

Comp 3350: Computer Organization & Assembly Language

HW # 2: Theme: x86 Organization Basics

All main questions carry equal weight.

(Credit awarded to only those answers with work shown)

1. Name all eight 32-bit general-purpose registers. What is the general function of each of the registers? Which of these registers can be addressed in parts?

Ans:

- 32-bit general-purpose registers: EAX, EBX, ECX, EDX, EDI, ESI, EBP, ESP 4 points
- General-Purpose 4 points
 - EAX – accumulator
 - ECX – loop counter
 - ESI, EDI – index registers
 - EBP – extended frame pointer (stack)
 - ESP – stack pointer
- EAX, EBX, ECX, EDX can be addressed in parts 4 points

2. What do the Sign Flag, Zero Flag, Auxiliary Carry Flag, and Parity Flag indicate when set?

Ans:

3 points * 4

- The Sign flag (SF) is set when the result of an arithmetic or logical operation generates a negative result.
- The Zero flag (ZF) is set when the result of an arithmetic or logical operation generates a result of zero.
- The Auxiliary Carry flag (AC) is set when an arithmetic operation causes a carry from bit 3 to bit 4 in an 8-bit operand.
- The Parity flag (PF) is set if the least-significant byte in the result contains an even number of 1 bits. Otherwise, PF is clear. In general, it is used for error checking when there is a possibility that data might be altered or corrupted.

3. What do the Overflow Flag and Carry Flag indicate when set? How do they differ?

Ans:

6 points * 2

- The Carry flag (CF) is set when the result of an unsigned arithmetic operation is too large to fit into the destination. The Overflow flag (OF) is set when the result of a signed arithmetic operation is too large or too small to fit into the destination.
- The difference is the CF is used for unsigned arithmetic operations while the OF is used for signed arithmetic operations.

4. Detail the process by which instructions and data are read from memory.

Ans: The steps are:

3 points * 4

1. Place the address of the value you want to read on the address bus.
2. Assert (changing the value of) the processor's RD (read) pin.
3. Wait one clock cycle for the memory chips to respond.
4. Copy the data from the data bus into the destination operand

5. What do you understand by Cache memory and what are its benefits?

Ans:

6 points * 2

A cache is a high-speed memory that store the most recently used instructions and data.
It reduces the amount of time spent reading and writing memory

6. What do you understand by Real-address mode, Protected mode, Multi-segment model? *Discuss in detail*

Ans:

4 points * 3

- Real-address mode:
 - Real-address mode is also called 16-bit mode because addresses are constructed from 16-bit values. It implements the programming environment of an early Intel processor with a few extra features
 - Only 1 MByte of memory can be addressed, from hexadecimal 00000 to FFFFF. The processor can run only one program at a time, but it can momentarily interrupt that program to process requests (called interrupts) from peripherals. Application programs are permitted to access any memory location, including addresses that are linked directly to system hardware.
- Protected mode
 - Protected mode is the native state of the processor, in which all instructions and features are available. Programs are given separate memory areas named segments, and the processor prevents programs from referencing memory outside their assigned segments.
 - Protected mode is the most robust and powerful, but it does restrict application programs from directly accessing system hardware.
 - The processor can run multiple programs at the same time. It assigns each process (running program) a total of 4 GByte of memory. Each program can be assigned its own reserved memory area, and programs are prevented from accidentally accessing each other's code and data. MS-Windows and Linux run in protected mode.
- Multi-segment model
 - Each program has a local descriptor table (LDT) that holds descriptor for each segment used by the program

7. In a 32-bit computer what are the maximum memory amounts that can be addressed in (a) real-address mode (b) protected mode? What is the linear address corresponding to the following segment-offset: 07B4:0238?

Ans:

- The maximum memory amounts
 - (a) Real-address mode: 1MB 3 points
 - (b) Protected mode: 4GB 3 points
- The linear address = adjusted segment value + the offset = $07B40 + 0238 = 07D78$ 6 points

8. Let us say your computer is running at 3 GHz. You come to know that the Sub instruction takes 6 clock periods in your computer. Express the time taken by the Sub instruction in nanoseconds.

Ans:

clock cycle duration = $1 / \text{frequency} = 1 / 3\text{GHz} = 1/3 \text{ nanoseconds}$ 6 points

the time taken by the Sub instruction = clock cycle duration \times #clock
 $= 1/3 \text{ nanoseconds} \times 6 = 2 \text{ nanoseconds}$ 6 points