# Midterm Exam
# CS 410, Fall 1998

October 22, 1998

There are 8 problems on the exam, with 75 points total available. There are 7 pages to the exam, including this one, make sure you have all of them. Don't forget to put your name at the top of the exam. Please read over the whole test before beginning. Good luck!!!

We use the following conventions for grammars on the exam, except where noted:

- epsilon, the empty string is represented by $\epsilon$
- terminals are represented by lower-case letters and punctuation symbols
- non-terminals are represented by upper-case letters

| | value | grade |
|---|---|---|
| Problem 1 | 5 pts. | |
| Problem 2 | 2 pts. | |
| Problem 3 | 8 pts. | |
| Problem 4 | 12 pts. | |
| Problem 5 | 10 pts. | |
| Problem 6 | 8 pts. | |
| Problem 7 | 15 pts. | |
| Problem 8 | 15 pts. | |
| TOTAL: | 75 pts. | |

## Problem 1 [5 pts]

Write a regular expression for non-negative even integers. The integers may have leading zeroes (e.g., `0034`). You may use the following regular definition in your regular expression:

```
digit ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
```

## Problem 2 [2 pts]

Fill in the blank:

For a recursive-descent parser, we create one function for each _____ in the grammar.

## Problem 3 [8 pts]

For each of the following statements, fill in the blank with the word *first* or *follow*.

1. _____ sets of a right hand side of a production tell us for what inputs to choose that RHS in a LL(1) derivation.

2. The _____ set of a nonterminal tells us for what inputs to reduce to that nonterminal in SLR parsing.

3. The _____ set of a nonterminal tells us for what inputs to choose the epsilon production of that non-terminal (if there is one) in LL(1) parsing.

4. *[Note: answer one of each.]* _____ sets are used in computing _____ sets.

## Problem 4 [12 pts]

Using subset construction, create a DFA equivalent to the following NFA. Show your work.

| | a | b | $\epsilon$ |
|---|---|---|---|
| 1 | {2,5} | {1,3} | {} |
| 2 | {2} | {3} | {4} |
| 3 | {5} | {} | {} |
| 4 | {} | {4} | {3} |
| <u>5</u> | {} | {} | {} |

## Problem 5 [10 pts]

Eliminate left recursion from the following grammar:

$$
\begin{array}{rcl}
A & \rightarrow & ABA \\
 & | & B \\
 & | & x \\
B & \rightarrow & ByA \\
 & | & y \\
 & | & zB \\
 & | & Bwz
\end{array}
$$

## Problem 6 [8 pts]

For the grammar below, write semantic rules for computing the semantic attribute `S.len`, which is the number of tokens in the sentence generated from S. Note: the subscripts below just differentiate multiple instances of the same nonterminal in one production.

The grammar:

$S \rightarrow mS_1m$

$S \rightarrow B$

$B \rightarrow xB_1$

$B \rightarrow \epsilon$

## Problem 7 [15 pts]

Show that the following grammar is not LL(1). Hint: attempt to create an LL(1) parse table for it. Be specific about how it fails. Show your work.

$$
\begin{array}{lcl}
S & \rightarrow & mSm \\
 & | & B \\
B & \rightarrow & xB \\
 & | & \epsilon
\end{array}
$$

## Problem 8 [15 pts]

Show the canonical collection of sets of LR(0) items and the goto function for the grammar given below. You may show the states and transitions separately, or you may show it as a state transition diagram. Note: you will need to augment the grammar first.

$$
\begin{array}{rcl}
S & \rightarrow & MS \\
 & | & M \\
M & \rightarrow & (M) \\
 & | & ()
\end{array}
$$