Name: **Id#**

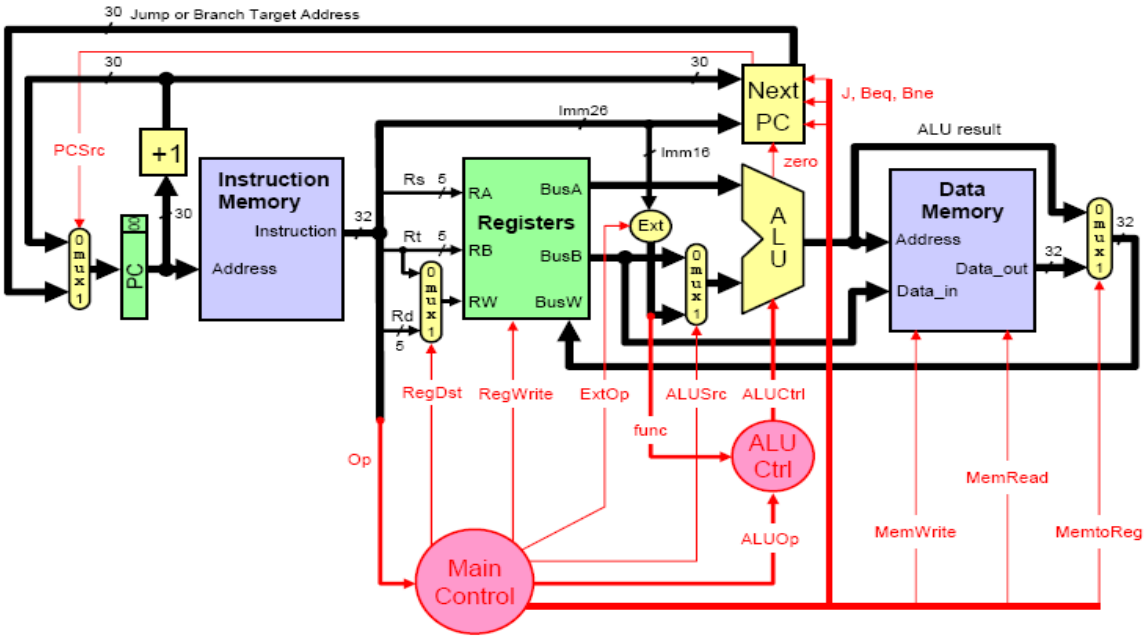
ICS 233, Term 141

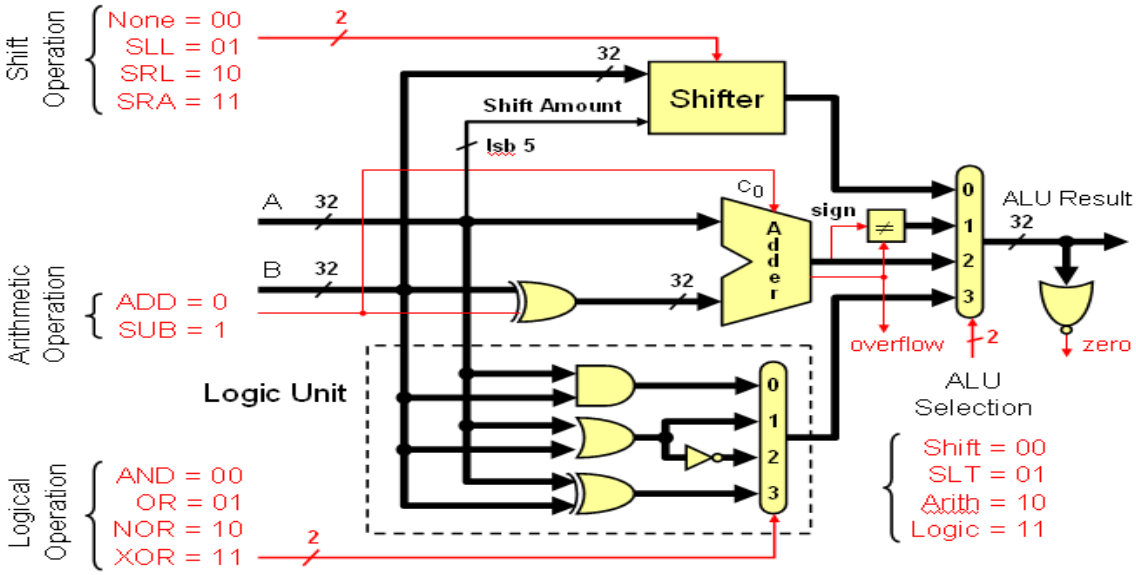
Computer Architecture & Assembly Language

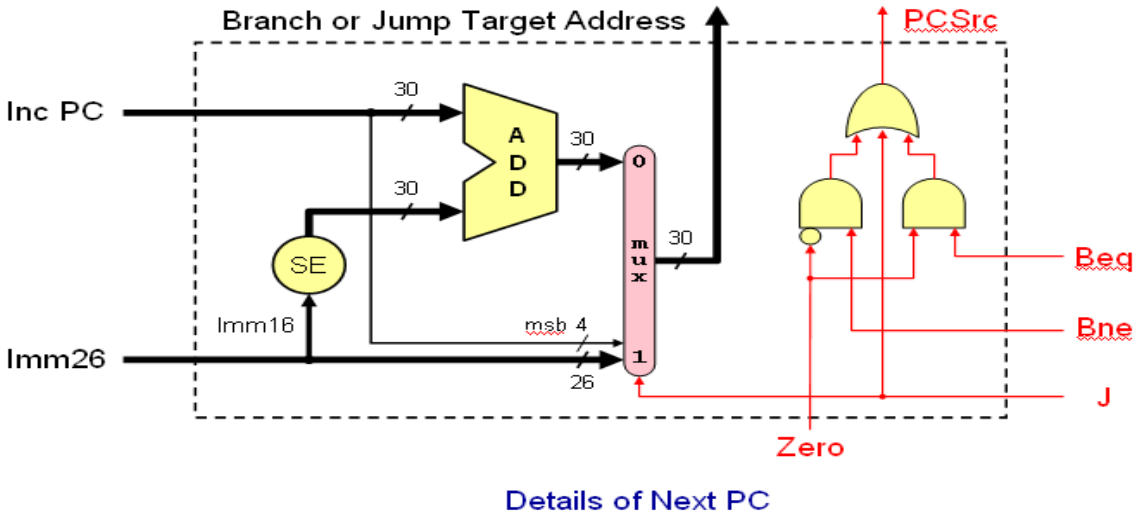
Quiz# 6

Date: Monday, Dec. 22, 2014

Q1. Consider the single-cycle datapath and control given below along with ALU and Next PC blocks design for the MIPS processor implementing a subset of the instruction set:







Details of Next PC

(i) Show the control signals generated for the execution of the following instructions by filling the table given below:

Op	RegDst	RegWrite	ExtOp	ALUSrc	ALUOp	Beq	Bne	J	MemRead	MemWrite	MemtoReg
R-type											
xori											
lw											
bne											

The format of these instructions is given below for your reference:

Instruction		Meaning	Format					
sub	rd, rs, rt	rd = rs - rt	$Op^6 = 0$	rs^5	rt^5	rd^5	0	0x22
xori	rt, rs, imm^{16}	rt = rs ^ imm^{16}	0x0e	rs^5	rt^5	imm^{16}		
lw	rt, imm^{16}(rs)	rt = MEM[rs+imm16]	0x23	rs^5	rt^5	imm^{16}		
bne	rs, rt, label	branch if (rs != rt)	0x05	rs^5	rt^5	imm^{16}		

(ii) We wish to add the following instructions to the MIPS single-cycle datapath. Add any necessary datapath modifications and control signals needed for the implementation of these instructions. Show only the **<u>modified</u>** and **<u>added</u>** components to the datapath. Show the values of the control signals to control the execution of each instruction.

a. lui

Instruction		Meaning	Format			
lui	rt, imm^{16}	rt= imm^{16} << 16	$Op^6 = 0xf$	0	rt^5	imm^{16}

b. sltiu

Instruction	Meaning	Format			
sltiu rt, rs, imm^{16}	rt=(rs<imm?1:0)	Op^6 = 0xb	rs^5	rt^5	imm^{16}

c. bgtz

Instruction	Meaning	Format			
bgtz rs, label	branch if (rs>0)	Op^6 = 7	rs^5	0	imm^{16}

(iii) Assume that the propagation delays for the major components used in the datapath are as follows:

- Instruction and data memories: 150 ps
- ALU and adders: 100 ps
- Register file access (read or write): 60 ps
- Main control: 20 ps
- ALU control: 20 ps

Ignore the delays in the multiplexers, PC access, extension logic, and wires. What is the cycle time for the single-cycle datapath given above?