UNIVERSITY OF SWAZILAND
FINAL EXAMINATION, DEC, 2011

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 notations and show all 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 u, v, w $\in$ $\{0, 1\}^*$.

(i). L1 = {uwv, |u| = |v| = 2}

(ii). L2 = {00w} $\cup$ {w11}

(iii). L3 = {w, (|w| mod 3 $\neq$ 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, {q0, q2}), where δ is given as :

δ(q0,0) = q2 ; δ(q0,1) = {q0, q1} ;

δ(q1,0) = q2 ; δ(q1,1) = q1 ;

δ(q2,0) = q1 ; δ(q2,1) = q0 .

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

(b). Compute δ^*(q0,w) where w = 111, 100 and 101.

(c). Convert the above **nfa** into an equivalent **dfa** and write its state transition table **(STF).**

SECTION-B (Maximum marks 50)

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

Q3(a) (marks 10). Explain with examples the language of signed and unsigned integer data values in PASCAL programming language. Write a corresponding right linear grammar.

Q3(b) (marks 9+6). Assuming n, m and $k \geq 0$, find Context Free Grammars **(CFG)** G1 and G2 that generate the following languages. -

(i). $L(G1) = \{a^n b^{m+2n} c^{3m}\}$

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

Write left most derivations for w1 = abb, w2 = bbcccccc, w3 = abbbccc using G1 and w4 = bbc, w5 = aa and w6 = aabb using G2.

Include production number at each step of your derivation.

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

$$L = \{w \in a^n b^m \ , \ n > m, \text{ and } n, m >= 1\}$$

Give functional steps and clearly describe as to how your **dpda** accepts and rejects words of L. Write instantaneous descriptions for w1 = aaabb and w2 = aaa.

Q4(b) (marks 6 + 4). Design a non deterministic pushdown automaton **(npda)** to recognize the language generated by the grammar –

G = ({S, Z, B}, {a,b}, S, P)

where the set of productions P is

{ S ⟶ aBZ | aZ | aB | a

B ⟶ bB | b

Z ⟶ aBZ | aZ | BZ | a }

Write instantaneous descriptions for w = aaab.

Q5 (marks 15 + 5 + 5). Write the design of a Turing Machine (**TM**) to compute –

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F(x)  = 2x + 1
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Assume x to be a non zero positive integer in unary representation. Clearly write the functional steps of your TM computations. Also write the instantaneous descriptions using the value of x as 11 and 1111 (in unary representation) for your Turing Machine.

(End of Examination Paper)