KENYA METHODIST UNIVERSITY
END OF TRIMESTER I 2007 EXAMINATION

FACULTY: **SCIENCE**
DEPARTMENT: **MATHEMATICS AND COMPUTER SCIENCE**
COURSE CODE: **COMP 422**
COURSE TITLE: **AUTOMATA AND FORMAL LANGUAGES**
TIME : **3Hrs**

INSTRUCTIONS: Answer Question ONE (Compulsory) and ANY OTHER TWO questions:

Question One (20 Marks):

(a.) Define:
- i. Finite state automata
- ii. Nondeterminism
- iii. Regular expression
- iv. Decision problem (4 marks)

(b.) Assuming the alphabet {a,b}, give a pattern that matches each of the following:
- i. Strings containing at least three occurrences of letter a.
- ii. Strings with no occurrences of letter a. (2 marks)

(c.) Describe Church's thesis and its relationship to Turing machines (4 marks)

(d.) Give a deterministic finite state automaton that accepts the regular set
$\{x \in \{a,b\}^* \mid x \text{ contains a substring with two consecutive a's}\}$ (4 marks)

(e.) Distinguish between a pushdown automata (PDA) and a finite state automata (FSA) (2 marks)

(f.) For a set A, define:
- i. The powers A^n of A
- ii. The asterate A* of A (4 marks)

Question Two (20 Marks):

(a.) Briefly describe the halting problem (3 marks)

(b.) Define:
- i. A monoid (1 mark)
- ii. Prefix for a string x (2 marks)
- iii. A pattern (2 marks)

(c.) Run the cocke-kasami-younger algorithm on the string aab to show whether it's a sentence in the language of the grammar

$S \rightarrow AB$
$A \rightarrow a$
$B \rightarrow AB \mid b$ (4 marks)

(d.) List the equivalence classes of the collapsing relation $\approx$ and construct a minimal DFA for the following DFA

	a	b
→1	1	4
2	3	7
3F	4	2
4F	3	5
5	4	6
6	6	3
7	2	4
8	3	1

(8 marks)

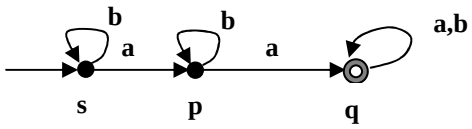
Question Three (20 Marks):

(a.) For a pushdown automata M, describe:

i. Configuration (2 marks)

ii. Acceptance (4 marks)

(b.) Consider the DFA:



Describe the set accepted by the automata (2 marks)

(c.) Consider the following two deterministic finite state automata:

	A	b
→1	1	2
2F	2	1

	a	b
→1	2	3
2	3	1
3F	1	2

use product construction to construct a DFA accepting the intersection of the two sets accepted by these automata (4 marks)

(d.) Convert the following grammar into Chomsky normal form, briefly explaining your working:

$S \rightarrow aSbb \mid T$

$T \rightarrow bTaa \mid S \mid \in$ (6 marks)

(e.) When is a turing machine said to be <u>total</u>? (2 marks)

Question Four (20 Marks):

(a.) Describe a deterministic one-tape turing machine and how it works. (4 marks)

(b.) Describe the Chomsky normal form. (2 marks)

(c.) Briefly describe how the cocke-kasami-younger algorithm works. (5 marks)

(d.) Give an NFA, with four states, equivalent to the regular expression

$(01^{+}011^{+}0111)^{*}$ (4 marks)

(e.) Give the regular expression equivalent to the following DFA

	a	b
→1	1	2
2F	2	1

(2 marks)