UNIVERSITY OF ESWATINI

Department of Computer Science

NOVEMBER/DECEMBER MAIN EXAMINATION

COURSE TITLE : THEORY OF COMPUTATION

COURSE CODE : CSC211

TOTAL MARKS :100

DURATION OF EXAM : THREE (3) HOURS

NUMBER OF EXAM PAGES: 6 (includes cover page)

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Answer all questions

QUESTION ONE {15 marks}

True/False questions: Indicate whether the statement is true or false.

1.1) A language is called an irregular language if some finite automaton recognizes it. {1 mark}

1.2) The class of regular languages is closed under the union operation. {1 mark}

1.3) The class of regular languages is not closed under the star operation. {1 mark}

1.4) A language is regular if and only if some regular expression describes it. {1 mark}

1.5) If a language is described by a regular expression, then it is irregular. {1 mark}

1.6) If a language is irregular, then it is described by a regular expression. {1 mark}

1.7) A language is context free if and only if some pushdown automaton recognizes it. {1 mark}

1.8) If a language is context free, then some pushdown automaton does not recognizes it. {1 mark}

1.9) If a pushdown automaton recognizes some language, then it is context free. {1 mark}

1.10) The class of DCFLs is not closed under complementation. {1 mark}

1.11) A deterministic context-free grammar is not a context-free grammar such that every valid string has a forced handle. {1 mark}

1.12) An end marked language is generated by a deterministic context-free grammar if and only if it is deterministic context free. {1 mark}

1.13) Every DCFG has an equivalent DPDA. {1 mark}

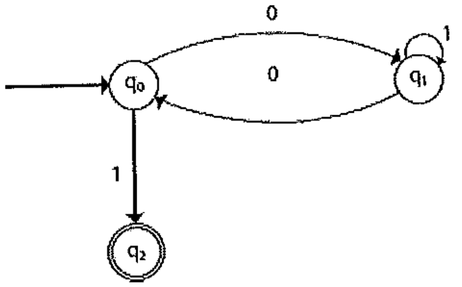
1.14) Call a language Turing-recognizable if some Turing machine recognizes it.

{1 mark}

1.15) A language is Turing-recognizable if and only if some nondeterministic Turing. machine recognizes it. {1 mark}

QUESTION TWO {33 marks}

2.1) Let M be the Deterministic Finite Automata (DFA) shown below.



Provide a formal description of M. {6 marks}

2.2) Assume an alphabet Σ that is {0, 1}

a. Draw the *simplest* possible DFA (in terms of number of states and arcs) that describes the language of all strings that end in "00". {7 marks}

b. Draw the *simplest* possible NFA (in terms of number of states and arcs) that describes the language of all strings that end in "00". {7 marks}

c. Provide the regular expression that describes the language in part a.

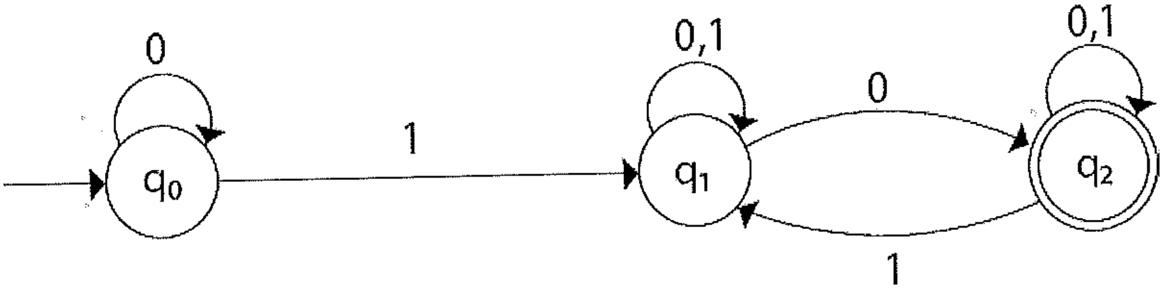
{3 marks}

d. Write the regular expression for the language accepting all the string which are starting with 1 and ending with 0, over ∑ = {0, 1}. {3 marks}

2.3) Draw the NFA that recognizes the language where w contains the substring 0101. Do this using 5 states and assuming a binary alphabet. {7 marks}

QUESTION THREE {15 marks}

3.1) Convert the given NFA to DFA.



{10 marks}

3.2) The pumping lemma states that all regular languages have a special property and it can be shown that if a language does not have this property, it is not a regular language.

Provide a mathematical formulation of the pumping lemma. {5 marks}

QUESTION FOUR {27 marks}

4.1) Discuss the steps for converting a context free grammar (CFG) into Chomsky normal form(CNF). {7 marks}

4.2) A CFG is in CNF (Chomsky normal form) if all production rules satisfy one of a number of conditions. Name these conditions. {7 marks}

4.3) Convert the given CFG to CNF.

Consider the given grammar G1:

S → a | aA | B

A → aBB | ε

B → Aa | b

{7 marks}

4.4) Pushdown automata is a way to implement a CFG in the same way we design DFA for a regular grammar. A DFA can remember a finite amount of information, but a PDA can remember an infinite amount of information.

Provide a Context Free grammar that generates the language 00*1*. {3 marks}

4.5) Provide a context free grammar that generates $L = \{a^n b^m : n \neq m\}$ {3 marks}

QUESTION FIVE {10 marks}

The Turing machine was invented in 1936 by Alan Turing. It is an accepting device which accepts Recursive Enumerable Language generated by type 0 grammar. Briefly discuss the following:

5.1) The various features of the Turing machine: {5 marks}

5.2) Formal definition of a Turing machine {5 marks}