ROLL NO. _____

Code: AC68 Subject: FINITE AUTOMATA & FORMULA LANGUAGES

AMIETE – CS

Time: 3 Hours **JUNE 2014** **Max. Marks: 100**

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q.1 must be written in the space provided for it in the answer book supplied and nowhere else.**
- **The answer sheet for the Q.1 will be collected by the invigilator after 45 Minutes of the commencement of the examination.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

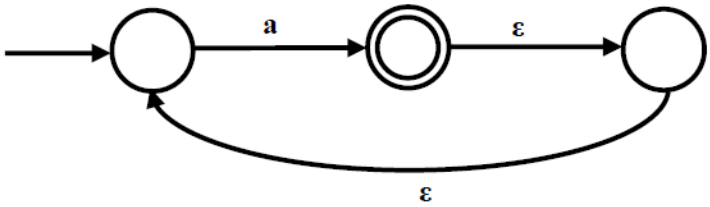
Q.1 a. Given the language L = {ab, aa, baa}, which of the following strings are in L*? **(2×10)**

(i) abaabaaabaa (ii) aaaabaaaa
(iii) baaaaabaaaab (iv) baaaaabaa

(A) (i), (ii) & (iii) **(B)** (ii), (iii) & (iv)
(C) (i), (ii) & (iv) **(D)** (i), (iii) & (iv)

b. What is the complement of the language accepted by the NFA shown below? $\sum = \{a\}$. Assume and ε is the empty string.

(A) {a}
(B) a*
(C) ϕ
(D) a^+



c. Let L be the language consisting of all strings of zeros or more 0's followed by one or more 1's, followed by two or more 2's. Write a regular expression whose language is L.

(A) 0+11*22+ **(B)** 0*1+222*
(C) 01*222* **(D)** 0*11+22+

d. Consider the following grammar

$S \rightarrow AB$
$A \rightarrow a$
$A \rightarrow BaB$
$B \rightarrow bbA$

Which of the following is false?

(A) The length of every string produced by the grammar is even
(B) No string produced by the grammar has an odd number of consecutive b's
(C) No string produced by the grammar has three consecutive a's
(D) No string produced by the grammar has four consecutive b's

e. The idea of an automation with a stack as auxiliary storage is called ----------

(A) Finite automata
(B) Push down automata
(C) Deterministic automata
(D) Turing Machine

f. Which of the following is true for a language $\{a^p | p \text{ is a prime}\}$?

(A) It is not accepted by a Turing Machine
(B) It is regular but not context free
(C) It is context free but not regular
(D) It is neither regular nor context free, but accepted by a Turing Machine.

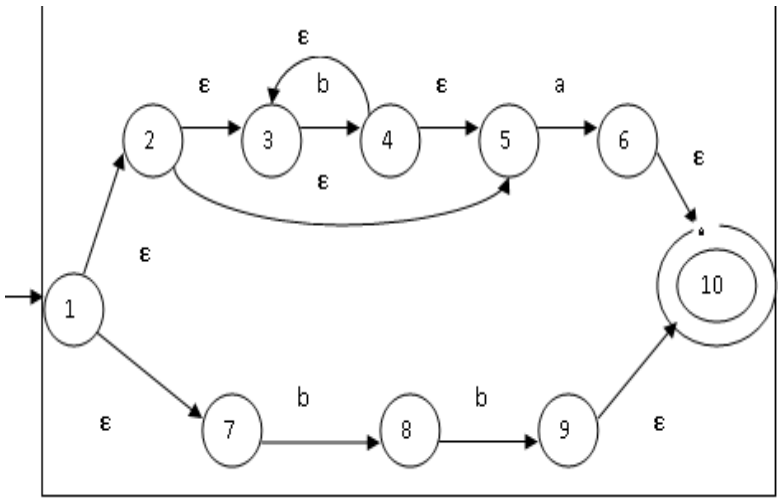
g. What is ε–closure (1)?

(A) {1, 2, 3,5, 7}

(B) {1, 2, 3, 4, 5, 7}

(C) {2, 3, 5, 7}

(D) {2, 3, 5, 7, 10}



h. Which of the following problems are decidable?
(i) Does a given program ever produce an output?
(ii) If L is a context-free language, then $\bar{L}$ is also context-free?
(iii) If L is a regular language, then $\bar{L}$ is also regular?
(iv) If L is a recursive language, then $\bar{L}$ as also recursive?

(A) (i), (ii), (iii), (iv)
(B) (i), (ii)
(C) (ii), (iii), (iv)
(D) (iii), (iv)

i. If we allow a push down automaton to access two stacks instead of just one, we obtain a more powerful device, equivalent in power to a _____

(A) Non-Deterministic Finite Automata
(B) Deterministic push down automaton
(C) Turing machine
(D) Context Free Grammar

j. Context Free Languages are not closed under

(A) reversal
(B) intersection
(C) homomorphism
(D) Inverse Homomorphism

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. Show by using Mathematical Induction that $\sum_{i=1}^{n} i^2 = \frac{n \cdot (n+1) \cdot (2 \cdot n+1)}{6}$ **(8)**

b. Define language. Let $\sum = \{0; 1\}$ denote an alphabet. Enumerate five elements of the following languages:
(i) Even binary numbers,
(ii) The number of zeros is not equal to the number of ones in a binary string.
(iii) The number of zeros is exactly one greater than the number of ones. **(8)**

Q.3 a. Construct DFA to accept all possible strings of 0's and 1's which does not contain 011 as a substring **(5)**

b. Obtain DFA from the following NFA defined by transition table given below: **(5)**

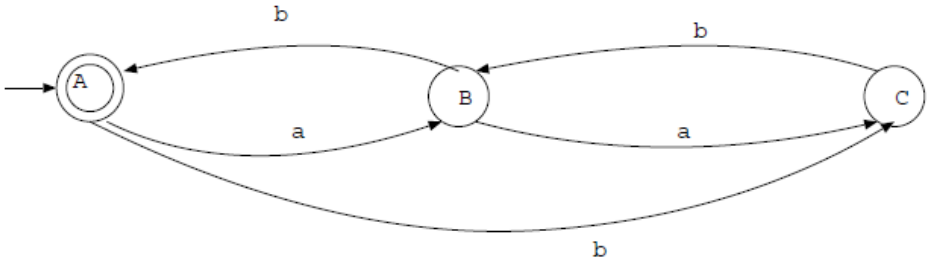
State	δ		
	0	1	2
$\rightarrow q_0$	$\{q_0, q_1, q_2\}$	$\{q_1, q_2\}$	$\{q_2\}$
q_1	Φ	$\{q_1, q_2\}$	$\{q_2\}$
$*q_2$	Φ	Φ	$\{q_2\}$

c. Prove that a language L is accepted by some ε-NFA if and only if L is accepted by some DFA. **(6)**

Q.4 a. Prove that if L and M are regular languages, then so is L∩M **(6)**

b. Define Context Free Grammar. Give Context Free Grammar that generates the following Languages:
(i) L = {w∈{0, 1}* | w contains more 1's than 0's}
(ii) L = {$a^i b^j c^k$ | i, j,k ≥ 0 and either i = j or j = k}
(iii) L ={a^nu | u ∈{a, b}* and |u| = n, n ≥ 0} **(10)**

Q.5 a. Write a regular expression for the language represented by the Finite Automata given in the below figure: **(6)**



b. Explain algebraic laws for regular expressions. **(10)**

Q.6 a. Design a PDA to accept the language $L = \{a^i b^j c^k : i + j = k; i \geq 0, j \geq 0\}$ **(6)**

b. Consider the grammar G = (V, T, S, P), with productions defined by:
$S \rightarrow aSbS \mid bSaS \mid \varepsilon$.
Is G ambiguous? If so, prove and also provide the unambiguous grammar for the same language. **(6)**

c. What is the relationship between Deterministic Push Down Automata, regular Languages and Context Free Languages? **(4)**

Q.7 a. Convert the following simplified grammar to CNF
G = ({S, A, B}, {a, b}, {S $\rightarrow$ ASB | AB, A $\rightarrow$ aAS | a | aA, B $\rightarrow$ SbS | bb | Sb | bS | b | aAS | a | aA }, S) **(7)**

b. State Pumping Lemma for Context Free Language. Show that the language, $L=\{0^i 1^j 2^i 3^j \mid i \geq 1, j \geq 1\}$ is not a Context Free Language. **(9)**

Q.8 a. Design a Turing Machine to accept the language L = {w $\in$ {a, b}*| w is a palindrome}. Give traces of the machine for the strings "baab" and "ababa" **(10)**

b. Prove that every language accepted by a multitape Turing Machine is recursively Enumerable. **(6)**

Q.9 Define the following languages with diagram:

(i) Recursively Enumerable **(6)**
(ii) Non- recursively enumerable **(6)**
(iii) Recursive **(4)**