

CSE-504 Compiler Design

Spring '13

Mid-term Exam

March 26, 2013.

Duration: 1 hour.

Name: _____

USB ID Number: _____

INSTRUCTIONS

Read the following carefully before answering any question.

- Make sure you have filled in your name and USB ID number in the space above.
- Write your answers in the space provided; Keep your answers brief and precise.
- The exam consists of 4 questions, in 7 pages (including this page) for a total of **30** points.

Question 1 is on one page.

Question 2 is on one page.

Question 3 is on two pages.

Question 4 is on two pages.

Question	Max.	Score
1.	7	
2.	4	
3.	9	
4.	10	
Total:	30	

1. [Total: 7 points] For this question, consider the Proto(1) program shown below:

```
1: x = input();
2: a = x + 1;
3: b = x * 2;
4: c = a + b;
5: d = c + x;
6: e = d * b;
7: f = e - a;
8: g = e * f;
9: h = g - x;
10: print (h);
```

- (a) [3 points] Using liveness analysis, compute the set of variables live at each program point in the above program.
- (b) [4 points] Can we allocate all variables using only **3** registers using the Simplify-Select-Spill algorithm *without* spilling? If so, show the register interference graph and the allocation. If not, show where the allocation will fail.

2. [Total: 4 points] Consider the following fragment of an imperative programming language's grammar:

$$S \rightarrow \text{if } e \text{ then } S \text{ else } S$$
$$S \rightarrow \text{if } e \text{ then } S$$
$$S \rightarrow o$$

- (a) [2 points] Show that this grammar is ambiguous by showing two distinct parse trees for the sentence `if e then if e then o else o`

- (b) [2 points] Consider an SLR(1) parser for this grammar. The action table will have a shift-reduce conflict. If we want to associate an “else” with the nearest enclosing “if”, how will you resolve this conflict? Why?

3. [10 points total] A grammar is said to be in X-form if every production is either of the form $A \rightarrow \epsilon$ (i.e. an epsilon-production) or of the form $A \rightarrow \mathbf{a} B$, where $\mathbf{a}$ is a terminal symbol and B is a non-terminal symbol (i.e., exactly two symbols, one terminal followed by one non-terminal, on the right hand side).

(a) [3 points] Write a grammar in X-form for the language of regular expression $(a|b)^*a$.

(b) [3 points] Does every X-form grammar describe a regular language? Justify.

(c) [3 points] Does every regular language have a grammar in X-form? Justify.

4. [10 points total] Consider the language $\mathcal{L}$ of regular expression $(a|b)^*a$.
- (a) [5 points] Write a grammar for $\mathcal{L}$ such that it is $LL(1)$. For this question, you should argue convincingly that the language of your grammar is indeed $\mathcal{L}$, then show that it is $LL(1)$.

- (b) [5 points] Write a grammar for $\mathcal{L}$ such that it is $SLR(1)$. For this question, you should argue convincingly that the language of your grammar is indeed $\mathcal{L}$, then show that it is $SLR(1)$.