

**The University of Alabama in Huntsville**  
**ECE Department**  
**CPE 431 01**  
**Test 1**  
**October 7, 2014**

**Name:** \_\_\_\_\_

1. (1 point) A \_\_\_\_\_ belongs to the class of computers with the highest performance and cost.
2. (1 point) An \_\_\_\_\_ is the supervising program that manages the resources of a computer for the benefit of the programs that run on the computer.
3. (1 point) \_\_\_\_\_ is the number of tasks completed per unit time.
4. (1 point) A \_\_\_\_\_ is a program selected for use in comparing computer performance.
5. (1 point) A \_\_\_\_\_ is the smallest individual picture element.
6. (15 points) In a von Neumann architecture, groups of bits have no intrinsic meanings by themselves. What a bit pattern represents depends entirely on how it is used. What decimal number does the bit pattern 0xFDCB A987 represent if it is a floating point number? Use the IEEE 754 standard.

7. (15 points) Translate the following C code to MIPS. Assume that the variables `f`, `g`, `h`, `i`, and `j` are given and are assigned to registers `$s0`, `$s1`, `$s2`, `$s3`, and `$s4`, respectively. Assume that the base address of the arrays `A` and `B` are in registers `$s6` and `$s7`, respectively. Assume that the elements of the arrays `A` and `B` are 4-byte words:

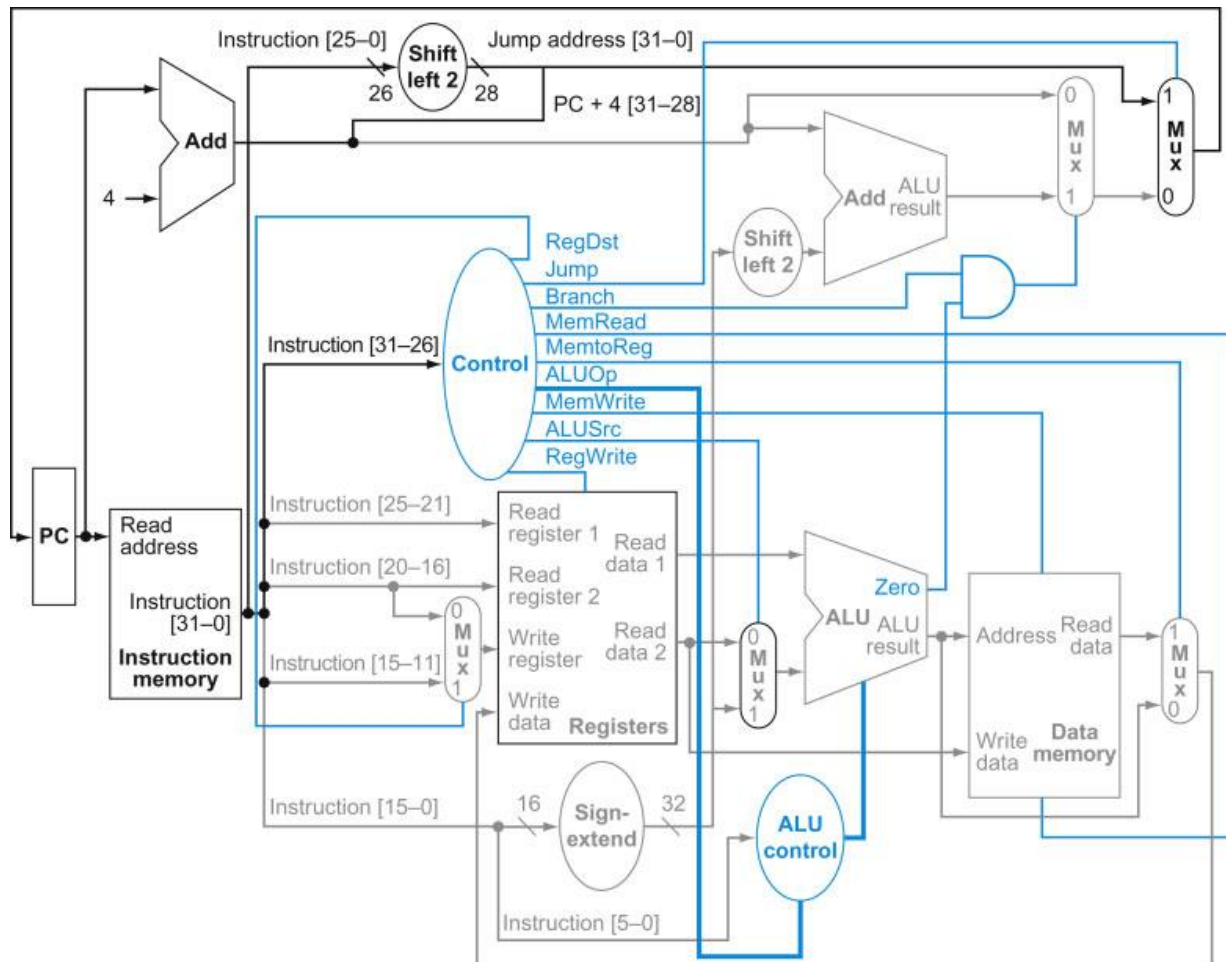
```
B[j] = A[i] + B[8]
```

8. (10 points) Provide the type and hexadecimal representation of the following instruction:
- ```
jr    $s3
```

9. (20 points) When processor designers consider a possible improvement to the processor datapath, the decision usually depends on the cost/performance trade-off. In the following three problems, assume that we are starting with the datapath shown.

| Element      | I-Mem  | Add | Mux | ALU | Regs | D-Mem | Control | ALU Control | Sign Extend | Shift Left 2 |
|--------------|--------|-----|-----|-----|------|-------|---------|-------------|-------------|--------------|
| Latency (ps) | 400 ps | 100 | 30  | 120 | 200  | 350   | 100     | 70          | 10          | 20           |

- a. (15 points) What is the clock cycle time for this datapath?  
 b. (5 points) How would it change if the control time was 300 ps rather than 100 ps?



10. (20 points) The results of the SPEC CPU2006 bzip2 benchmark running on an AMD Barcelona has an instruction count of  $3.256 \times 10^{12}$ , an execution time of 750 s, and a reference time of 9650 s. Suppose that we are developing a new version of the AMD Barcelona processor with a 3.5 GHz clock rate. We have added some additional instructions to the instruction set in such a way that the number of instructions has been reduced by 15%. The execution time is reduced to 680 s and the new SPECratios is 13.7.
- (10 points) Find the new CPI.
  - (10 points) Determine the clock rate required to give a further 10% reduction in CPU time while maintaining the number of instructions and with the CPI unchanged.

11. (15 points) Consider the following code executing on a MIPS five stage pipeline that has full forwarding and in which branches are resolved in the ID stage. Neglecting pipeline fill, how many cycles does it take to execute this code, given the branch taken/not taken information given in the comments?

```
        lw      $t2, 0($t1)
label1: beq     $t2, $zero, label2    # not taken once, then taken
        lw      $t3, 0($t2)
        beq     $t3, $zero, label1    #taken
        add     $t1, $t3, $t1
label2: sw      $t1, 0($t2)
```