LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

B.Sc. DEGREE EXAMINATION – **MATHEMATICS**

FIFTH SEMESTER – NOVEMBER 2014

MT 5407 – FORMAL LANGUAGES AND AUTOMATA

Date : Dept. No. Max. : 100 Marks

Time :

SECTION A

ANSWER ALL QUESTIONS. **(10 × 2 = 20)**

1) Define non-deterministic finite automaton.
2) Write any two differences between DFA and NFA.
3) What is meant by the language accepted by a finite automaton?
4) Define context- free languages.
5) Show that $L = \{a^p : p \ is \ prime\}$ is not regular.
6) Define Phrase-structure grammar.
7) Define the product or concatenation of two languages.
8) What is meant by Ambiguity?
9) Give an example of Chomsky Normal form.
10) Define Star closure.

SECTION B

ANSWER ANY FIVE QUESTIONS. **(5 × 8 = 40)**

11. Let $M = \{(q_0, q_1, q_2, q_3, q_4), (a, b), \delta, q_0, \{q_0\}\}$ be a finite automaton, where δ is given by $\delta(q_0, a) = q_2, \delta(q_0, b) = q_1, \delta(q_1, a) = q_3, \delta(q_1, b) = q_4, \delta(q_2, a) = q_2,$ $\delta(q_2, b) = q_1, \ \delta(q_3, a) = q_3, \delta(q_3, b) = q_1, \delta(q_4, a) = q_1, \delta(q_4, b) = q_3.$ Draw the state diagram and construct the state table.
12. Construct a finite automaton that accepts exactly those input strings of 0's and 1's that end in 11.
13. Construct a DFA M accepting the strings over (a, b) and ending $\{ab, ba\}$.
14. Prove that union of two regular set is regular.
15. Write a short note on Chomskian hierarchy.

16. Consider the grammar $G = (N, T, P, S)$, where $N = \{S, (P_T), (VP), V, A, N, (Aux), P\}$, $T = \{They, are, flying, planes\}$. $P = \{S \to (P_T)(VP), P_T \to They, VP \to (V)(NP), V \to are, NP \to (A)(N), A \to flying, N \to planes, V \to (Aux)(P), (Aux) \to are, NP \to N, P \to flying\}$. Find two derivations and draw their corresponding generation trees.

17. Let L= $\{a^n b^n, n \geq 1\}$. Then prove that the grammar $G = (N, T, P, S)$ where $N = \{S\}$, $T = \{a, b\}$ and $P = \{S \to aSb, S \to ab\}$ generates L.

18. Let $L = \{a^n / n \geq 1\}$ give an ambiguous and unambiguous grammar to generate L.

SECTION C

ANSWER ANY TWO QUESTIONS. **(2 x 20 = 40)**

19. a) Construct a FA equivalent to NFA with the transition table given below.

δ	a	b
s_0	$\{s_0, s_1\}$	$\emptyset$
s_1	□	s_2
s_2	□	s_2

b) Find $\hat{\delta}(q_0, 1001)$ for the NFA given by $M = \{(q_0, q_1, q_2, q_3), (0,1), \delta, q_0, \{q_3\}\}$ and δ is defined in the following table: **(10+10)**

δ	0	1
q_0	$\{q_0, q_1\}$	$\{q_0, q_2\}$
q_1	q_3	—
q_2	—	q_3
q_3	q_3	q_3

20. a) Construct an automata M such that $T(M) = \{a^m b^n, m, n \geq 1\}$.

b) State and prove pumping lemma. **(7+13)**

21. a) Let $G = (N, T, P, S)$ where $N = \{S, A\}, T = \{a, b\}$. Construct a production rule to show that the word $\boldsymbol{abab}$ has two different leftmost derivations and generation trees.

b) Let $L = \{a^n b^m / n \neq m\}$. Then prove that $G = (N, T, P, S)$ whereN={S,A,B}, T={a,b} and $P = \{S \to aSb,\ S \to aA,\ A \to b, A \to a, S \to a, S \to bB,\ B \to b,\ S \to b$, generates L.

(10+10)

22. a) Let $G = (\{S, Z, A, B\}, \{a, b\}, P, S)$ where P consists of the following productions:

1. $S \rightarrow aSA$ 2. $S \rightarrow aZA$ 3. $Z \rightarrow bZB$ 4. $Z \rightarrow bB$ 5. $BA \rightarrow AB$ 6. $AB \rightarrow Ab$
7. $bB \rightarrow bb$ 8. $bA \rightarrow ba$ 3. $aA \rightarrow aa$.

Then prove that $L(G) = \{a^n b^m a^n b^m / \ n, \text{m} \geq 1\}$ is a CSL.

b) Construct a grammar to generate all three digit even numbers. **(12+8)**