OLLSCOIL NA hÉIREANN
THE NATIONAL UNIVERSITY OF IRELAND, CORK

COLÁISTE NA hOLLSCOILE, CORCAIGH
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CS4150: Principles of Compilation

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1.5 Hours

Answer All Questions
Total marks 100%

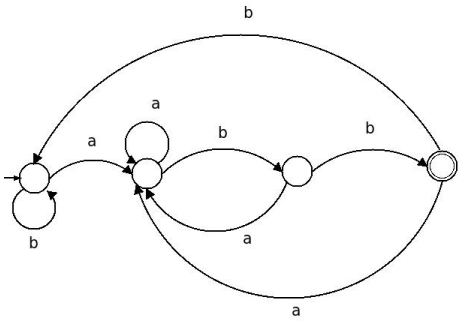
PLEASE DO NOT TURN THIS PAGE UNTIL INSTRUCTED TO DO SO

PLEASE ENSURE THAT YOU HAVE THE CORRECT EXAM

Question 1 *[30%]*

(i) Give both a regular expression and a deterministic finite automaton that captures the following subset of Java floating point literals. Such literals comprise in turn: i) an optional sign ($\oplus$ or $\ominus$) , ii) one or more digits, iii) a decimal point ($\odot$) following by one or more digits (optional) and iv) the exponent symbol (E) followed by one or more digits (optional). Valid examples include: 17, $\oplus 3 \odot 14$ and $6 \odot 022E24$ (*10%*)

(ii) Give a sucint description of the set of strings over $\{a, b\}$ accepted by the following finite automaton both in English and as a regular expression.



(*10%*)

(iii) Give a regular expression for the set of strings over $\{a, b\}$ that do not contain the subsequence *abb*. Note the symbols need not appear side by side, so the string `ababa` contains the subsequence and hence is not in the language. (*10%*)

Question 2 *[20%]*

(i) Consider the context-free grammar shown below.

⟨bexpr⟩ → ⟨bexpr⟩ **or** ⟨bterm⟩ | ⟨bterm⟩
⟨bterm⟩ → ⟨bterm⟩ **and** ⟨bfactor⟩ | ⟨bfactor⟩
⟨bfactor⟩ → **not** ⟨bfactor⟩ | **(** ⟨bexpr⟩ **)** | **true** | **false**

Give a complete parse tree for the following expression. (*5%*)

not (**false or true and true**)

(ii) Design a grammar for the set of all strings over $\{0, 1\}$ with an equal number of 0s and 1s. Justify your answer briefly. (*15%*)

Question 3 *[35 %]*

(i) The following is a modified version of the Boolean expression grammar of the previous question. Identify the nullable nonterminals. *(5%)*

⟨bexpr⟩ → ⟨bterm⟩ ⟨bexpr'⟩
⟨bexpr'⟩ → **or** ⟨bexpr⟩ | ϵ
⟨bterm⟩ → ⟨bfactor⟩ ⟨bterm'⟩
⟨bterm'⟩ → **and** ⟨bterm⟩ | ϵ
⟨bfactor⟩ → **not** ⟨bfactor⟩ | **(** ⟨bexpr⟩ **)** | **true** | **false**

(ii) Identify the FIRST set for each nonterminal in this grammar. *(10%)*

(iii) Identify the FOLLOW set for each nonterminal in this grammar. *(10%)*

(iv) Contruct an LL(1) parse table for this gramnmar. *(10%)*

Question 4 *[15 %]*

Suppose that we wished to develop a Java application to perform some simple analysis on context-free grammars. The tool should read any grammar from a text file and should report whether the empty string belongs to the language defined by the grammar. Outline an approach to this problem. You do not need to provide code, but your answer should provide a coherent outline of a feasible solution to the problem that indicates the main conceptual ingredients (software tools, data structures, algorithms etc.) the approach relies upon.