CSEE 3827: Homework 5 — Due: 4/20/11

1. Suppose you wish to run a program P with 7.5×10^9 instructions on a 5GHz machine with a CPI of 0.8. What is the expected CPU time?

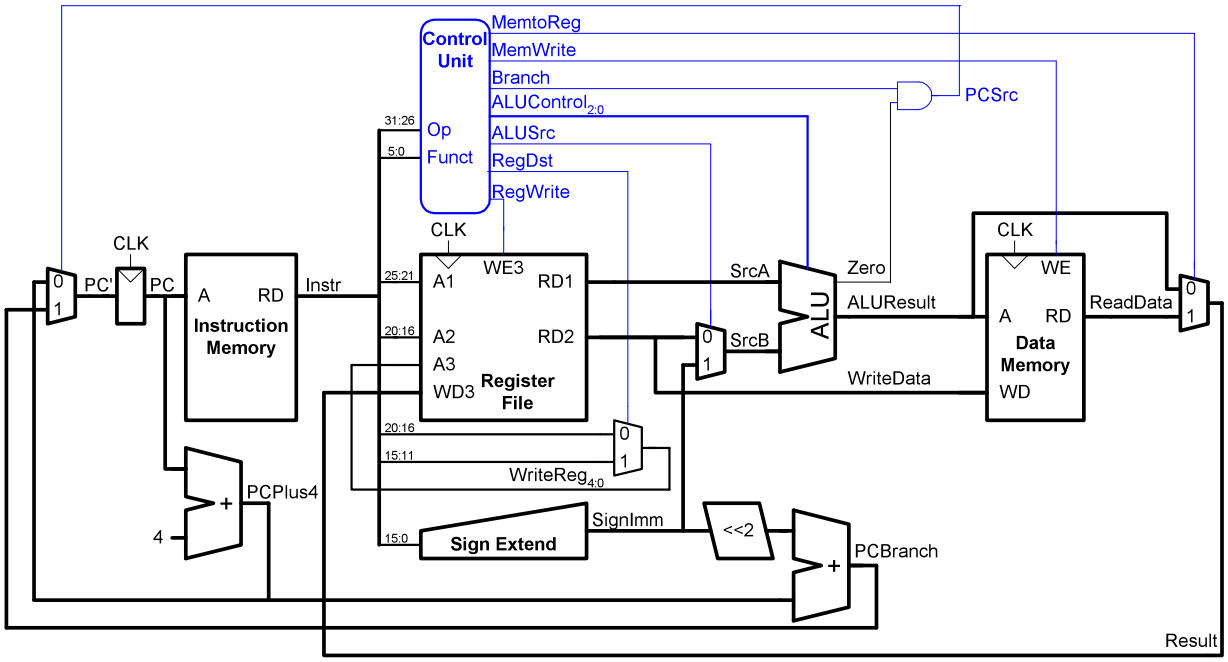
2. For the following set of variables, identify all of the subsets that can be used to calculate execution time. Each subset should be minimal (i.e., it should not contain any unnecessary variables. $CPI, clockrate, cycletime, numberofinstructionsinprogram, numberofcyclesinprogram$

3. Show how to add the `linc` ("load increment") instruction to the single-cycle MIPS processor. Start from the base processor implementation shown on the last page of this assignment. This instruction corresponds to the following sequence of two instruction: `lw $rt, L($rs)` then `addi $rs, $rs, 1`. Add all necessary datapaths and control signals to the processor.

4. Show how to implement the instruction `swap $rs, $rt`, which swaps the contents of registers $\$rs$ and $\$rt$. As before, start your design from a clean base processor.

5. One could always have executed two instructions to carry out the swap operation. Call this the software implementation of swap. Imagine your hardware implementation of swap (from the previous problem) increased the clock period by 10%. What percentage of swap operations in the instruction mix would make it worthwhile to implement in hardware rather than using the two software instructions?

Datapath:



Control (Main Decoder):

Instruction	$Op_{5:0}$	RegWrite	RegDst	AluSrc	Branch	MemWrite	MemtoReg	$ALUOp_{1:0}$
R-type	000000	1	1	0	0	0	0	10
`lw`	100011	1	0	1	0	0	0	00
`sw`	101011	0	X	1	0	1	X	00
`beq`	000100	0	X	0	1	0	X	01

Control (ALU Decoder):

$ALUOp_{1:0}$	Funct	$ALUControl_{2:0}$
00	X	010 (Add)
X1	X	110 (Subtract)
1X	100000 (`add`)	010 (Add)
1X	100010 (`sub`)	110 (Subtract)
1X	100100 (`and`)	000 (And)
1X	100101 (`or`)	001 (Or)
1X	101010 (`slt`)	111 (SLT)