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UNIVERSITY OF SWAZILAND
FINAL EXAMINATION, MAY 2005

Title of Paper : THEORY OF COMPUTATION

Course number : CS211

Time allowed : Three (3) hours.

Instructions : (1) Read all the questions in Section-A and Section-B before you start answering any question.
(2) Answer all questions in Section-A. Answer **any two** questions of section-B. Maximum mark is 100.
(3) Use correct notation and show all your work on the answer script.

This paper should not be opened until the invigilator has granted permission.

SECTION-A

Q1 (marks 6 + 6+ 12). The following languages are given on symbol set {0, 1}. Assume $w \in \{0, 1\}^*$.

(i). L1 = {w, $1 < |w| < 5$}

(ii). L2 = {w, w starts with one zero and ends with two ones}

(iii). L3 = {w, such that $|w| \bmod 3 \neq 0$}

The following set of words is given -

{λ, 0, 1, 0100, 0011, 1100, 00101, 1111101,11111, 00000, 0010110, 0101011}

(a). From the above set, write all the words belonging to L1, all the words belonging to L2 and all the words belonging to L3.

(b). Write three regular expressions representing L1, L2 and L3.

(c). Design three deterministic finite acceptors (**dfa's**) that accept L1, L2, and L3.

Q2 (marks 6 + 8 + 12). The following non deterministic finite acceptor (**nfa**) is given :

M = ({q0, q1, q2}, {0, 1}, q0, δ, {q1}), where the transitions are given as :

δ(q0,0) = q1 ; δ(q0,λ) = q1 ;

δ(q1,0) = q0 ; δ(q1,0) = q2 ; δ(q1,1) = q1;

δ(q2,0) = q2 ; δ(q2,1) = q1 .

(i). Draw the transition digraph of the **nfa.**

(ii). Write the corresponding right linear grammar generating L(M)

(iii). Convert the above **nfa** into an equivalent **dfa**.

SECTION-B

Note: Answer **any two** questions in this section.

Q3(a) (marks 10). The regular expression of signed real type data values in Pascal is -

$(\lambda + s)\ (dd^{*}tdd^{*} + dd^{*}t + tdd^{*})\ (\lambda + x\ (\lambda + s)\ dd^{*})$

where digit, d ∈ {0, 1, 2, 3, 4, 5, 6, 7, 8, 9}, sign, s ∈ {+, -}, exponent, x ∈ {e, E} and t = '.' .

Give one example of each of the possible forms of real data values. Write a linear grammar for the above language.

Q3(b) (marks 15). Find Context Free (**CFG**) grammars that generate the following languages -

(i). $L(G1) = \{a^n b^m c^{n+m}$ where $n, m \geq 0\}$

(ii). $L(G2) = \{a^n b^m c^k$, either $(n = m)$ or $(k \geq m)$ where $n, m, k \geq 0\}$

write left most derivations for -

w1 = aabbcccc (using G1) and w2 = abbccc (using G2).

Include production number of your grammar at each step of derivation.

Q4(a) (marks 15). Design a non deterministic pushdown automaton (**npda**) to recognize the language –

$L = \{ w \in \{a, b\}^{*}, n_a(w) = n_b(w)$, w always starts with an a $\}$

Describe the functional steps of your **npda**. Write instantaneous descriptions for w = aabbab.

Q4(b) (marks 10). Design a non deterministic pushdown automaton (**npda**) to recognize the language generated by the grammar in Greibach Normal Form–

G = ({S, A, B, C}, {a,b,c}, S, P)

where the set of productions P is

{
S → aA
A → bB | aABC | a
B → b
C → c
}

Write instantaneous descriptions for w = aaabc.

Q5 (marks 15 + 5 + 5). Write the functional steps of the design of a Turing machine to compute –

F(x) = x div 3

Assume x to be a non zero positive integer in unary representation. Also write the design and instantaneous descriptions using the values of x as 1111 and 1111111 (in unary representation) for your Turing Machine.

(End of Examination Paper)