(Please write your Roll No. immediately) **Roll No. ……………………**

End-Term Examination

Second Semester [MCA] – MAY-JUNE 2006

Paper Code: MCA-104	**Subject: Theory of Computation**
Paper ID: 44104	

Time: 3 Hours **Maximum Marks: 60**

Note: Answer question 1 and any four of the remaining six questions. Question 1 is of 20 marks and the rest are of 10 marks each.

Q. 1

(a) Draw a finite automata that accepts sets of strings composed of zeros and ones which end with string 00.

(b) Define an inherently ambiguous language. Give an example of such language.

(c) Give a recursive formula for addition of two positive numbers using initial functions like zero, identify and successor functions. Hence show that addition of two positive numbers is computable.

(d) Show that if M_1 is a Moore machine then their exists a corresponding Mealy machine.

(e) Draw a NFA with three states that accepts L= $\{a^n : n \geq 1\} \cup \{b^k a^m : k \geq 0\ m \geq 0\}$.

(4 x 5 = 20)

Q. 2

(a) Show that the set of all strings in {0, 1} such that every third symbol is the same as the first symbol is a regular language.

(b) Construct a context free grammar for the language L={w | w ε {0, 1}* , | w | is odd and w contains 0 in the middle of the string}.

(5, 5)

Q. 3 Convert the following Context Free Grammar into GNF.

S → bA
S →aB
A →bAA
A →aS
A →a
B →aBB
B →bS
B →b'

Q. 4

(a) Draw a Push Down Automata with minimum number of pushdown stores of the language $\{wcw^R \mid w\ \varepsilon\ \{0, 1\}^*\}$. Here w^R is reverse string of w.

(b) Give a matrix grammar for the above language. **(7, 3)**

Q. 5

(a) Define a Turing machine. Draw a Turing Machine that adds two positive integers.

(b) State and prove the pumping lemma for CFL. **(5, 5)**

Q. 6

(a) Define Derivation Tree. Is it possible to draw a derivation tree for a string derived from context sensitive grammar? Give reasons for your answer. **(5, 5)**

(b) Let '10011010011' is a symbol sequence. Apply the following prioritized Markov rules to convert the sequence such that all symbols following the pattern '1101' should be '0'.

(1) a0 $\rightarrow$ 0a
(2) a1 $\rightarrow$ 0a
(3) a $\rightarrow$
(4) 1101 $\rightarrow$ 1101a
(5) $\rightarrow$

Q. 7 Write short notes on any two of the following:- **(5, 5)**

(a) L –System of grammar
(b) Partial recursive function
(c) Unsolvable class or problem.

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End-Term Examination

Second Semester [MCA] – MAY 2004

Paper Code: MCA-104	**Subject: Mathematical Function of Computer Science**

Time: 3 Hours **Maximum Marks: 60**

Note: Attempt any six questions.

Q. 1 (a) Prove that any set S and its Power set P(S) are not equivalent. The proof should hold for arbitrary sets. 4

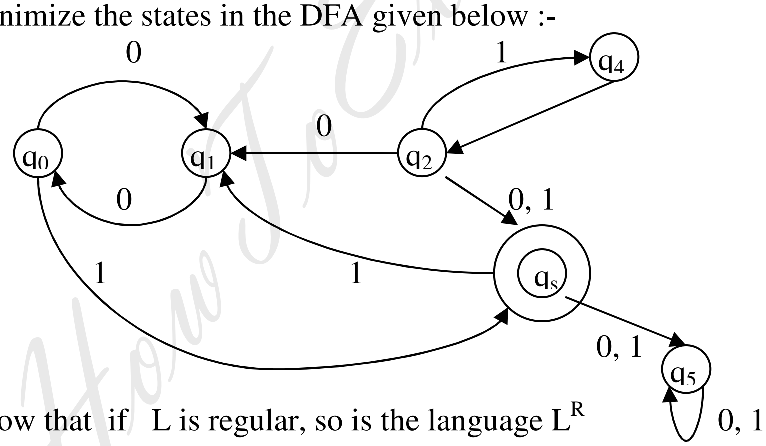
(b) Establish the following properties for finite sets 6

(i) if $| S_1 | = n$ and $|S_2| = m$, then $| S1 \cup S2 | \leq n + m$

(ii) $| S_1 \times S_2 | = |S_1| |S_2|$

(iii) $S_1 \cup S_2 - (S_1 \cap \overline{S_2}) = S_2$ $\overline{S_2}$ represents the compliment of S_2 (w.r.t. Universal set).

Q. 2 (a) Minimize the states in the DFA given below :- 5



(b) Show that if L is regular, so is the language L^R 5

Q. 3 (a) Construct a DFA that accepts the language generated by the grammar 5

S → abA
A → baB
B → aA | bb

(b) Construct a right-linear grammar for the language L ((aab * ab)*). 5

Q. 4 (a) Is the following language regular? Prove your answer: 4

(i) $L = \{a^n b^\ell : n \leq \ell \}$
(ii) $L= \{w w^R v : v, w \in \{a, b\}^+\}$

(b) Determine whether or not the following are context free language or not:
(i) $L = \{a^n ww^R a^n : n \geq 0, w \in \{a, b\}^*\}$
(ii) $L = \{a^n b^m : n = 2^m\}$
(iii) $L = \{a^n b^n c^j : n \leq j\}$ 6

Q. 5 (a) Construct a non deterministic push down automata for the grammar. 5

A → aABB | aAA
A → ABB | a
B → bBB | A

(b) Design Turing machine to compute the following functions for x and y positive integers represented in unary. 5

(i) $f(x) = 3x$
(ii) $f(x, y) = x - y; \quad x > y$
$\quad = 0, \quad x \leq y$

Q. 6 (a) For $\sum = \{a, b, c\}$, find a Post system that generates the following languages :
(i) $L(a * b + ab * c)$
(ii) $L = (a^n b^n c^n)$ 5

(b) Find an L- system that generates L (aa*). 5

Q. 7 (a) Show that every context sensitive language is recursive. 5

(OR)

Prove that the Ackermann's function is not primitive recursive.

(b) Prove the statement that if a language L_1 is NP-Complete and polynomial time reducible to L_2, then L_2 is also NP-Complete. 5

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End-Term Examination

Second Semester [MCA] – MAY 2003

Paper Code: MCA-104	**Subject: Mathematical Foundations of Computer Science**

Time: 3 Hours **Maximum Marks: 60**

Note: Attempt any five questions. All questions carry equal marks.

Q. 1 (a) Construct a DFA that accepts all strings on {0,1} that have three consecutive zeros.
(b) Construct a DFA equivalent to following regular expression 10 + (0+11) 0 *1 .

Q. 2 Which one of the following language are regular sets. Prove your answer
(a) Set of all strings with equal number of zeros and ones.
(b) $\{x\ w\ x^R \mid x, w \text{ in } (0 + 1)^+\}$
(c) $\{0^m\ 1^n\ 0^{m+n} \mid m \geq 1 \text{ and } n \geq 1\}$

Q. 3 (a) Give context free grammars generating the following sets.
$\{a^i\ b^j\ c^k \mid i \neq j \text{ or } j \neq k\}$
(b) Let G be the Grammar
S→ a B | b A
A → a | a S | b AA
B → b | b S | a BB

For the string aaabbabbba find a
(i) Left most deviation
(ii) Right most deviation
(iii) Parse Tree

Q. 4 (a) Construct a Push down Automata equivalent to the following grammar.
S→ a AA, A→ aS | b S | a
(b) With a suitable example describe pumping frame for context free language.

Q. 5 (a) Prove that a two counter machine can simulate an arbitrary Turing machine.
(b) Design a Turing machine to recognize the following languages
$\{ww^R \mid w \text{ is in } (0+1)^*\}$

Q. 6 Which of the following properties of recursively enumerable sets are themselves recursively enumerable? Give reasons for your answer.
(a) L contains Atleast two strings.
(b) L is infinite
(c) L is a context free language.
(d) $L = L^R$

Q. 7 (a) Prove that context free language are not closed under intersection.

(b) Let G1 and G2 be grammars with G1 regular. Is the problem L(G1) =LG(2) decidable when

(i) G2 is unrestricted

(ii) G2 is regular

Q. 8 Write notes on following

(a) Non-deterministic Turing Machine

(b) Mealy Automation.

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End-Term Examination

Second Semester [MCA] – JUNE 2001

Paper Code: MCA-104	**Subject: Mathematical Foundations of Computer Science**

Time: 3 Hours **Maximum Marks: 70**

Note: Attempt five questions in all including Q. 1 which is compulsory. Q. 1. carry 30 marks and Q. 2 to Q. 8 carry 10 marks each.

Q. 1 Answer any four parts from the following :

(a) Find grammar for $\sum = \{a, b\}$ that generates the sets of all strings with no more than three a's.

(b) What language does the grammar with these productions generate?

$S \rightarrow Aa$, $A \rightarrow B$, $A \rightarrow Aa$

(c) Find the grammar for the following language on $\sum = \{a\}$:

$L = \{w: |w| \bmod 3 > 0\}$

(d) Give the DFA for the following language :

$L = \{ab^5 wb^4 : w \in \{a, b\}^*\}$

(e) Find the regular grammar for the following language on {a, b}:

$L = \{ w : n_a(w)$ and $n_b(w)$ are both even$\}$

Where $n_a(w)$ and $n_b(w)$ are number of a and b, respectively in string w

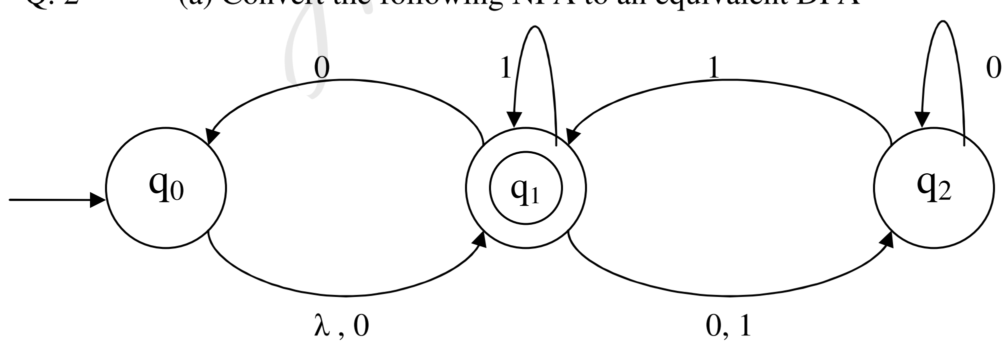
(f) Construct a NPDA that accept the following language on

$\sum \{a, b, c\}$

$L = \{wcw^R : W \in \{a,b\}^*\}$

Where W^R is the reverse of string W.

Q. 2 (a) Convert the following NFA to an equivalent DFA



(b) Convert the grammar $S \rightarrow abSb / aa$ in Greibach Normal Form.;

Q. 3 (a) Construct a Turing machine that computes the function f(n, m) = n * m.

(b) Let $\sum = \{a, b\}$
Show that $L = \{w w^R : w \in \sum^*\}$ is not regular.

Q. 4 (a) What language is accepted by the machine

$M = (\{q_0, q_1, q_2, q_3\}, \{a, b\}, \{a, b, \Pi\}, \delta, q_0, \square, q_3\})$
With
$\delta(q_0, a) = (q, a, R)$
$\delta(q_0, b) = (q_2, b, R)$
$\delta(q, b) = (q_1, b, R)$
$\delta(q_1, \square) = (q_3, \square, R)$
$\delta(q_2, b) = (q_2, b, R)$
$\delta(q_2, a) = (q_3, a, R)$

(b) What is Non-deterministic Turing Machine? Explain with suitable example.

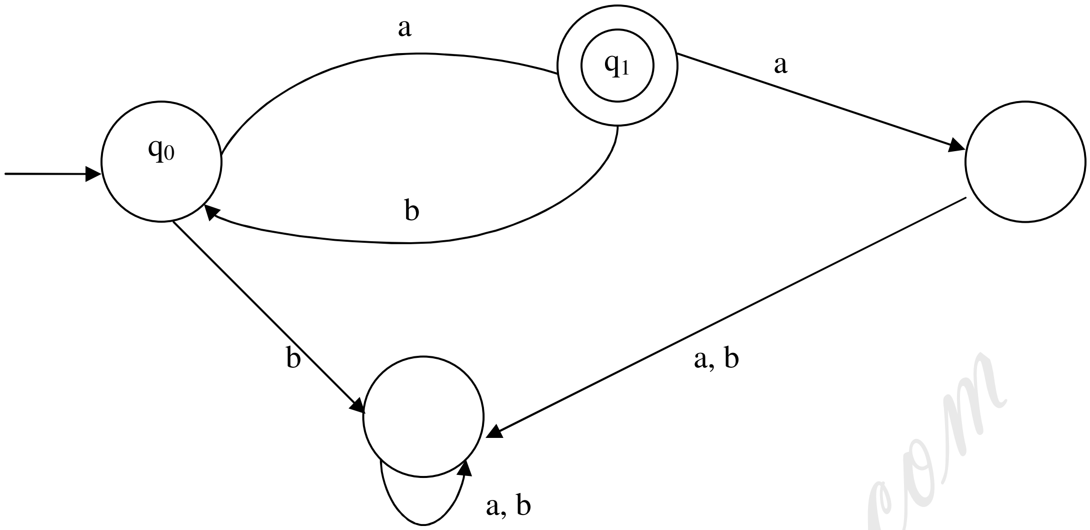
Q. 5 (a) Remove all unit production from
$S \rightarrow Aa \mid B,$
$S \rightarrow A \mid bb,$
$S \rightarrow a \mid bc \mid B$

(b) What is pumping leema? Discuss its use.

Q. 6 Let the Grammar G be defined by :
$S \rightarrow AB,\ B \rightarrow A \mid Sb,\ A \rightarrow Aa \mid bB$
Given the Derivation tree for the following sequential form :
(a) baSb
(b) baabaab
(c) bBABb

Can you find an inherently ambiguous context free language? If yes give an example.

Q. 7 (a) Give the regular expression for the following :-



(b) Use induction on the size of S to Show that if S is a finite set then $|2^S| = 2^{|S|}$

Q. 8 Write short notes on any two of the following :-

(a) Computational complexity
(b) Unrestricted Grammars
(c) Closure property for DFL's
(d) Mealy Machines

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End-Term Examination

Second Semester [MCA] – MAY 2005

Paper Code: MCA-104	**Subject: Theory of Computation**
Time: 3 Hours	**Maximum Marks: 70**

Note: Attempt five questions in all, including Q.1 which is compulsory.

Q. 1 Answer the following :- 20

(a) Find the set of strings on T = {a, b } produced by the regular expression b*(a+b)*ab*.

(b) Show that Class of CFL is not closed under complement and intersection.

(c) What class of language can be generated by grammar with only left context i.e. grammar in which each production is of the form $\alpha A \rightarrow \alpha B$, where α and β belong to (n U ϵ)* ?

(d) Prove that {awa | w ϵ {a, b}*} is a regular language.

(e) Give the matrix grammar for $\{a^n b^n c^n \mid n > 0\}$.

Q. 2 (a) Differentiate between partial recursive function and Total recursive function. What is bounded minimization? 5

(b) Give the following recursive function 5

A (0, y) =1;
A(1, 0) = 2;
A(x,0) = x + 2 for all x ≥ 2 and
A(x +1, y+1) = A(x, y + 1), y)

Determine A (3, 2)

Q. 3 (a) State and prove the pumping lemma for Regular Language (RL). 5

(b) Show that $\{a^n b^n c^n \mid n > 0\}$ is not a RL. 5

Q. 4 (a) Define complexity of an algorithm. Show that every logarithmic function f(n) = $\log_b n$ has the same order as g(n) = $\log_2 n$ 5

(b) Define ε-closure set of states in a NFA. How is it used to convert a NFA with ε-move into a DFA without a ε-move. 5

Q. 5 (a) Define Instantaneous Description in a PDA. Draw a PDA for the language {ww | w ϵ {0, 1}*}. 7

(b) Describe the same PDA as a sequence of IDs. 3

Q. 6 (a) Define the Turing machine. Draw a Turing machine that concatenate two strings in the alphabet {a, b}. 5

(b) Show that proper subtraction is a total computable function. Draw a Turing machine for this. 5

Q. 7 (a) Check whether G = ({E}, {a, b, c, +, *}, E, P) where P is given as

$E \rightarrow E + E \mid E * E \mid a \mid b \mid c$ is ambiguous. 5

(b) Convert the grammar of part (a) into GNF. 5

Q. 8 Write short notes on any two of the following:- 10

(i) Post-independence Problem.

(ii) Universal Turing Machine.

(iii) Context- Sensitive Language.
