



**METRO STATE
UNIVERSITY**

**ICS 232 Computer Organization & Architecture
Homework 6 - Chapter 5 - 10 points
Due Date: 6/21/2023**

Name: Key

Note: Please post your homework to ICS232 D2L on or before the due date.

Chapter 5 – A Closer Look at Instruction Set Architectures

Essential Terms and Concepts

11. Name the seven types of data instructions and explain each.

1. Data movement - move data between registers and memory
2. Arithmetic operations – add, subtract, multiply, divide
3. Boolean logic instructions – and, or, xor, not
4. Bit manipulation instructions – shift, rotate
5. Input/output instructions – control devices
6. Instructions for transfer of control – conditional and unconditional jumps, subroutine call
7. Special purpose instructions – string processing, memory protection

12. What is the difference between an arithmetic shift and a logical shift?

A right arithmetic shift sign extends while a right logical shift zero fills.

14. What is an addressing mode?

1. immediate – operand is part of the instruction
2. direct – address of the operand is part of the instruction
3. register / indirect – register provides address of the operand
4. Variations of 2 and 3.

18. Explain the concept behind instruction pipelining.

The fetch, decode, and execute cycles are overlapped to improve performance.



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Exercises

1. Assume you have a byte-addressable machine that uses 32-bit integers and you are storing the hex value 3456 at address 0.

- a) Show how this is stored on a big endian machine.
- b) Show how this is stored on a little endian machine.

```
Address      00 01 10 11
Big Endian   00 00 34 56
Little Endian 56 34 00 00
```

11. Convert the following expressions from infix to reverse Polish (postfix) notation.

- a) $(8 - 6) / 2$
- b) $(2 + 3) * 8 / 10$
- c) $(5 \times (4 + 3) \times 2 - 6)$

- a) $8\ 6\ -\ 2\ /\$
- b) $2\ 3\ +\ 8\ *\ 10\ /\$
- c) $5\ 4\ 3\ +\ \times\ 2\ \times\ 6\ -$

14. Convert the following expressions from reverse Polish notation to infix notation.

- a) $W\ X\ Y\ Z\ -\ +\ *$
- b) $U\ V\ W\ X\ Y\ Z\ +\ *\ +\ *\ +$
- c) $X\ Y\ Z\ +\ V\ W\ -\ *\ Z\ +\ +$

- a) $W * (X + Y - Z)$
- b) $U + (V * (W + (X * (Y + Z))))$
- c) $X + ((Y + Z) * (V - W) + Z)$



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18. Suppose a computer has an instruction format with space for an opcode and either three register values or one register value and an address. What are the various instruction formats that could be used for an ADD instruction on this machine?

Format 1: ADD R1, R2, R3

where R1 is the destination and R2 and R3 are sources. We could also use R3 as the destination and R1 and R2 as sources

Format 2: ADD R1, addr

where addr holds the contents of memory we wish to add to the value in R1

20. What is the difference between using direct and indirect addressing? Give an example.

Direct addressing provides the actual memory address of the operand in the instruction, whereas indirect addressing provides, as part of the instruction, a pointer to a memory location. For example, the instruction Load X interpreted using direct addressing would go to memory location X and load the value found there. Using indirect addressing, memory location X would be used as the effective address of what should actually be loaded. So if a value of 200 were found at location X, the value located at address 200 would be loaded.

23. A nonpipelined system takes 200ns to process a task. The same task can be processed in a 5-segment pipeline with a clock cycle of 40ns. Determine the speedup ratio of the pipeline for 200 tasks. What is the maximum speedup that could be achieved with the pipeline unit over the nonpipelined unit?

$$\text{SpeedUp} = (200\text{ns} \times 200) / ((5 + 200 - 1)(40\text{ns})) = 40000/8160 = 4.9019$$
$$\text{Max SpeedUp} = 5$$

True or False

3. An instruction takes less time to execute on a processor using an instruction pipeline than on a processor without an instruction pipeline.



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False, the pipeline just executes different steps simultaneously.

10. The effective address of an operand is the value of its actual address in memory.

True

Prepare for next class by reading lecture notes Irvine Chapter 2 and 4

Prepare for Mid-Term exam next week.

Continue working on Project 1

Continue working on Your Group Project