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Paper Code: CS-402 **Roll No.** | | | | | | | | | | |

B.Tech.
(SEM IV) EVEN SEMESTER THEORY EXAMINATION, 2015-16
THEORY OF AUTOMATA AND FORMAL LANGUAGE

[Time: 3 hrs.] **[Max. Marks: 100]**

Note:

(i) Attempt all questions. All questions carry equal marks.
(ii) Notations/ Symbols/ Abbreviations used have usual meaning.
(iii) Make suitable assumptions, wherever required.

1. Attempt any FOUR parts of the following: - **[5x4=20]**

(a) Distinguish between nondeterministic finite automata (NFA) and deterministic finite automata (DFA). Obtain a deterministic finite automata which (DFA) with minimum number of states which accepts all the strings over **Σ = {1, 2, 3, 4, 5},** which if interpreted as number, is divisible by **3**.

(b)
(i) Let $\mathbf{r_1}$ and $\mathbf{r_2}$ be regular expressions over the alphabetΣ. Simplify the following regular expression. $\mathbf{r_1 (r_1^* r_1 + r_1^*) + r_1^* + (r_1 + r_2 + r_1 r_2 + r_2 r_1)^*}$
(ii) Explain the Chomsky hierarchy of languages

(c) Convert the following NFA having **r** as final state to a DFA.

Present State	Next State			
	a	b	c	ε
ϕp	{p}	{q}	{r}	
q	{q}	{r}		{p}
r	{r}		{p}	{q}

2. Attempt any TWO parts of the following:- **[10x2=20]**

(a) State the pumping Lemma for Regular Sets. Prove that the language $\mathbf{L = \{a^n \mid n}$ is prime number} is not regular.

(b) Prove the following statements or give counter example
(i) There exists an algorithm to decide whether the language **L(M)** accepted by a given finite automata **M** is infinite or not.
(ii) If **L** and **M** are regular languages then **L - M** is also regular.
(iii) If **L** and **M** are nonregular languages then union of **L** and **M** is also nonregular.

(c) Using Arden's theorem, obtain the regular expression for the following finite automata having $\mathbf{q_3}$ as final state.

Present State	Next State	
	Input 0	Input 1
ϕq_0	q_2	q_1
q_1	q_2	q_3
q_2	q_3	q_1
q_3	q_3	q_3

3. Attempt any TWO parts of the following:- **[10x2=20]**

(a) Convert the following grammar into Greibach Normal Form (GNF).

S ϕ AA | a
A ϕ SS | b

(b) What do you understand by useless symbol in a CFG. Given the following CFG having **S** as start symbol, find an equivalent CFG with no useless symbols.

S ϕ AB | AC
A ϕ aAb| bAa | a
B ϕ bbA | aaB | AB
C ϕ abCa | aDb
D ϕ bD | aC

(c) Using CYK algorithm to show whether the string **aabab** is member of the language generated by the grammar **G** or not. The grammar **G** is defined as follows.

S ϕ BC | CA
A ϕ BC | a
B ϕ CB | a
C ϕ AA | b

4. Attempt any TWO parts of the following: - **[10x2=20]**

(a) Construct a PDA which accepts the strings **w ε (0 + 1)*** in which number of **0's** is same as number of **1's**

(b) Attempt the following:-

(i) Given a PDA which accepts language L by empty stack. Suggest a procedure for construction of a PDA which accepts L by final state.

(ii) Write a context free grammar for the language **L** defined as follows.

L=$\{a^i b^j c^k \mid i = j$ **or** $j = k;\ i, j, k$ are positive integers $\}$.

(iii) Consider the following ambiguous context free grammar G with start symbol **S**, which generates a set of arithmetic expressions.

S ϕ S + S | S * S | S ^ S | a

Given that the precedence of operators in decreasing order is ^**, *, +.** The operators **+, *** are left associative while ^ is right associative. Write an equivalent unambiguous context free grammar G_1 which generates the same language.

(c) Consider the PDA M= $(\{q_0, q_1, q_2\}, \{a, b\}, \{A, Z_0\}, \delta, q_0, Z_0, \Phi)$ where **δ** is given as follows.

$\delta(q_0, a, Z_0) = \{(q_0, AZ_0)\}$
$\delta(q_0, a, A) = \{(q_0, AA)\}$
$\delta(q_0, b, A) = \{(q_1, A)\}$
$\delta(q_1, a, A) = \{(q_1, \varepsilon)\}$
$\delta(q_1, \varepsilon, Z_0) = \{(q_2, \varepsilon)\}$

Obtain the context free grammar that generates the same language which is accepted by PDA **M.**

5. Attempt any TWO parts of the following:- **[10x2=20]**

(a) Define the Turing machine. Design a Turing machine that computes the function ***f*** defined as follows.

$f(n) = 2^n$; where ***n*** in a positive integer.

(b) Attempt the following:-

(i) Prove that if a Language ***L*** and its complement both are recursively enumerable then ***L*** is recursive.
(ii) Prove that intersection of two recursively enumerable languages is also recursively enumerable.
(iii) Prove that there exists at least one language which is not recursively enumerable.
(iv) What do you understand by NP-Complete Problems? Explain importance of the concept.

(c)

(i) State the Post Correspondence Problem (PCP) and Modified Post Correspondence Problem (MPCP). Determine whether following instance of PCP having two lists A={01, 001, 10} and B={011, 10, 00} has a solution or not?
(ii) Write short note on the Universal Turing Machine.