CS 553 Compiler Construction	**Midterm Examination**
Fall 2007	**October 15, 2007**

Name:

Please put your name on every sheet. The total number of possible points is 100.

Total points: 100, 20% of course grade

Good luck!

1. [20 points] Garbage Collection. For the following code,

```
class Main {
    public static void main(String[] a){ System.out.println(new Foo().testing());}
}
class Foo {
    Foo next;
    public int nextFoo(Foo p) { next = p;  return 7; }
    public int testing() {
        Foo local;  int i;  i = 0;
        while (i<N) {
            local = new Foo();  local.nextFoo(local);
            i = i + 1;
        }
        return 42;
    }
}
```

a) indicate the number of objects created by the whole program as a function of N,

b) indicate the number of objects as a function of N that will leak (not be destroyed even though it is unreachable) if a reference counting scheme is used,

c) and indicate the number of times a mark and sweep collector will be called as a function of N assuming 12 bytes of GC overhead (as in the MiniJava GC assignment), 4 bytes to store a pointer, and a 36 byte heap.

2. [20 points] Control flow and loops. For the given 3-address code,

Dominators

	ENTRY
A	j = 0
B	L1:
C	j = j + 1
D	if j < N goto L1
E	if j < M goto L2
F	x = y + z
G	L2:
H	if z > N goto L1
	EXIT

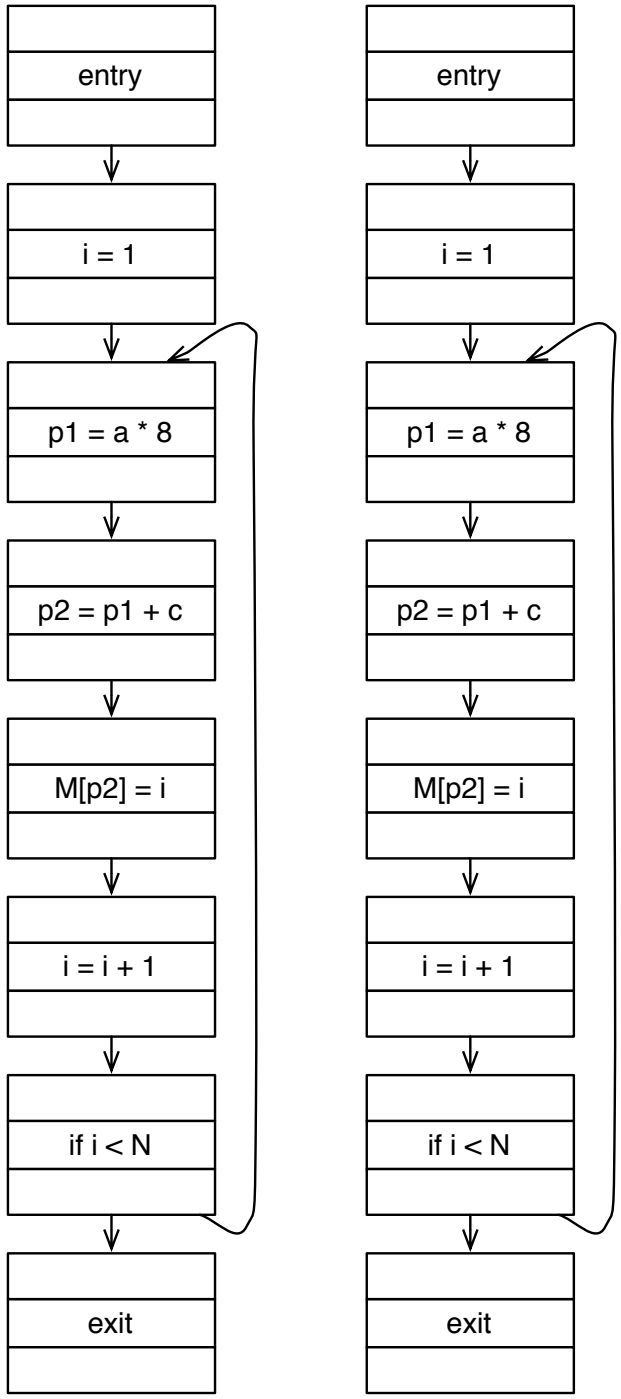
a) draw the control-flow graph (preferably in place)

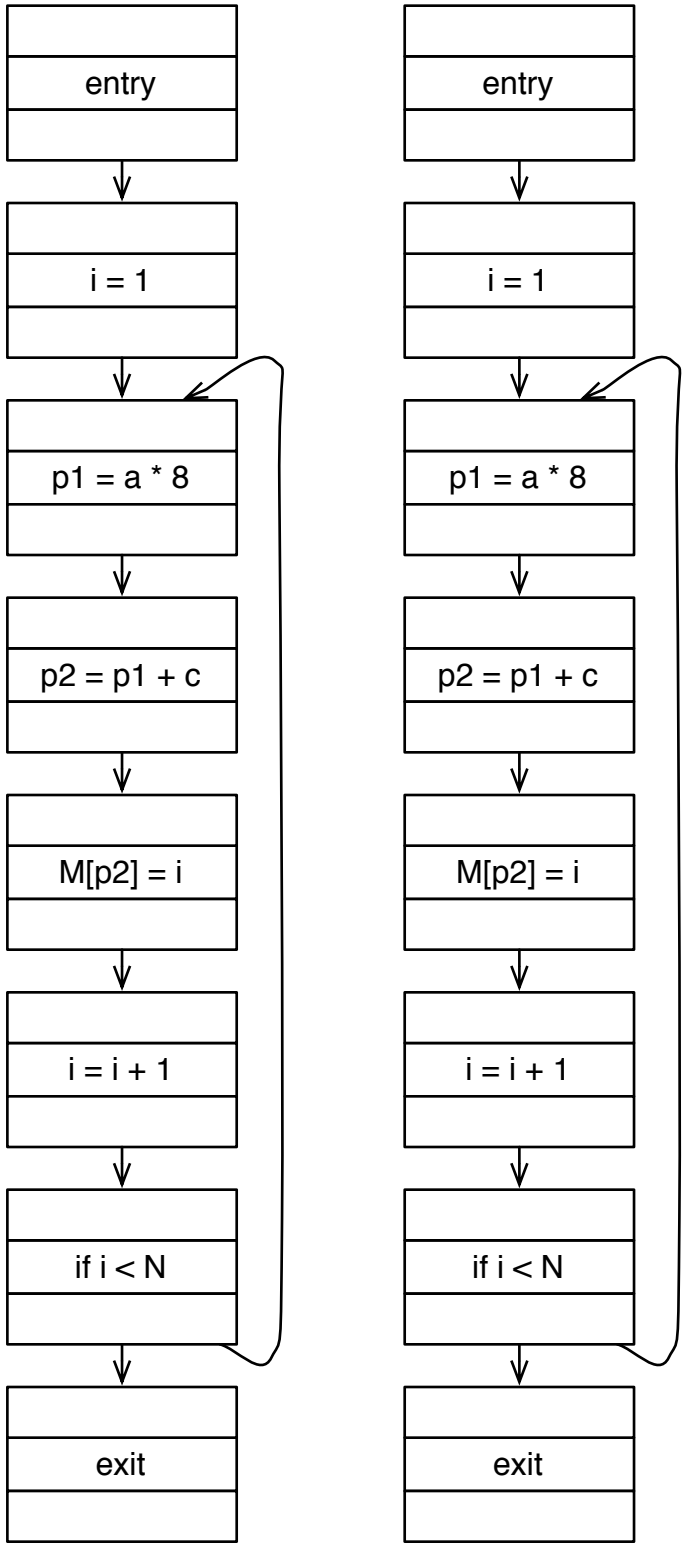
b) calculate the dominator set for each node

c) label each of the following (there can be more than one of each): pre-header, header, back edge, exit node,

d) indicate the loop(s) as set(s) of nodes.

3. [30 points] Partial Redundancy Elimination. Fill in the given control-flow graphs with anticipated, PRE availability, earliest, postponable, latest, and used expression data-flow analysis results. Label the top of each control-flow graph with the property being computed. latest and earliest should be shown next to one of the control-flow graphs. Based on the results perform PRE with the lazy code motion algorithm and write out the resulting 3-address code.




entry
i = 1
p1 = a * 8
p2 = p1 + c
M[p2] = i
i = i + 1
if i < N
exit
entry
i = 1
p1 = a * 8
p2 = p1 + c
M[p2] = i
i = i + 1
if i < N
exit

4. [20 points] After PRE. What other data-flow optimizations should follow PRE? Why? Perform the two most important on your 3-address code from problem 4.

5. [20 points] Instruction scheduling.

a) Rewrite the code resulting from problem 4 with the loop unrolled twice. Use a different set of temporaries (p#) for the second loop body. Recall that there should only be one set of loop overhead statements.

b) Draw the DAG for the new loop body. Do NOT include the branch. Assume a latency of 2 between any instructions with a flow dependence, a latency of one between output dependences, and a latency of zero between anti dependences.

c) Use list scheduling with the following priorities to find a schedule. How many cycles does the schedule require assuming only one instruction can be issued each cycle?

```
Priorities
1) Avoid stalls with previously scheduled instructions.
2) Pick instructions that interlock with the most immediate successors.
3) All else being equal pick the initial instruction ordering.
```