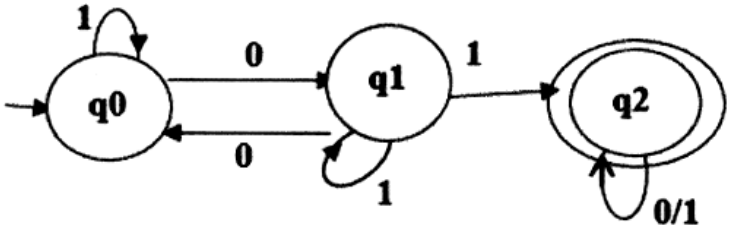
(iii) Design a Moore machine for a binary input sequence such that if it has a substring 101, the machine output A, if the input has substring 110, its outputs B otherwise it outputs C. 1 + 2 + 2 (CO 2)

(b) Generate the minimum state (optimized) DFA equivalent to the given NFA.

δ	0	1
→q0	q1	q2
q1	q1, q3	q1
q2	q2, q3	q3
*q3	q0	q0

5 (CO 2)

3. (a) Develop the Regular Expression which represents the given FA using Arden's theorem and Identity rules.



3 (CO 2)

(b) Prove that the language $L = \{1 \wedge p \mid p$ is prime number$\}$ is not a regular language. 2 (CO 1)

(c) Eliminate the **Left recursion** and then generate the **Reduced** grammar :

$E \rightarrow E + T / T$

$T \rightarrow T * F / F$

$F \rightarrow (E) / I$

$I \rightarrow I0 / I1 / I0 / I1$ 5 (CO 1)

OR

(d) Carry out the conversion of given CFG to Greibach Normal Form :

$S \rightarrow XX \mid 0$

$X \rightarrow SS \mid 1$ 5 (CO 1)

4. Solve any **Two** :—

(a) Construct a PDA for the language $L = \{a^m b^{m+2} c^n c^{n-1} \mid m, n >= 1\}$. Check the strings w1 = abbbccdd is accepted by the PDA. 5 (CO 3)

(b) Design Push Down Automata for the language :

$L = \{a^n b^m c^{|n-m|} \mid m, n > 0\}$

Show the acceptance of strings w1 = aaabbc. 5 (CO 3)

(c) Construct Pushdown automata for $L = \{a^{(2*m)} c^{(3*n)} d^n b^m \mid m, n \geq 0\}$, and check transition for the string aacccccddb. 5 (CO 3)

5. (a) Design Turing machine for the performing the Logical OR operation of two binary numbers. Consider the input and output on the tape as shown below :

INPUT : B0011 | | 0101 = B and *OUTPUT* : B0011 | | 0101 = 0111B 6 (CO 3)

(b) Construct Turing machine for function Sub_4, which defined as follows :

$Sub_4(n) = n - 4$ if $n > 3$

$= 0$ if $n <= 3$ 4 (CO 3)

OR

(c) Construct a Turing Machine for language of the set of strings with an equal number of 0's and 1's. 4 (CO 3)

6. Solve any **Two** :—

(a) Show that the following functions are primitive recursive :

(i) $f(a, b) = a^{4b+3}$

(ii) $f(a, b) = 3 * (a - b)$. 5 (CO 4)

(b) Prove that $ack(2, y) = 2y + 3$ for $y >= 0$ where ack is Ackermann's function. 5 (CO 4)

(c) (i) Let A = {001, 0011, 11, 101} and B = {01, 111, 111, 010}. Does the pair {A, B} have a PCP solution.

(ii) Does PCP with two lists x = (b, a, aba, bb) and y = (ba, ba, ab, b) have a solution ? 5 (CO 4)