



**METRO STATE  
UNIVERSITY**

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

**Name:**

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.

Data movement: data moved from memory into registers, registers to registers, and from registers to memory, and different sources along with their destinations

Arithmetic operations: instructions that use numbers, ADD, SUBTRACT, MULTIPLY, DIVIDE, INCREMENT

Boolean logic instructions: perform boolean operations. AND, OR, XOR, NOT

Bit manipulation: setting/resetting individual bits of given data, shift then rotate instructions

Input/Output: input transfers data from a device/port into memory/register. Output transfers data from register/memory to device/port

Instructions for Transfer of Control: alter normal sequence of program execution Include branches, skips, procedure calls, returns, and program termination

Special purpose Instructions: string processing, language support/protection, flag control, word/byte conversions, and all others that don't fit into previous categories

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

Logical shift: treat number as unsigned number

Arithmetic shift: treat number as a signed number

14. What is an addressing mode?

Addressing mode: refers to the way in which the operand of an instruction is specified, specifies rules for interpreting/modifying the address field of the instruction before the operand is actually executed



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18. Explain the concept behind instruction pipelining.

Instruction pipelining: a technique where multiple instructions are overlapped during execution. Pipeline divides stages into fetch, decode, and execute cycles

**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)  $X\ Y\ Z + V\ W - * Z + +$



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

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?

Option 1) ADD R1, R2, R3 where R1 is the destination and R2 & R3 are the sources

Option 2) ADD R1, address where address is the content of memory to add into R1

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

Direct addressing: contains the concerned operand in the instruction code's address field

Indirect addressing: operand's address stays in the address field

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?

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

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

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**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**