Homework 5

Due **December 15**, Monday during TA Praveen's **office hour**, TBD (Firm date/time, no exceptions)

Distance-learning students submit on **December 15, midnight** on Blackboard (no exceptions)

1 (20 pts). Perform loop invariant code motion on the program in Figure 9.10 (in the textbook). Please explain how the loop invariant operations are identified.

2 (20 pts). In ***Figure 9.9*** **in the textbook,** suppose no **scalar** variables are live after B6 is executed.

(i) Please draw the interference graph for all the scalar variables in ***Figure 9.9***. You do not need to show the work that analyzes liveness.
(ii) Assume that the processor has **six** hardware registers. Please allocate the scalar variables to registers by applying the graph simplification algorithm (presented in the lecture note) to the interference graph. Please minimize register spills, if any. Please show the code after register allocation and spilling. If the register holding variable x is spilled, we store it to Mem[x_spill], and so on. We assume every loop in this program has 10 iterations each time the loop is executed.

3 (20 pts). Please perform common sub-expression removal on the program shown in Figure 9.10 in the textbook. Explain how the available expressions are identified.

4 (20 pts). Suppose statement (1) in Figure 9.10 is modified from "a = 1" to "a = 0". Determine all other statements that will be affected by this change. Explain how they are determined. For simplicity we ignore the branch conditions (not shown) in this program.

5 (20 pts) Please transform the program in Figure 9.10 into the static single assignment (SSA) form. Please explain how the transformation is performed by showing the relevant dominance frontiers.