Spring, 2018 Name: _____

(Please *don't* write your id number!)

COP 5021 — Program Analysis

Midterm Exam

This test has 8 questions and pages numbered 1 through 3.
This test is open book and notes, but no electronics.
If you need more space, use the back of a page. Note when you do that on the front.
Before you begin, please take a moment to look over the entire test so that you can budget your time.
Clarity is important; if your answers are sloppy and hard to read, you may lose some points.

For Grading

Question:	1	2	3	4	5	6	7	8	Total
Points:	10	20	10	10	10	5	10	25	100
Score:									

1. (10 points) [Concepts] Briefly summarize the overall goal of your semester project (i.e., that of your group, if you are in a group).

2. (20 points) [Concepts] Describe, in English, one analysis question that your semester project needs to answer in order to achieve its goal.

3. (10 points) [Concepts] For the Reaching Definitions analysis, what makes an analysis result *more precise* (for a given program point): an answer set that is larger or one that is smaller? Answer "larger" or "smaller" and briefly justify your answer.

4. (10 points) [Concepts] For the Very Busy Expressions analysis, which is *more safe* for an analysis result at a given program point: an answer set that is larger or one that is smaller? Answer "larger" or "smaller" and briefly justify your answer.

Definitely Assigned Analysis

The following questions concern checking a WHILE language program to find what variables must have been assigned on all paths leading to a program point. We call this analysis the "Definitely Assigned" (DA) analysis.

At the beginning of the program, no variables are definitely assigned. After an assignment of the form $[x := a]^\ell$ the variable x is definitely assigned.

Consider the following example.

```
[i := 0]^1;
[j := i]^2;
if [i > 0]^3 then [m := i-j]^4 else [q := 3]^5;
[j := m-(i*q)+j]^6;
[k := j]^7
```

In this example, at the entry to block 1, no variables are definitely assigned. At exit from block 1, only `i` is definitely assigned. At the exit from block 2, both `i` and `j` are definitely assigned. At the exit from block 4, `m`, `i`, and `j` are all definitely assigned. At the exit from block 5, `q`, `i`, and `j` are all definitely assigned. At both the entry to and the exit from block 6, both `i` and `j` are definitely assigned (but not `m` or `q`). At the exit from block 7, `k`, `i`, and `j` are all definitely assigned.

5. (10 points) [Concepts] Could the Definitely Assigned analysis be formulated using a type system? Answer "yes" or "no" and briefly justify your answer. (Note: you do not have to describe an implementation technique.)

6. (5 points) [Concepts] As a dataflow analysis, would the Definitely Assigned analysis be best thought of as a forward or backward analysis? Answer "forward" or "backward" and briefly justify your answer.

7. (10 points) [Concepts] Give a definition of: (a) the set (L) that would be useful for tracking the information needed for the Definitely Assigned analysis and (b) the combination operator ($\sqcup$) that would be suitable for combining information from different paths for that the analysis.

8. (25 points) Using the property space in your answer above, write dataflow equations to formalize the Definitely Assigned analysis.