**Computer Architecture Homework #3**

**Lecturer: Nachum Danzig**

**Topic: the Single Cycle processor**

**Question 1:**

Relate to the single-cycle configuration of the MIPS processor. We want to add to it the functionality for the jr instruction so that the chip will be able to handle this instruction. Assume that the command is in the I format even though in the instruction manual the instruction is listed as R type.

1. Describe what physical changes need to be made to the chip (adding elements, wires)
2. What will be the values on the control lines for the new instruction?
3. If you have added a new control line, specify what its value will be for all other instructions.

**Question 2:**

Relate to the single-cycle configuration of the MIPS processor. Add to the processor the following new instructions: lw rd, rs, rt. This instruction will calculate the memory address given by the sum rs + rt. The value of the word at that memory address will be placed in rd.

Note: The command is neither in the R format or the I format (because it contains three registers and also accesses the memory) . This means we must change the controller to recognize this new format.

Example: The command lw $s0, $s1, $s2 would add the values in $s1 and $s2 and the arrived at value will be the address of the desired datum. That datum will be placed in $s0.

1. Describe what physical changes need to be made to the chip (adding elements, wires)
2. What will be the values on the control lines for the new instruction?
3. If you have added a new control line, specify what its value will be for all other instructions.
4. Describe all the steps for the execution of the command.

**Question 3:**

What are the values of the control lines in the single cycle configuration of MIPS for the command addi?

**Question 4:**

Relate to the single-cycle configuration of the MIPS processor. Add to the processor the following new instruction, jal.

1. Describe what physical changes need to be made to the chip (adding elements, wires)
2. What will be the values on the control lines for the new instruction?
3. If you have added a new control line, specify what its value will be for all other instructions.

**Question 5:**

A new instruction was defined in the MIPS chip set, beqal rs,rt,label. It is of type I. This instruction jumps to label if rs == rt. In addition, if the jump is in fact executed, the return to location (PC+4) is stored in $ra. The address of jump to location will be calculated in the same way as it is calculated for the BEQ instruction.

1. Update the data path of the single cycle MIPS so that it will support the new instruction.Use the solution the requires the minimum number of changes. Explain your changes.
2. What will be the values on the control lines for the new instruction?

**Question 6:**

In a single cycle MIPS based computer that a student built in the course Computer Architecture a flaw was discovered. The zero line leaving the ALU was always 1.

1. Given an example of a command that will no longer function properly. Specify if it is type J, I or R. Explain your answer.
2. Give two (2) examples of instructions (of different types) which will not be adversely affected by this flaw. Give the type of each instruction.
3. On this computer the following program was run (assume the following initializations $1=1, $2=2, $3 = 100):

beq $1, $2, label

addi $3, $3, **5   
 j continue**

**label : addi $3 , $3 ,** 7

continue : ……….

Once the computer reaches the address indicated by the label continue, what will the value of the following registers $1, $2, $3 be assuming there is no flaw in the computer? What will those values be with the flaw present?

Success!!