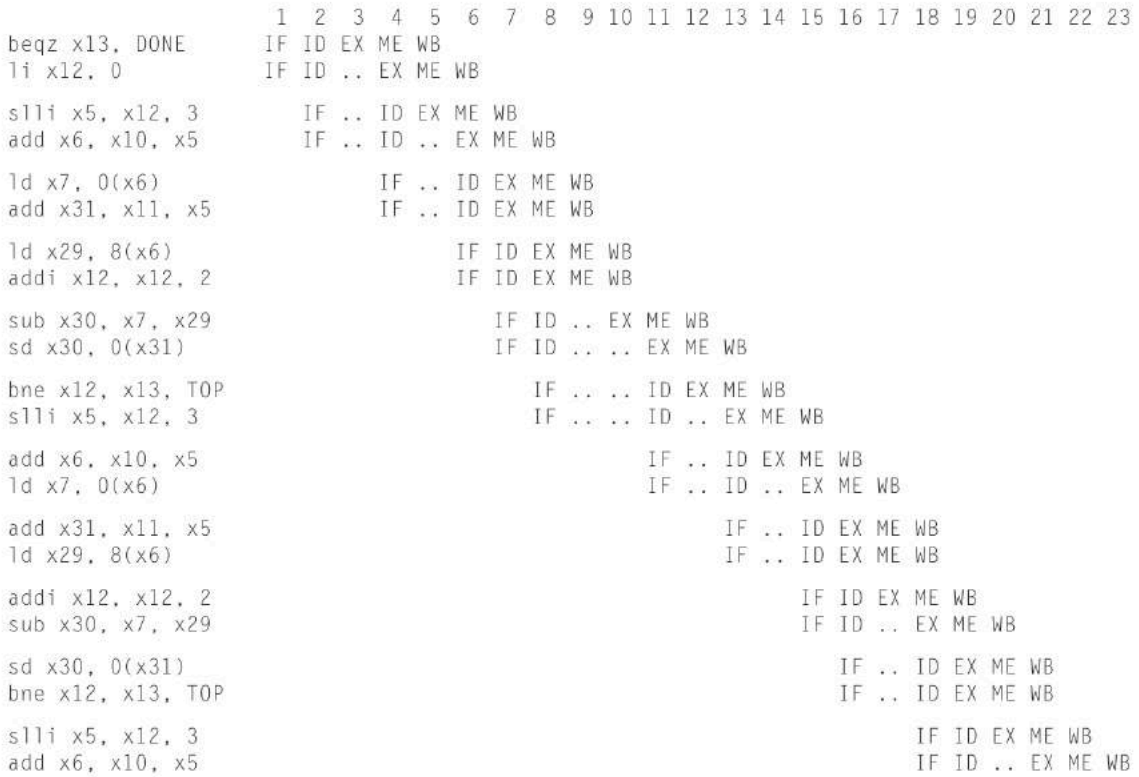
4.31.5



Note that our two issue processor has all possible forwarding logic so as soon as data is available it can be used in the next cycle. Also, since we have perfect branch prediction, we do not have any branch miss penalties and also can preemptively schedule instructions when running the unpaired bne.

Homework 6 Solutions

4.31.6

Speed from 4.31.3 - 9 cycles/iteration

It takes 9 cycles from TOP to DONE with no hazards. This is a single issue processor without any hazards, each instruction will take a single cycle once we have reached the steady state.

Speed from 4.31.4 - 7.5 cycles/iteration

We begin the first instruction for our loop at cycle 5. We complete two iterations of the loop and would start the third iteration at cycle 20. Thus, it takes us 15 cycles to complete two iterations.

Speedup = (9 cycles/iteration) / (7.5 cycles/iteration) = 1.2

4.31.7

This is one possibility. The intuition here is that we want to reduce the amount of possible hazards in our loop through two iterations.

```
    beqz x13, DONE
    li x12, 0
TOP:
    slli x5, x12, 3
    add x6, x10, x5
    add x31, x11, x5
    ld x7, 0(x6)
    ld x29, 8(x6)
    ld x5, 16(x6)
    ld x15, 24(x6)
    addi x12, x12, 4
    sub x30, x7, x29
    sub x14, x5, x15
    sd x30, 0(x31)
    sd x14, 16(x31)
    bne x12, x13, TOP
DONE:
```