UNIVERSITY OF SWAZILAND
SUPPLEMENTARY EXAMINATION, JULY 2010

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 all your work on the script.

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

SECTION-A (Maximum marks 50)

Note: Answer **all** questions in this section.

Q1 (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| = 1 and |v| = 2}

(ii). L2 = {0w0} ∪ {1w1}

(iii). L3 = {w, (|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 three regular expressions representing L1, L2 and L3 respectively.

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

Q2 (marks 6 + 8 + 12). 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). Compute δ^*(q0,w), where w = 0000, 0111, 0001 and 0010.

(c). Find an equivalent **dfa** of **M.**

SECTION-B (Maximum marks 50)

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

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

{ S $\rightarrow$ aS | aSbS | λ }.

Using G, write left most derivations for w1 = aaaab and w2 = abab. Taking examples of both, w1 and w2, show that G is ambiguous by drawing two distinct parse trees for w1 and w2. What is the complexity of G?

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) = $\{a^{2n} b^{i} c^{m}$, 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 = bbcc, w3 = λ using G1 and w4 = bc, w5 = aabbcc and w6 = aaaa 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 < m and w always starts with an a }

Clearly describe as to how your **dpda** accepts and rejects words of L. Write instantaneous descriptions for w1 = abbb 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 mod 2.
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Assume x to be a non zero positive integer in unary representation. Clearly write the steps as to how your TM accomplishes the computations. Also write the instantaneous descriptions using the value of x as 11 and 111 for your Turing Machine.

(End of Examination Paper)