UNIVERSITY OF SWAZILAND
FINAL EXAMINATION, DEC, 2006

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 and **any two** questions of section-B. Maximum mark is 100.

(3) Use correct notation and show your work on the script.

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

SECTION-A (Maximum marks 50)

Q1(a) (marks 6 + 6 +12). The following languages are given on symbol set {0, 1}. Assume that $w \in \{0, 1\}^*$ and $\lambda \notin$ L1, L2 or L3.

(i). L1 = {w, |w| , length of w is never 1,3 or 5}

(ii). L2 = {000w11}

(iii). L3 = {w, such that |w| mod 4 = 0}

The following set of words is given -

{λ, 0, 1, 01, 001, 0100, 00011, 1111101, 0001111, 00000011, 001111011, 010101}

(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 regular expressions representing L1, L2 and L3.

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

Q2 (marks 6 + 6 + 14). 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 .

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

(b). Using the **nfa,** compute $\delta^*(q0, w)$ completely, where w = 0111, 1000 and 1010.

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

SECTION-B (Maximum marks 50)

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

Q3(a) (marks 10). Explain with examples the languages of integer and real type data values in Pascal (excluding exponent form). Write right linear grammars for Pascal integer and real type data values. Assume the alphabet set as –
{0, 1, 2, 3, 4, 5, 6, 7, 8, 9, ., +, -}.

Q3(b) (marks 15). Assuming n, m and k ≥ 0. Find Context Free Grammars **(CFG)** G1 and G2 that generate the following languages. -

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

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

write left most derivations for w1 = aabbcccc, w2 = abcc and w3 = abbccc using both G1 and G2.

Include production number at each step of derivation.

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

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

Describe the functional steps of your **dpda**. Write instantaneous descriptions for w = aabba.

Q4(b) (marks 6 + 4). 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 –

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F1(x) = x mod 3
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Assume x to be a non zero positive integer in unary representation. Also write the design and instantaneous descriptions using the value of x as 1111 and 11111 (in unary representation) for both the Turing Machines.

(End of Examination Paper)