UNIVERSITY OF SWAZILAND
SUPPLEMENTARY EXAMINATION, JULY 2015

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 from page one to page four before you start answering any question.

(2) Answer all questions in Section-A, and **any two** questions in 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 = {uwv, |u| = 2 and |v| = 1}

(ii). L2 = {0w0} ∪ {1w1}

(iii). L3 = {w, (|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, q2}), where the transitions are given as :

δ(q0,0) = {q0, q1} ;

δ(q1,1) = {q0, q2} ;

δ(q2,1) = {q1, q2) .

(a). Draw the transition digraph of the above **M.**

(b). Trace computations of all the words of L , where L = {111, 000 and 010}.

(c). Find an equivalent **dfa** of **M** and write the state transition table of your **dfa**.

SECTION-B (Maximum marks 50)

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

Q3(a) (marks 4+4+2). A context free grammar , G = ({S}, {a,b}, S, P) where the set of productions P is given as

{ S $\rightarrow$ aS | aSbS | λ }.

Find is the complexity of G. Write left most derivations and parse trees for w1 = aaaab and w2 = abab. Taking example of w1, show that G is ambiguous.

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^{2n} b^{i} c^{2m}, such that i = m + n}

(ii). L(G2) = {a^{n} b^{m} c^{k}, such that m = k }.

Write left most derivations for w1 = aab, w2 = bcc, w3 = aabbcc using G1 and w4 = bbcc, w5 = aabbcc and w6 = aabc 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} , such that (n > 0) and (m > n) }

Clearly describe the functional steps as a numbered list of actions of your **dpda** of L. Write instantaneous descriptions for w1 = abb and w2 = aaabbbb.

Q4(b) (marks 3 + 7). Design a non deterministic pushdown automaton **(npda)** to recognize the language generated by the grammar G, where –

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

The set of productions P is

{ S $\longrightarrow$ aZ | aB | a

B $\longrightarrow$ ZB | bB | b

Z $\longrightarrow$ aBZ | aZ | aB | a }

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

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F(x) = x div 2.
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Assume x to be a non zero positive integer in unary representation. Clearly write as to how your TM accomplishes the computations. Also write the instantaneous descriptions using the value of x as 11 and 11111 for your Turing Machine.

(End of Examination Paper)