ROLL NO. _____

Code: AC68/AC120 Subject: FINITE AUTOMATA & FORMULA LANGUAGES

AMIETE – CS (Current & New Scheme)

Time: 3 Hours **JUNE 2017** **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 Choose the correct or the best alternative in the following: (2×10)

a. Assume the statements S1 and S2 given as:
S1: Given a context free grammar G, there exists an algorithm for determining whether L(G) is infinite.
S2: There exists an algorithm to determine whether two context free grammars generate the same language.
Which of the following is true?
(A) S1 is correct and S2 is not correct.
(B) Both S1 and S2 are correct.
(C) Both S1 and S2 are not correct.
(D) S1 is not correct and S2 is correct.

b. Which of the following conversion is not possible (algorithmically)?
(A) regular grammar to context-free grammar
(B) nondeterministic FSA to deterministic FSA
(C) nondeterministic PDA to deterministic PDA
(D) nondeterministic TM to deterministic TM

c. Regular expression for the language L = { w∈ {0, 1}* | w has no pair of consecutive zeros} is
(A) (1 + 010)* **(B)** (01 + 10)*
(C) (1 + 010)* (0 + λ) **(D)** (1 + 01)* (0 + λ)

d. Recursively enumerable languages are not closed under:
(A) Union **(B)** Intersection
(C) Complementation **(D)** Concatenation

e. Grammar that produces more than one Parse tree for same sentence is:
(A) Ambiguous **(B)** Unambiguous
(C) Complementation **(D)** Concatenation Intersection

f. For the language {ap | p is a prime}, the statement which hold true is
(A) It is not regular but context free
(B) It is regular but not context free
(C) It is neither regular nor context free, but accepted by a Turing machine
(D) It is not accepted by Turing machine

g. Write the regular expression to denote the language L over alphabet={a,b} such that all the string do not contain the substring " ab".
(A) a*b* **(B)** b*a*
(C) (ab)* **(D)** (ba)*

h. Recognize the CFL for the given CFG. S → aB | bA, A→a|aS|bAA, B→b | bS | aBB
(A) strings contain equal number of a's and equal number of b's.
(B) strings contain odd number of a's and odd number of b's.
(C) strings contain odd number of a's and even number of b's.
(D) strings contain even number of a's and even number of b's.

i. Given the following statements:
(i) Recursive enumerable sets are closed under complementation.
(ii) Recursive sets are closed under complementation.
Which is/are the correct statements?
(A) only (i) **(B)** only (ii)
(C) both (i) and (ii) **(D)** neither (i) nor (ii)

j. Given the following statements:
(i) The power of deterministic finite state machine and nondeterministic finite state machine are same.
(ii) The power of deterministic pushdown automaton and nondeterministic pushdown automaton are same.
Which of the above is the correct statement(s)?
(A) Both (i) and (ii) **(B)** Only (i)
(C) Only (ii) **(D)** Neither (i) nor (ii)

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

Q.2 a. Prove by Induction that every expression has equal number of left and right parenthesis. **(8)**

b. Define Automata Theory and give reason to study Automata Theory. **(4+4)**

Q.3 a. Design a DFA and give the transition table to accept the language L = {w | w is of even length and begins with 01} **(4)**

b. Convert to a DFA the following NFA **(4)**

Δ	**0**	**1**
→p	{p,q}	{p}
q	-	{r}
*r	{p,r}	{q}

c. Convert the DFA given by the transition table to Minimized DFA **(8)**

	0	1
→q_0	q_1	q_5
q_1	q_6	q_2
*q_2	q_0	q_2
q_3	q_2	q_6
q_4	q_7	q_5
q_5	q_2	q_6
q_6	q_6	q_4

Q.4 Write the regular expression for the following languages over {0, 1}*:

a. The set of strings over alphabet {a,b,c} containing at least one "a" and at least one "b". **(4)**

b. The set of all strings of 0's and 1's such that every pair of adjacent 0's appears before any pair of adjacent 1's. **(4)**

c. Give English description of the language of the following regular expression: (1+ε)(00*1)*0* **(3)**

d. Consider the DFA below: **(5)**

δ	0	1
→q_1	q_2	q_1
q_2	q_2	q_3
q_3	q_3	q_2

Give all the regular expression R_{ij}^{0} and R_{ij}^{1}. Also construct the transition diagram for the DFA and give a regular expression for its language by eliminating sate q_2.

Q.5 a. Prove that the following languages are not regular
(i) $\{0^n10^n \mid n \geq 1\}$;
(ii) $\{0^n \mid n$ is a perfect square$\}$ **(4+4)**

b. Design context-free grammars for the following languages:
(i) $\{0^n1^n \mid n \geq 1\}$;
(ii) $\{a^ib^jc^k \mid i \neq j$ or $j \neq k\}$ **(4+4)**

Q.6 a. Consider the grammar S→aS | aSbS | ε. This grammar is ambiguous. Show in particular that the string "aab" has two (i) Parse trees (ii) Leftmost derivation (iii) Rightmost derivation. **(2+2+2)**

b. Design a PDA to accept each of the following languages. You may accept either by final state or by empty stack, whichever is more convenient.
(i) $\{0^n1^n \mid n \geq 1\}$ (ii) $\{a^ib^jc^k \mid i = j \text{ or } j = k\}$ **(5+5)**

Q.7 a. Find a grammar equivalent to S→AB | CA; A→a; B→ BC | AB; C→aB | b, with no useless symbols. **(4)**

b. Begin with the grammar S→ ASB | ε; A→aAS | a; B→SbS | A | bb
(i) Eliminate the ε-productions. **(4)**
(ii) Eliminate any unit productions in the resulting grammar. **(4)**

c. Use CFL pumping lemma to show that the following language is not context free $\{a^ib^jc^k \mid i< j < k\}$ **(4)**

Q.8 a. Design a Turing Machine (TM) which accepts the language consisting of all palindromes of 0 and 1. **(8)**

b. (i) Consider a Turing Machine
$M = (\{q_0,q_1,q_2,q_f\}, \{0,1\}, \{0,1,B\}, \delta, q_0, B,\{q_f\})$. Clearly describe the language L(M) if δ consists of the following set of rules:
$\delta(q_0,0)=(q_1,1,R)$; $\delta(q_1,1)= (q_0,0,R)$; $\delta(q_1,B)=(q_f,B,R)$ **(4)**

(ii) In general simulation of a k-tape TM by a one-tape TM. Suppose this technique is used to simulate a 5-tape TM that had a tape alphabet of seven symbols. How many tape symbols would the one tape TM have? **(4)**

Q.9 a. What string is W_{37}? **(4)**

b. Show that following question is decidable:
the set of codes for TM's M such that, when started with blank tape will eventually write some nonblank symbol on its tape. **(4)**

c. Tell whether the following is recursive, RE-but-not-recursive, or non-RE,
"the set of all TM codes for TM's that halt on every input". **(4)**

d. Tell whether the following instance of Post's Correspondence Problem (PCP) has a solution. It is presented as two lists A and B, and the i^{th} string on the two lists correspond for each i = 1,2…… A = (01, 001, 10); B = (011, 10, 00). **(4)**