COP4020: Programming Languages Midterm
(10 questions)

Name: **Last 4 digits of your ID:**

1. (10 points) Formally define regular expression.

2. (10 points) Explain the major differences between imperative language and declarative language.

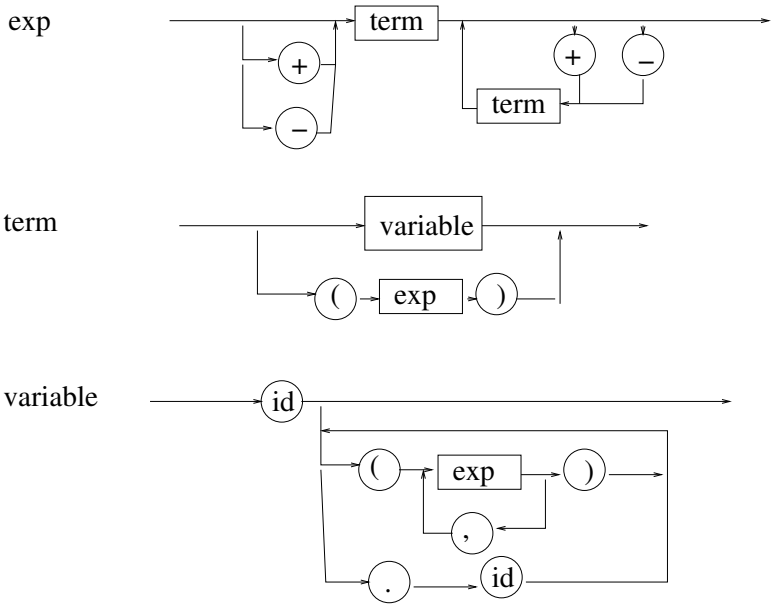
3. (10 points) Briefly explain the concept of dynamic linking.

4. (10 points) Express the language recongized by the following grammar with a regular expression:

$$A \rightarrow a\ A \mid b\ A \mid a$$

5. (10 points) Briefly explain L-attributed grammar.

6. (10 points) Write a grammar that corresponds to the following syntax diagrams.



7. (10 points) Construct the NFA for regular expression $((ab|c)*)(ac)*$.

8. (10 points) The parsing table for an LL(1) grammar is as follows.

	(	)	[	]	$
P	$P \rightarrow E$		$P \rightarrow E$		$P \rightarrow E$
E	$E \rightarrow F\ E$	$E \rightarrow \epsilon$	$E \rightarrow F\ E$	$E \rightarrow \epsilon$	$E \rightarrow \epsilon$
F	$F \rightarrow (\ E\ )$		$F \rightarrow [\ E\ ]$		

Show step-by-step (content of stack andinput string as well as the parser action) how the string `(())[]` is parsed in the LL(1) parser. Show the parse tree for string `(())[]`.

9. (10 points) The following grammar recognizes all strings of properly balanced parentheses and brackets.

$$
\begin{aligned}
P &\rightarrow E \\
E &\rightarrow F\ E \\
E &\rightarrow \epsilon \\
F &\rightarrow (\ E\ ) \\
F &\rightarrow [\ E\ ]
\end{aligned}
$$

Augment the grammar with a set of attribute rules that associate a Boolean attribute `ok` with P such that `P.ok = true` if and only if there are no more than two parentheses in the string. For example, `P.ok== true` for string `(())[]` and `P.ok == false` for string `(())[([])]`.

10. (10 points) Consider the following pseudo-program:

```
a : integer

procedure foo
  a = 10
  goo()
  hoo()
  write (a)

procedure goo
  a = 20

procedure hoo
  write(a)

procedure main
  a : integer
  a = 30
  foo()
  write (a)
```

What is the output of the program with static scoping (closest nested scope rule)? What is the output with dynamic scoping?