CURTIN UNIVERSITY

DEPARTMENT OF COMPUTING

Practice Interim Test

2nd Semester 2013

NAME:

STUDENT NUMBER:

SUBJECT: Theoretical Foundations of Computer Science 300 / 552

INDEX NUMBER: 12334

Time Allowed: Sixty (60) Minute test preceded by a 5 MINUTE READING PERIOD during which time only notes may be made. The supervisor will indicate when answering may commence.

AIDS: None

INSTRUCTIONS: This paper consists of five (5) questions with a total of 50 marks.

ATTEMPT ALL QUESTIONS

No electronic devices such as Phones and PDA are allowed. All phones, even in a bag, must be turned off.

INSTRUCTIONS FOR PROBLEMS 1 TO 4:

PROBLEMs 1 to 4 each describe a problem in English, set notation or in terms of strings. It is your task to do the following for each of the four problems:

1. Classify the problem into one the appropriate category; Regular, Context-Free or neither.
   (2 marks)
2. For a problem that is <u>Regular</u>, prove that this is the case by constructing either a DFA, a NFA, or a Regular Expression that accepts the language of the problem.   **(6 marks)**
3. For a problem that is <u>Context-Free</u>, do both of the following:
   a. Prove that the problem is not Regular using the pumping lemma.   **(7 marks)**
   b. Prove that the problem is Context-Free by constructing either a PDA or CFG that accepts the language of the problem.   **(7 marks)**
4. For a problem that is <u>neither</u>, prove that it is not Context-Free using the pumping lemma for Context-Free grammars.   **(7 marks)**

If you are unable to do a pumping lemma proof, a small amount of marks may be awarded for a good explanation of why the problem is not Regular or Context Free.

You may choose to prove that something is not Regular (or Context-Free) using a method other than the pumping lemma, if you are sure that this form of proof is convincing. However, use of the pumping lemma is strongly recommended.

PROBLEM 1:

Problem Description:

An electric circuit that controls a generator monitors an overload input to check whether the generator needs to be shut down for safety reasons. The overload input sends a '0' if the voltage is within acceptable limits, or '1' if it is too high; sending exactly one digit per second. The circuit normally runs in "standard" mode, but when it receives a '1' it enters "alert" mode. If it receives another '1' within 3 seconds of the first, it will enter "shut-down" mode and wait for manual intervention, otherwise it will return to "standard" mode.

Classification:

Reasoning:

PROBLEM 2:

For a ternary code ($\Sigma = \{a,b,c\}$), find all strings of the form $\{ a^n b^{2n} c^n \}$, $n>0$.

Classification:

Reasoning:

PROBLEM 3:

A scientist working on the behavioural patterns of termites is looking for patterns in how they line up to enter a nest. He uses computer video recognition to classify termites as workers (W) and soldiers (S). He wishes to write some software to check through the input stream of these letters to test his theory; that twice as many workers enter the hive compared to the number of soldiers.

You may assume that the input stream of Ws and Ss starts after a rainy period, where all termites had returned to the hive.

Classification:

Reasoning:

PROBLEM 4:

Recognize all binary strings that contain a zero and have an odd number of symbols.

<u>Classification</u>:

<u>Reasoning</u>:

QUESTION 5 - Short Answer

Label each of the following statements true or false, and briefly state your reasoning. No marks will be given for an answer without reasoning.

Statement 1:

All problems that can be expressed by Regular Languages should be solved using scripting languages.

Statement 2:

The pumping lemma states three properties that hold for every string in every Regular language.

Statement 3:

Any Finite Automaton can be transformed into a Push-Down Automaton.

End of Test Questions