CDA3101 - Spring 2015
Assignment 5
Pipelining Exercises

Objectives. Learn how instructions are pipelined and branches are predicted.

Solve the following problems. You must show your work in order to receive full credit. A hardcopy of your solution is due by the beginning of class on March 5.

(1) Fill in the traditional pipeline diagram that shows in which cycle each of the instructions in problem 1 will be in each stage of the 5-stage MIPS pipeline discussed in class. (25 points)

cycle	1	2	3	4	5	6	7	8	9	10
`or $t4,$t2,$t4`										
`lw $t3,0($t4)`										
`add $t5,$t3,$t2`										
`sw $t3,0($t5)`										

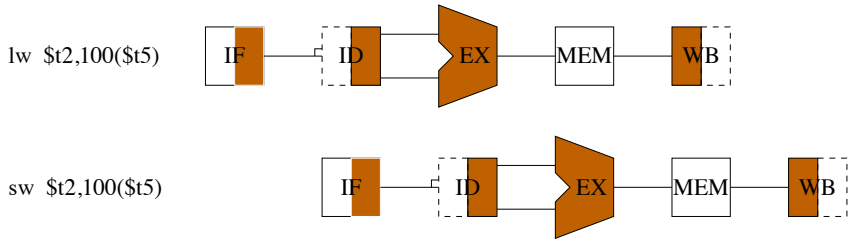
(2) Consider a code sequence consisting of 100 consecutive `lw` instructions. Except for the first instruction, each instruction uses the register that was loaded in the previous instruction as shown below. What would be the total number of cycles required for this sequence of instructions to execute given the pipelined datapath of Figure 4.65 on page 325 of your text? (25 points)

```
lw $t2,0($t1)
lw $t2,0($t2)
...
```

(3) Consider an instruction sequence used for a memory-to-memory copy.

```
lw   $t2,100($t5)
sw   $t2,200($t6)
```

The value in `$t2` to be stored into memory by the `sw` is actually not needed until *MEM* stage of the MIPS pipeline. Below is a drawing showing the two instructions being pipelined. Modify this figure in a manner similar to Figure 4.29 on page 279 of your text to show how the value could be forwarded to avoid a stall.



Rewrite the following stall formula so this code sequence won't stall. (25 points)

```
if (ID/EX.MemRead AND
    (ID/EX.RegisterRt == IF/ID.RegisterRs OR
     ID/EX.RegisterRt == IF/ID.RegisterRt) AND
    ID/EX.RegisterRt != 0)
  stall the pipeline
```

(4) Fill in the following branch prediction information for the table below for the various types of branch predictors for the predictions of a single branch in an application. Assume the initial state of the 1-bit predictor is not taken and the initial state of the 2-bit predictor is the bottom right state in Figure 4.63. (25 points)

branch result	1-bit predictor		2-bit predictor	
	prediction	correct?	prediction	correct?
taken				
taken				
not taken				
taken				
taken				