

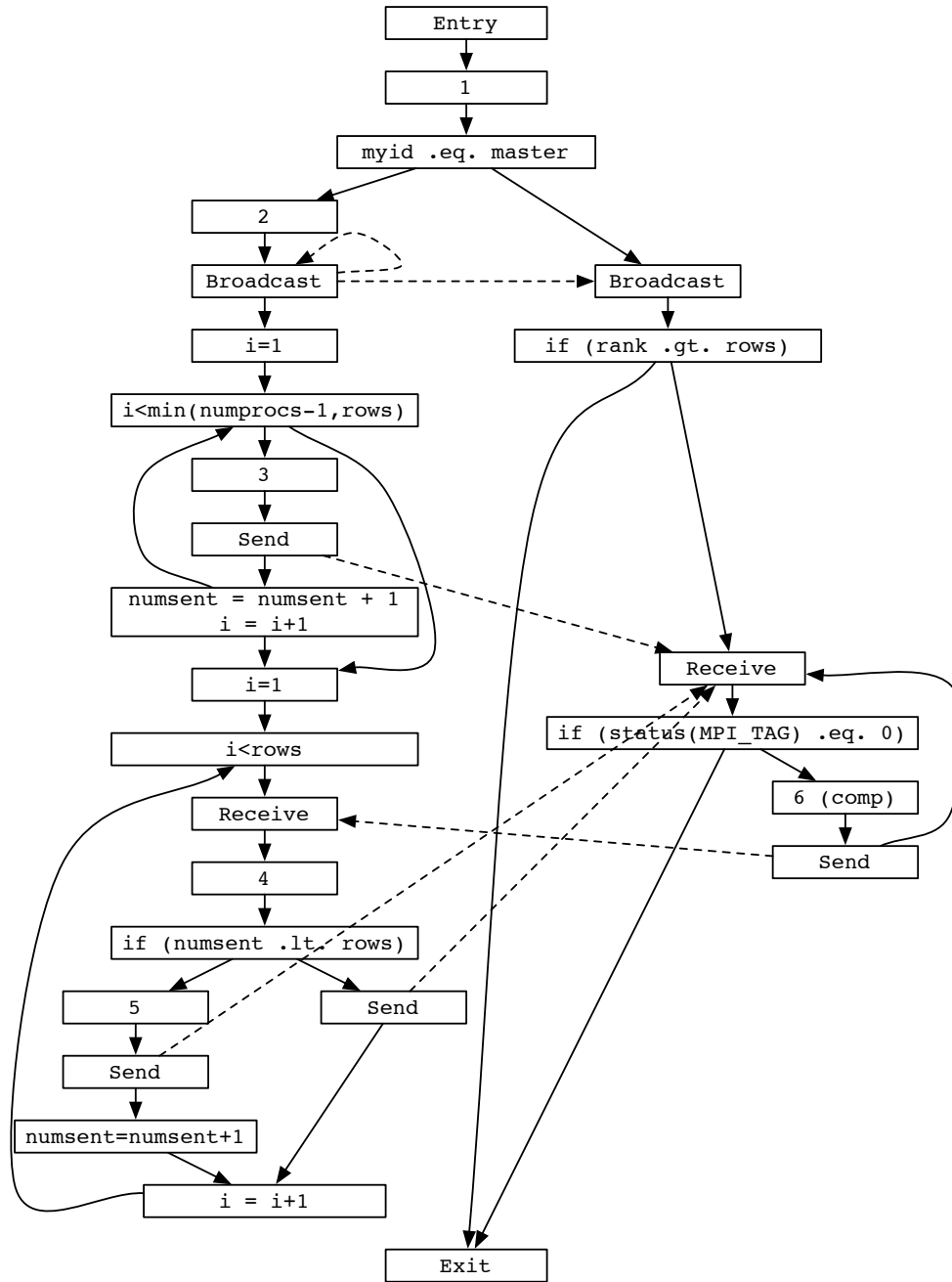
Write your answers on another sheet of paper. Homework assignments are to be completed individually. Hand written submissions are fine, but they must be readable. Due at the beginning of class. Total points: 100, 5% of course grade

1. [30 Points] Here is an example program.

```
y = ...
t = ...
a = 3 + t
b = a
c = a
x = 40
if (y<x) goto L1
    z = y + c
    x = b + 30
    goto L2
L1:
    z = y + 30
L2:
    t = z + x
```

- (a) Draw a control-flow graph for the given program.
- (b) Show the dominance frontiers.
- (c) Show the SSA representation for the given program.

2. [20 Points] Below is the MPI-CFG for a parallel version of matrix-vector multiplication. An MPI-CFG is a control-flow graph extended with communication edges to indicate possible pairings between message passing sends and receives. The nodes labeled with just numbers include more code that has been removed since the code is not immediately relevant. If the communication edges are not treated any differently than the control-flow edges, then is the graph reducible? Explain why it is reducible or not.



3. [50 Points] Consider the following code (assume that read is a function that reads input from stdin):

```
a = read()
b = read()
z = read()
w = read()
x = a + b
y = b + a
j = 0
loop:
  z = b * a
  if (z > j) goto L1
  w = a * b
  goto L2
L1:
  w = b * a
L2:
  x = a + b
  y = x
  j = j + 1
  if (j < 10) goto loop
print w,x,y,z
```

- (a) Compute the dominators for the given program.
- (b) What statements are involved in loop(s)?
- (c) Perform pessimistic global value numbering.
- (d) Perform optimistic global value numbering.