

CS451/551/ECE441/541 - Advanced Computer Architecture

Optional Assignment - Fall 2015

For the exercises below, consider the following code. The loop is called the DAXPY loop (**D**ouble-precision **aX** plus **Y** and is the central operation in Gaussian elimination. This code implements the operation $Y = aX + y$ for a vector of length 100. Initially, $R1 = 0$ and $F0$ contains a .

```
foo:  L.D      F2, 0(R1)    ;load X(i)
      MUL.D   F4, F2, F0   ;do a*X(i)
      L.D      F6, 0(R2)   ;get Y(i)
      ADD.D   F6, F4, F6   ;calc a*X(i) + Y(i)
      S.D      F6, 0(R2)   ;Store Y(i)
      DADDUI  R1, R1, #8   ;increment X index
      DADDUI  R2, R2, #8   ;increment Y index
      DSGTUI  R3, R1, #800 ;test if done
      BEQZ    R3, foo      ;No? Then loop again
```

1. (Static scheduling) Assuming the pipeline latencies from Figure 3.2, unroll the loop as many times as necessary to schedule it without any delays, and collapsing the loop overhead. Assume a one-cycle delayed branch. Show the schedule, and determine the number of cycles required for each iteration of the original loop.

2. (Dynamic Scheduling) For this exercise we will add timing to the Tomasulo machine shown in Figure 3.6. Assume the following:

- The number of reservation stations are as shown in Figure 3.6
- There is no forwarding between function units; results are communicated by the CDB.
- One instruction can issue at each clock cycle. Execution of the instruction can begin in the next clock cycle following issue.
- Only 1 value can be on the CDB at a time. If two instructions complete in the same clock cycle, the later instruction is stalled until the next cycle.
- Loads take 1 cycle in execution.
- Other function unit latencies are as shown in Figure C.34

Show the clock cycle when each instruction issues, starts execution, and completes (writes its result onto the CDB) for the first three iterations of the loop. Report your answer in a table similar to Figure 3.19 (Note that figure 3.19 shows a dual issue processor - we are doing a single issue example here.)