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CMPUT 415 — Fall 2000
Compiler Design
Midterm Examination
November 22, 2000

Name:
Id:

Instructions

- This is an open book exam. Time: 120 minutes.
- Place all answers in the spaces provided on the question pages. **JUSTIFY** each answer appropriately such that I can understand what you are doing.
- This exam counts 30% toward your final grade in this course. This exam is worth 60 points. The weight of each question is indicated in square brackets by the question number.
- This exam is not impossible, but the questions do not necessarily have obvious answers. Think about each question for a couple of minutes before answering it.
- There should be 6 questions and 9 numbered pages in this exam booklet. You are responsible for checking that your exam booklet is complete.

Question	Mark	Out Of
1		15
2		5
3		10
4		5
5		5
6		20
TOTAL		60

Question 1 [15 marks]: Given is the following (non-deterministic) finite state accepter:

$$FSA =< S, V_T, P, A, D >$$

where:

- $S = \{A, B, C, D\}$ is the set of states,
- $V_T = \{a, b, c\}$ is the terminal alphabet,
- $P = \{\langle A, a, B\rangle, \langle A, a, C\rangle, \langle B, b, C\rangle, \langle B, c, D\rangle, \langle C, b, B\rangle, \langle C, c, D\rangle\}$ is the transition relation,
- A is the initial state,
- D is the final state.

Part 1a [2 marks]: Draw a graph representation of FSA.

Part 1b [4 marks]: Write a regular non-contracting grammar that generates the language recognized by FSA.

Part 1c [5 marks]: In a systematic way, derive a regular expression equivalent to FSA. Show your work, no magic please.

Part 1d [4 marks]: Minimize FSA and draw a graph representation of the minimized accepter.

Question 2 [5 total marks]: Determine whether the following grammar is $LL(k)$ and if so, give the value of k.

$$A \rightarrow yB \mid zB \mid y \mid z$$
$$B \rightarrow xB \mid yB \mid y \mid \epsilon$$

Question 3 [10 total marks]: Consider the following grammar G:

$$L \rightarrow Lb \mid a$$

Part 3a [3 marks] Is G an LR(0) grammar? Justify your answer.

Part 3b [1 mark] Is G an LR(1) grammar? Justify your answer.

Consider a modification of G resulting in the following grammar H:

$$L \rightarrow MLb \mid a$$
$$M \rightarrow \epsilon$$

Part 3c [1 mark] Using regular expressions define $L(G)$ and $L(H)$? Is $L(G) = L(H)$?

Part 3d [3 marks] Is H an LR(1) grammar? Justify your answer.

Part 3e [2 marks] Is H an LR(k) grammar for some k? *Hint*: In What order would a bottom-up parser apply the reductions to the input strings *abb* and *abbbbb*?

Question 4 [5 total marks]: Consider the following grammar G over terminal alphabet $\{a, b, c\}$:

$S \to B\$ \quad B \to C \quad B \to BaC \quad C \to b \quad C \to Ccb$

List 10 shortest elements of $L(G)$ in alphabetic order.

Question 5 [5 total marks]: What is a local look-up in a symbol table? What is a global look-up in a symbol table? Give 3 examples of each.

Question 6 [20 total marks]: Consider the following grammar G over terminal alphabet $\{a, b, c, d\}$:

1. $S' \rightarrow S\$$
2. $S \rightarrow Aa$
3. $S \rightarrow bAc$
4. $S \rightarrow Bc$
5. $S \rightarrow bBa$
6. $A \rightarrow d$
7. $B \rightarrow d$

Part 6a [4 marks]: Compute the following:

- FOLLOW(S) =
- FOLLOW(A) =
- FOLLOW(B) =
- FIRST($S\$$) =
- FIRST(Aa) =
- FIRST(bAc) =
- FIRST(Bc) =
- FIRST(bBa) =

Is G an LL(1) grammar? Why or why not?

Part 6b [5 marks]: Here is G again:

1. $S' \rightarrow S\$$
2. $S \rightarrow Aa$ 3. $S \rightarrow bAc$ 4. $S \rightarrow Bc$ 5. $S \rightarrow bBa$
6. $A \rightarrow d$ 7. $B \rightarrow d$

Is G an LR(0) grammar? Why or why not? Find the collection of LR(0) items for G. You do not have to find all of them, find only these that are required to answer the question above and make a comment about the remaining ones.

Part 6c [2 marks]: Is G an SLR(1) grammar? Why or why not?

Part 6d [6 marks]: Here is G again:

1. $S' \rightarrow S\$$
2. $S \rightarrow Aa$ 3. $S \rightarrow bAc$ 4. $S \rightarrow Bc$ 5. $S \rightarrow bBa$
6. $A \rightarrow d$ 7. $B \rightarrow d$

Is G an LR(1) grammar? Why or why not? Find the collection of LR(1) items for G. You do not have to find all of them, find only these that are required to answer the question above and make a comment about the remaining ones.

Part 6e [3 marks]: Is G an $LALR(1)$ grammar? Why or why not?