UNIVERSITY OF SWAZILAND
FINAL EXAMINATION DEC, 2012 (SEM-I)

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 ∈ $\{0, 1\}^*$.

(i). L1 = {uw, (|u| = 4) or (|u| = 2)}

(ii). L2 = {00w11}

(iii). L3 = {vw, such that (|v| = 1) and (|w| mod 3 = 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 Automata 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,q2} ; δ(q1,1) = q1;

δ(q2,0) = q2 ; δ(q2,1) = q1 .

(a). Draw the transition digraph of M. Write all the reasons, why M is an **nfa.**

(b). Compute $\delta^*(q0, w)$ where w = 000, 111 and 110 .

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

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 integers. Write a corresponding right linear grammar showing all your work. Give left most derivations trees of two integers, 23412 and -7642012.

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

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

(ii).L(G2) = $\{a^n b^m c^k$, either (n = m) or (k $\geq$ 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 6 + 4 + 5). Design a deterministic pushdown automaton **(dpda)** to recognize the language –

L = $\{a^n b^{n+2}$, n $\geq$ 1 $\}$

Describe the functional steps of your **dpda**. Write instantaneous descriptions for w = aaabb and aabbbb.

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

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

where the set of productions P is

{ S ⟶ aA

A ⟶ bB | aABC | a

B ⟶ bB | b

C ⟶ c | cC }

Write instantaneous descriptions for w = aaabc using your **npda**.

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

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

(End of Examination Paper)