UNIVERSITY OF SWAZILAND
FINAL EXAMINATION (SEM-I) DEC, 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 $\in$ $\{0, 1\}^*$.

(i). L1 = {uwv, u = 0 or 00 and v = 1 or 11}

(ii). L2 = {1w1} $\cup$ {0w0}

(iii). L3 = {w, (|w| mod 4) <> 0}

The following set of words is given -

{λ, 0, 1, 01, 001, 0100, 00011, 1111101, 0001111, 00000011, 101111010, 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). A non deterministic finite acceptor (**nfa**) M is given. Assume q0 as the initial state, q3 as the final state. The transition table is given as -

	0	1
q0	{q1, q3}	{q1}
q1	{q2}	{q1,q2}
q2	{q3}	{q0}
q3		{q0}

(a). Write the Machine M in correct notation and draw its transition digraph..

(b). Compute $\delta^*(q0, w)$, where w = 0000, 1111, 1000 and 1001.

(c). Find an equivalent **dfa** of M showing all your steps.

SECTION-B (Maximum marks 50)

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

Q3(a) (marks 4+5). Explain with examples the language of simple variable identifiers in PASCAL programming language. Assume that a valid identifier always starts with a letter and can have zero or more letters, digits, and underscores (_) characters only. Write a corresponding right linear grammar.

Q3(b) (marks 4+4+8). Assuming n, m and $k \geq 0$, find Context Free Grammars (**CFG**) G1 and G2 that generate the following languages. -

(i). $L(G1) = \{a^k b^m c^n$, such that either $k = m$, or $n = m\}$

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

Write left most derivations, using G1 for -

1. $w1 = aa$, $(k = 2, m = 0, n = 0)$,
2. $w2 = aaabbbc$, $(k = 3, m = 3, n = 1)$,
3. $w3 = aaaabbbbcccc$, $(k = 4, m = 4, n = 4)$ and
4. $w4 = \lambda$. $(k = 0, m = 0, n = 0)$.

and using G2 for -

1. $w4 = aaaabbbb$, $(m = 4, k = 0)$,
2. $w5 = bbb$, $(m = 0, k = 3)$,
3. $w6 = aaabbbccc$ $(m = 3, k = 3)$ and
4. $w4 = \lambda$. $(k = 0, m = 0)$.

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 the conditions when your **dpda** accepts and rejects words of L. Write instantaneous descriptions for $w1 = aaaabb$ and $w2 = aaabbb$.

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

$G = (\{S, T, B\}, \{a,b\}, S, P)$.

The set of productions P is

$$\{ \quad S \longrightarrow TB$$

$$T \longrightarrow aTb \mid ab$$

$$B \longrightarrow bB \mid b \ \}$$

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

$F(x, y) = x + y$.

Assume x and y to be nonzero positive integers 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 y as 111 for your Turing Machine.

q_0 x 0 y $\vdash^*$ q_f x 0 y 0 F(X,Y)

What is the final configuration when your TM has computed the result and has stopped.

(End of Examination Paper)